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Editor

The research in Artificial intelligence field aims to design and develop software able to perform tasks that require usually some form of human intelligence. Several techniques have been developed to program systems that can, to some extent, reasoning, learning, planning and taking rational decisions in many areas or to understand and speak in natural language. Current artificial intelligence technologies include voice interfaces, expert systems, mobile robots and intelligent web assistants. These technologies are certainly significant, but the ultimate goal of having machines capable of competing with human intelligence in all aspects remains elusive. The aim is therefore to introduce the principles of solving a given problem using the various techniques of artificial intelligence.

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NCAIIT'21

جامعة الشاذلي بن جديد
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The impact of immersive technologies in our daily life

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Informations

KEYWORDS:

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Virtual Reality (VR)
Augmented Reality (AR)
Mixed Reality (MR)
Immersive Videos (IV)

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Abstract

We began this year with the same picture we did last year due to the pandemic. In the whole world, communication and meet with each others are no longer possible, which leads the governments of all countries to resort to video call communication Visio conference using software such ZOOM. This latter is also being used in so many domains and with regard to the academic field, specially teaching. The Visio conference way comes short, in other words it is not as effective as the traditional technique therefore the IT (information technology) section takes place the immersive technologies to come out with optimal solutions. In this paper, we will discuss the efficient use of immersive technologies in improving virtual communication and meeting in many fields such as academic, politics, psychology, … But not only, Immersive technologies are used also to facilitate training with simulation techniques, effectively used by virtual shopping, education, army training, medicine, physical rehabilitation, etc.

1. Introduction

With the evolution of technology into our daily life, we now live in the world of experience driven global connectivity, people share moments on social media, people learn from YouTube… Technology has never been the same in the past, technology is developed in order to help us share stories many aspects of our lives better than we have ever before. The rise of immersive technologies is giving us new opportunity to carry the communication road through direct experiences.

Most people think that virtual augmented realities can only be used in entertainment and gaming but the immersive technologies have revealed a power of key communication gasps, we would like to explore it with you a few ways how.

We propose in this paper to discuss the effect of immersive technologies in our lives in current pandemic situation and in which field those technologies are the most applied and helping. In fact, since we cannot attend courses, talking face-to-face with colleagues or sharing moment outside with friends, we are more using social networks, videoconferencing and tele-working to keep in touch whether in a professional or friendly context. For this purpose, people have turned to immersive technologies such as VR (virtual reality) that immerse yourself completely in a digital world using VR goggles. AR (augmented reality), which allows you to place digital objects into the real world seeing without manipulation. MR(mixed reality, which is about interact with digital objects that are superimposed onto the real world using Hololens, IV (immersive videos) are spherical videos based on video recordings in all directions at the same time.

The paper is organized as follow. In the second section, we will discuss related work. In the third section, we will introduce immersive technologies and their methods such as virtual reality, mixed and augmented reality. The different application domains of immersive technologies will be presented in the fourth section. We will finish the article with the section of conclusion and some perspectives.

2. Related work

Many research works were done in the field of immersive technologies. Our study aims to review the impact of the immersive technologies on all the aspects of the communication and in the use of simulation technique in some particular areas.

Staler **[1]** defined immersive technology as technology that offers a high quality or quantity of sensory information to the use, while, Lee et al.**[2]** defined it as technology that blurs the lines between the physical and virtual worlds.

Honda et al. **[3]** studied the challenges and the opportunities of immersive technologies. They underlined the use of immersive technology as a management tool where they focused on virtual and augmented realities (VR and AR), haptic technology

and tele-immersion. Sharm et al. **[4]** discussed how the immersive technologies could influence software engineering. Hall et al. **[5]** analyzed the promise and the peril of immersive technologies by focusing on augmented and virtual reality methods. Calvet at al. **[6]** reviewed the basics and the main application of immersive technologies in higher education in order to enhance e-learning.

The table below summarizes some research works and studies on the application of immersive technologies in different fields.

Table 1. Summary of literature review on immersive technologies

Year	Authors	discussed methods	Application	Deduction
2015	Shelton et al. **[7]**	VR, AR and MR	Games and robotics	A variety of immersive technologies used with elderly people were effective
2018	Feng et al. **[8]**	Immersive virtual reality (IVR) based serious games (SGs)	Game	IVR based SGs methods attracted more attention because they are highly engaging and promote greater cognitive learning
2021	Khan et al. **[9]**	ImTs system including VR, AR and MR	The construction Industry	Integration level of ImTs was relevant for academicians and professional industry
2020	Elghaish et al. **[10]**	Drones based on immersive technologies		The use of immersive technology helped in digital transformation of the construction industry
2019	Checa and Bustillo**[11]**	VR and game based approach	Learning and training tasks	The use of VR combined to game based approach enhanced learning and training methodologies
2019	Lorenzo and Lorenzo **[12]**	AR and VR	Education	Using VR and AR technologies helped students to better understand their projects
2020	Hamilto et al. **[13]**	VR and Head-Mounted-Displays (HMD)		HMD allowed students to explore complex subjects in a way that traditional methods cannot.
2020	Radianti et al. **[14]**			The interest in immersive VR technologies for educational purposes increased these last years.

Immersive technologies are more considered now in the current pandemic situation in the world. In fact, the application of immersive technologies brought solution during Covid'19, such as in healthcare education **[15]**, data protection **[16]** and virtual tourism using extended reality **[17].**

3. Immersive technologies and their methods

In the real world, immersive technologies have unearthed a power to solve key communication gaps, for the uninitiated the premise of immersive technology is quite simple, virtual reality is a fully enclosed digital environment that replaces user's world environment, augmented reality is a digital overlay into the real-world environment and mixed reality is combination hybrid of AR and VR or physical digital.

Immersive sensory feeling and 360 is an omnidirectional view, something like this can achieved using a 360 capture camera.

Immersive exhilarating connected experiences. To those who has sensation can start experimenting with 360 capture devises and bringing them along to shows the covered experience; putting the 360 footage into VR camera via a headset enables a wraparound view when you looked inside, it allows you to live vicariously and visually. This experience broke down social boundaries and connected people together better.

Immersive mediums like VR and AR can be worth a thousand pictures and videos.

This technology can be used as an empathy for raising awareness fundraising, education, storytelling mission, goals to outcomes.

3.1. Virtual Reality (VR)

The history of the virtual reality (VR) is fascinating; there are many different stages of development of virtual reality **[6]**, which are:

- In 1968 – The first VR HMD, The Sword of Damocles, was created,
- Then in1991, the first VR arcade machine, virtuality, was introduced.
- In 2015, Google launched Cardboard, which

uses a head mount to turn a smart phone into a VR device.
- In 2018, Facebook revealed camera-loaded glasses optimized for 'social VR'.
- More than 85 million VR headsets will be in use in China, according to PwC in 2018.
- In 2023 – Cloud-based VR gaming will be increasingly prominent, supported by 5G networks.
- And in 2030 – VR will be a $28bn market, according to Global Data forecasts.

Virtual reality (VR) is a computer-simulated experience that replaces the user's perception completely from the real world to a similar or completely different virtual world. VR is the most widely known of these technologies. It tricks the user's senses into thinking they are in a different environment.

VR is very immersive experience relying on Head Mounted Displays (HMDs). The sense of presence is using HMD or headset, the user experiences a computer-generated world of imagery and sounds in which one can manipulate objects and move around using haptic controllers while tethered to a console or PC**[18].**

It allows users to see a virtual world that totally replaces the real world. Interaction and movement within this alternative world are of great importance.

3.2. Augmented Reality (AR)

In 1960, Tom, Furness started his research in 1965 as a US Air Force officer at Wright-Patterson Air Force Base; he worked on designing better cockpits for fighter jets. In 1970, touch fewer Computers. If connecting planes were the first big step in AR, connecting computers was the second. In 1990_Hockey Pucks. The first real AR splash made towards mass adoption was often described as among the most contested inventions in sports history. In 2000, L.Frank Baum has illustrated novel. In 2010 Smartphones. It was hard not to notice Pokémon Go, the augmented reality throwback by Niantic that encouraged players to get outside and catch digital monsters on their phones.

In the latest 20s Immersive. March 2019, supply-chain analyst Kuo Ming-Chi predicted that mass the production of Apple's first-generation AR headset, powered wirelessly by iPhone, would ramp up by Q4 2019**[19].**

Augmented reality (AR): is where virtual objects and environments are mixed with the real world, in other word, AR is a superimposition of virtual elements in a real environment seen through devices such as a Smartphone, tablet, or see-through glasses **[18]**.

The user views his real environment along with computer-generated perceptual information. AR overlay digital information on real-world elements. It enhances the real world experience with other digital details, layering new layer of perception, and supplementing the user's reality or environment by keeping the real world central.

3.3. Mixed Reality (MR)

Mixed reality (MR) ranges from one extreme end to another, where real and virtual worlds are mixed. MR combines real world and digital elements. Devices can be classified according to the role played in the real and virtual environments and can be placed on a continuum that goes from AR to VR. New images may be placed in a real space in such a way that they can interact, to some extent, with what is real in the physical world we know **[18]**. Usually, the user wears a head-mounted display (MR). In mixed reality, the user can interact with and manipulate physical and virtual items and environments, using next-generation sensing and imaging technologies. Mixed reality allows the user to immerse in the combination of real and virtual world using their own hands—all without ever removing one's headset. It provides the ability to have one foot (or hand) in the real world, and the other in an imaginary place, breaking down basic concepts between real and imaginary.

3.4. Immersive Video (IV) or 360 video

These are spherical videos based on video recordings where a view is recorded in all directions at the same time using a set of cameras or an omnidirectional camera, which allows the viewer, during playback on normal flat display, to control the viewing direction like a panorama **[18]**. However, there is little freedom to interact or move through the images.

4. Application domains of immersive technologies

The workable applications usage of the immersive technologies, such as IV, VR, AR, and MR is not term of imagination; it is an effective useful technology in multiple fields like army, decoration, medicine and re-education using simulation and communication methods, also our current worldwide disaster which all lead to the resource to the immersive technologies.

According to the pandemic situation, VR have successfully created a virtual shopping space which lets customers to superimpose 3D products in their phones or tablets, they can buy or place order whether from fashion or furniture with no need to leave the home, thanks to the virtual reality, and we now have virtual trial rooms.

In the grocery shopping experience, many technologists like Richmond who said: "I can imagine an augmented reality app being developed in the future that helps people deal with social distancing more efficiently" **[20]**. Using such an app, would essentially map out where a user is in relation to where other users are; it would pull data on higher risk areas based on population density and other factors, enabling the user to navigate around a particular area more safely.

Anderson Maciel, an IEEE Member notes that immersive technologies have been utilized in medical education for over two decades now. "Applications range from helping educate physicians

prior to delicate surgeries to enabling patients to virtually interact with doctors in an appointment" **[20]** also said: "Immersive technologies have been leveraged in medicine for some time now."

IEEE Senior Member Jacob Scharcanski also mentioned the use of VR and 3D :"Virtual reality and 3D imaging technologies can be leveraged to better spot the unique characteristics associated with COVID-19" **[20]**.

Moving forward, AR/VR technologies are poised to potentially augment care providers' ability to understand specific illnesses, such as COVID-19, providing unprecedented insight into how to combat them.

In one specific example of an immersive technology that sought to address the notion of returning to a new normal and supporting transition back into schools (and/or entering a new school for the first time) the lead author co-developed a HMD-based VR tour of an autism specific school in the U.K. The purpose of this was to develop a visual and highly immersive experience of the entire school that could be viewed on a HMD or even a computer monitor. This experience was designed to provide a tour of the school with social distancing measures in place. Firstly, yellow lines on the floor indicate a 2-meter separation and secondly, the classroom views provide a view of spaced tables; indicating reduced class sizes and how a classroom during COVID-19 will appear. In addition to the spacing and classroom views, users also are able to tour the school grounds to identify a range of places and spaces well in advance of returning to, or joining, the school (i.e. soft play area, quiet rooms, teaching/staff rooms) **[21]**. The school is using this to help alleviate pressures of entering the "unknown" and "unexpected". This has implications for anxiety, as well.

Due to the social distancing norms, teaching for all students globally had come to a dead-end. AR brought the rescue through immersive and engaging learning solutions. Beyond education, immersive technologies are supporting citizens throughout the COVID-19 pandemic by enabling a sense of normalcy. For those practicing social distancing and remaining home, AR/VR/MR can also be used to augment fitness-focused games, enable virtual travel, and optimize social gatherings.

With the improvement of people's aesthetics and the demand for the innovation of indoor space emotional design, the evaluative experiment and analysis of interior decoration design can be conducted by immersive virtual reality technology, so as to effectively figure out the deficiencies and problems in the interior space decoration design process and make timely modification and optimization. Therefore, making theoretical and experimental research on the indoor space design of Guanzhong residents based on immersive virtual reality technology, and has achieved certain results **[22]**.

For the medicine field, Creation of the hybrid pediatric surgery book based on AR. A pediatric surgery book was created from lecture notes prepared using reference textbooks for subjects involving gastrointestinal atresias, ileus, malrotation, abdominal anomalies, and trauma. Then parts that had been found appropriate for implementing AR were enhanced with visual instructions to make the book easier to use.

The hybrid pediatric surgery book based on AR enabled students to examine spatial relationships and complicated pathologies and interact with them by walking around, zooming in/out, moving, and turning them**[23]**. In addition to models, anonymized radiological views were added to the related content, which allowed students to easily access the radiologic views, look at their highlighted or raw versions, and examine them in detail by zooming.

Construction of the Mirror World Simulation. 360-degree video recording of three selected places, including classroom, operation room, and meeting room, were recorded. Then, video file sizes and color/light settings were adjusted using the Gear 360 video. Using the operation room portal, students could experience the surgical procedure as if they were present in OR and review the surgical procedure from different angles**[23]**. The classroom portal would increase student engagement in lectures, and the meeting room would help incorporate crowded student groups in meetings.

There are numerous strengths underlying the use of VR with rehabilitation. Among these are that VR provides the opportunity for ecological validity, stimulus control and consistency, real-time performance feedback, independent practice, stimulus and response modifications that are contingent on a user's physical abilities, a safe testing and training environment, the opportunity for graduated exposure to stimuli, the ability to distract or augment the performer's attention, and perhaps most important to therapeutic intervention, motivation for the performer **[24]**. The application of Fish Tank VR as a rehabilitation tool for patients with spinal cord injury.

A related concept to the planning or rehearsal of a mission is the analysis of a completed mission for future training. In the military, such an analysis is known as after-action review (AAR). Both virtual environments and AR generate data that may be used for this type of training. In the same way that AR could reduce the modeling costs associated with virtual training, AR might help reduce the expense of setting up a formal AAR **[25]**.

Military equipment maintenance requires a high level of expertise. The application of AR can integrate knowledge into the system and save it in the form of animation, voice and text for a long time. The use of AR technology can also solve the problem that the actual equipment cannot appear in the training site and cannot be repeatedly disassembled in the training **[26]**. When the real equipment cannot appear in the training ground, virtual equipment can be used for training. When the real equipment cannot be disassembled repeatedly, AR technology can be used to display the internal structure and

disassembly process of the equipment without disassembling.

5. Conclusion

The immersive technologies have been very successful in recent years in many areas. In this paper, we discussed how immersive technologies are helpful and efficient in both communication and simulation fields. In fact, many training and learning process in education, army, medicine, and physical rehabilitation were done thanks to immersive AR, VR and MR techniques. With the apparition of the Covid'19, immersive technologies became more exploited, in particular, for virtual shopping, which allowed people to buy many things from home, teleconference for students and workers to reduce the risk of contamination, virtual tourism, which allowed people to visit places around the world without leaving home. However, the application of immersive technologies can become more widespread by applying it to mobile device, to space exploration from the earth or to flood the market.

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Modeling Based Multi-Agent System of an Industrial System

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Résumé

Industrial systems become more and more complex. This complexity is due to the great number of elements that composes them and their interactions. This papered scribes a multi-agent approach for modeling such systems. All of their parts are considered a dare modeled by using adequate agents. These to preoccupations were identified to find convenient multi-agent models for their resolutions. Then, we implemented our application by using a MADKIT multi-agent platform. The main goal of this work is to build a simulator based on reactive agents able to translate this complex industrial system into a data processing program that can represent its structure, its behavior, its interaction, its control loops and verify the integrity and proper functioning of the system. A concrete application of this approach was materialized by building an industrial boiler.

1. Introduction

The spectacular advances in the field of new technologies and their applications in practically all sectors, including the industrial field, contribute to making these domains more and more complex. Industrial systems acquire more and greater degree sin complexity resulting in the regular introduction of new elements and of the great number of interactions between the different parts of these systems. In order to develop such a system, to predict their behaviors and before beginning to build them, these systems are modeled and tried. In the other hand, the modeling and simulation of an actual system make it possible to handle, to observe and to improve understanding of its functioning. Different abstraction levels are considered and studied and this concerns fields ranging from natural phenomena to technological fields as for example, studies of biological systems, meteorological phenomena, road traffic management, etc. Most of the modeled phenomena reach today's complexities and high degrees of smoothness, which requires the use of models and thus, the data-processing tools become more and more performing and flexible. The modeling of systems has been the subject of many studies and researches considering its important impact on the phenomena implemented. So, and according to P. Fishwich's view **[1]**, modeling is represented by symbiosis between formalism and the techniques of modeling which follows the same target: "to release the best metaphors and analogies to allow understanding better any phenomena".

According to C. Oussalah's view **[2]**:"modeling is ear morphism between an actual system and a model that finality is to give a simplified and observable representation of the structure and behavior of the actual system"**.**
The experimentation of practical works can be observed as modeling of actual cases in the laboratory. The observation of the workers carrying out their tasks by timing the times spent in the factories observed by Taylor, the labors of the military, the models of planes built and tested in blowers, the mathematical equation scarrying of the differentials, the variables to various degree and constants, which represent the actual phenomena for which the resolutions for fixed sets of entries give the solutions to these phenomena for proper defined conditionsareasmanyexamplesofmodelswhichasfaithfullyrepresentaspossibledifferentrealities.

However, its hould be reflected in terms of accuracy, quality, and cost. For example, the construction of a model of the plane represents costs enough higher for relatively low quality. Moreover, the handling of such models is not easy and not flexible and cannot be reused. This concept of reuse is very significant if we want to test our model in various situations. The data-processing tool represents a very accurate solution in several cases and its use in the field of modeling and simulation is very wide spread ensuring excellent qualities for which the improvement is continuous at very reasonable costs.

According to Fishwick's view **[3]**, the data-processing simulation can be understood as follows : 'Computer simulation is the discipline of designing a model of anactual or theoretical physical system, executing the model on a digital computer and analyzing the execution output'.

Complex industrial systems are characterized by their large size, the complexity of the constituent subsystems and their dynamics, and the massive information over load. For example, the maintenance and management of complex process equipment and processes, and their integrated operation, play a crucial role in ensuring the safety of plant personnel and the environment as well as the timely delivery of quality products. Given the size, scope, and complexity of the systems and interactions, it is becoming difficult for plant personnel to anticipate, diagnose and control serious abnormal events in a timely manner **[4]**.

Thanks to multi-agent systems, it is possible to model real systems in which very complex behaviors emerge from relatively simple and local interactions between elements. Therefore, a multi-agents system gives more description that is natural and simulates a system by help of entities that compose it. It allows model to appear closer to reality and it is particularly well adapted to describe a system from the stand point of the activities of its components, that is to say when the behavior of the individuals is complex and sometimes difficult to describe with equations **[5-7]**. Another point of consideration is that MAS modeling is easier interpretable by a human observer, because the given description is more natural. The validation by an expert will be facilitated be cause he will be easily able to refer to the real world.

The rest of this paper is organized as follows: Section2 presents the multi-agent systems. Section 3 presents the industrial system to be simulated. The proposed multi-agent Model is described in section 4. The implementation of the system is shown in section5. Finally, section 6 concludes this paper.

2. The Multi-AgentSystems(MAS)

Multi-agent systems are an emerging conceptual paradigm to simulate the interaction of multiple autonomous agents in an environment **[8,9]**. Multi-agent systems have many applications; our interest is in their use to build a n operation a l simulator of an industrial system. In general, a system is called multi-agent if the system contains at least one agent that perceives a simulated environment through its actions that influence the environment and are influenced by the perceived situation in the environment.

2.1. *What is aMulti-agent System?*

According to Ferber's view **[10]**, the term 'multi-agent system' refers to a system consisting of the following parts:

- The environment E consisting of the following elements:
  - A set of objects O. Objects can be perceived, created, destroyed and modified by agents.
  - A set of agents A, which are able to perform actions and represent the active entities of the system.
  - A set of locations L determining the possible position of the objects (from the set O) in space.
- A set of relations R which link objects and also agents to each other.
- A set of operations Op enabling the possibility for agents to perceive, manipulate, create, destroy objects of O, in

particular representing the agents' actions.

- A set of operators U with the task of representing the application of the operations from Op and there actions of the world to this attempt of modification. The operators from U are called the laws of the universe.

2.2. *Agent definition*

According to the heterogeneity of the s t u d i e d field, there is no common agreement about a definition of the term agent. One primary characteristic that differentiates agents from an ordinary program is that the agent must be autonomous. Several definitions of agents include this characteristic, for examples:

- The term 'agent' refers to an entity (software or hardware) able to functioning continuously and autonomously in environments shared by other agents **[11]**.
- An agent is an entity capable of evolving in an environment through the acquisition of information emitted by the latter and by acting on it**[12]**.
- "An autonomous agent is a system situated within and a part of an environment that senses that environment and acts on it, in pursuit of its own agenda and so asto effect what it senses in the future" **[13]**.

Although not stated explicitly, Russell's definition implies the notion of autonomy as the agent will act in response to perceived changes in the environment. The other four definitions explicitly state autonomy. But all definitions add some other characteristics, among which interaction with the environment is mentioned by most. Another identified feature is the property of the agent to perform specific tasks on behalf of the user, coming thus to the original sense of the word agent, namely someone acting on behalf of someone else.

One of the most comprehensive definitions of agents is the one given by Wooldridge and Jennings view **[14]** in which an agent is:

"A hard ware or(more usually) a software-based computer system that enjoys the following properties : autonomy-agents operate without the direct intervention of humans or others, and have some kind of control over the iractions and internal state; social ability-agents interact with other agents (and possibly humans) via some kind of agent-communication language; reactivity: agents perceive their environment and respond in a timely fashion to changes that occur in it; pro-activeness: agents do not simply actin response to their environment, they are able to exhibit goal-d i r e c t e d behavior by taking in itiative".

2.3. *The Environment*

Common to all environments is that they provide percepts to the agent and that the agent performs actions in them. Multi-agent the or y regards the environment as an integral part of the frame work. In general, two classes of environments can be distinguished: artificial and real environments. Agents that are computer programs and exist in artificial software environments are called software agents.

Russell and Norvig **[15]** discuss a number of key properties of environments that are now adopted by most researchers in the domain:

- Accessible versus in accessible: Indicates whether the agents have access to the complete state of the environment or not.
- Static versus dynamic: indicates whether the environment can change while an agent deliberates or not.
- Discrete versus continuous: indicates whether the number of percepts and actions are limited or not. The most complex class of environments are those that are inaccessible, non deterministic, dynamic and continuous. The first three properties of this list are properties typically occurring in MASs.

3. GLOBALDESCRIPTIONOFTHESYSTEMTOBESIMULATED

In this section, we will show the architecture and the operation of the process concerning the steam generator.

3.1. *The feed water station*

The feed water station is a method that feeds the steam generator, it is constituted by:

- The condenser(15E01)
- The degasser(15B02)
- The feed water tank(15B01)

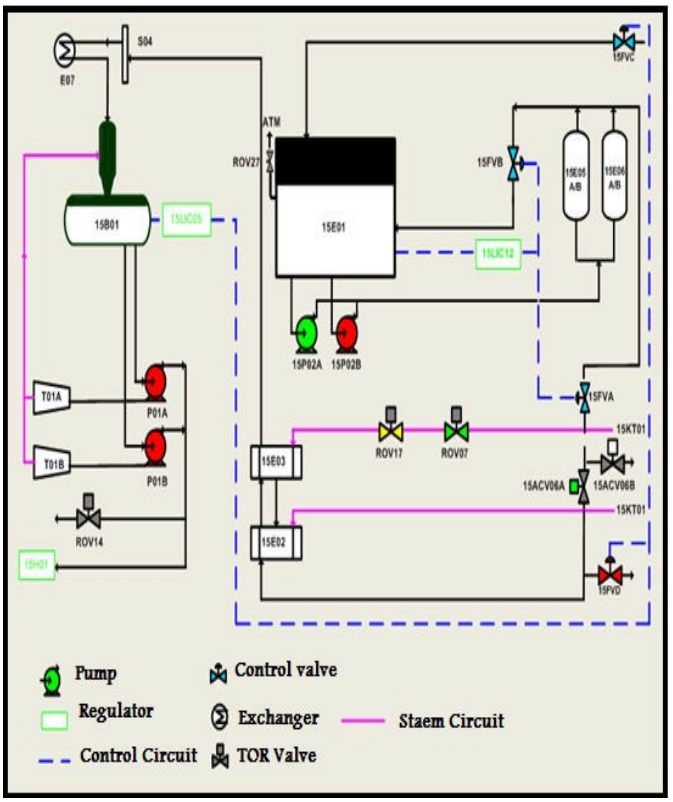

Fig.1. Technical drawing of the feed water station.

1) *Circuit description:* The extraction water comes from 15E01 by the bottom, it gets through a valve and a mesh filter before its inhalation by the pumps15PM02A/B.

The water is inhibited with 12 bars towards the maintaining ejectors 15E05A/B, and it will feed the heaters while passing by 15FVA towards the degasser and the15FVB returns towards the condenser. Those two valves' functions are insplitrange and controlled by 15LIC12(level15E01). Then, the water crosses 15 ACV06A/B(A towards the heaters, B towards the channel rejection).

The 15 FVD goes towards U50 and 15FVA supplement of Unit50 towards the 15 E01, and are controlled in split range by the 15LIC05 in order to maintain a constant level in the feed water tank.

The extraction water is then conducted towards 15E02 and 03 in contact with steam racking 2 and 3 of the 15KT01. The two heaters are provided with By-pass, the extraction water goes then to feed the degasser.

3.2. *The steam generator*

A boiler is a steam generator; it aims to raise the temperature of the water until the change of its status, that is to say, to become steam, and then to bring it to proper defined pressure and temperature.

In the construction of a boiler, we distinguish:

- A metal frame with it strim, masonry casing.
- The boiler: tubes, box back, screens, spray, superheaters, balloons…
- The combustion chamber: burners, air, and auxiliary circuits.

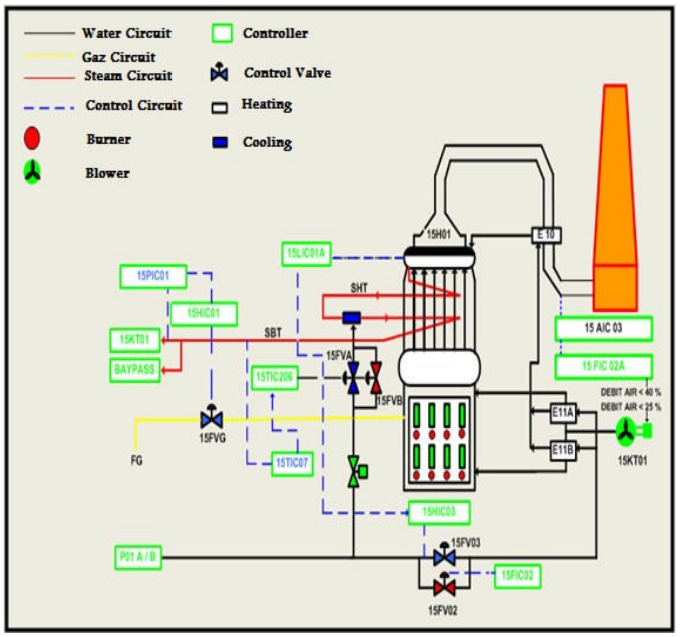

Fig.2. Technicaldrawingofthesteamgenerator.

1) *The Principle of operation:* The water is brought to the boiler by a feeding-water pump. The power of the boilerischaracterizedbytheintensityofsteamexpressedinkgproducedperhour.

- *The air circuit Combustion:* The air is provided by two blowers fans, the first one is conducted by turning turbine and these condone operates through an engine (those two fans do not operate simultaneously), the air is then heated by the air super heater before entering to the burners by using the heat of evacuated gases. The air flow is regulated according to the fuel to have complete combustion.
- *The water circuit:* The feeding of water is done starting from a pump controlled by two valves mounted in parallels, the first one is used to fill the balloon and the other one for regulation purpose(body of adjustment/regulation);from where it comes out to go then by an economizer in order to be heated by the calories of the evacuated smoke and returns finally to the higher balloon to produce the steam.
- The *steam circuit:* The saturated steams comes out from the higher balloon, goes by the super heater(in the hearth),its temperature increases while its pressure varies slightly. In the end, the final temperature of the produced steam will be regulated by the dish water(water injection)This dry steam is also called the load of the boiler.

4.Proposalformulti-agentmodelofthe simulator

To model our system we have used the organizational model Aalaadin**[16]**,which constitutes the basis of our design.

The organizational model Aalaadin is a project that focuses on the analysis, design, formalization, and implementation of multi-agent systems from an organizational perspective. The underlying conceptual model (AGR)is based on the concepts of agents, groups, and roles **[17]**.

Therefore, we have split up our process in to five groups each group contains a set of agents. The following diagram represents the organizational structure of the simulator based on the proposed AGR model.

4.1. Groups and Roles of the simulator

- *The perturbation group:* This group is composed of :

- *The APM Agent:* The agent system is a principal-agent; it is the meeting point of the system and the external environment. It periodically sends orders to agents and groups of the system until the adjustment of measurements; it ensures the connection between these groups thanks to these different communications.

  The APM Agent is a central agent that links all the groups of the simulator.

- *The GUS(Gui User Interface) Agent*: Its role is to trigger the disturbances. Thanks to this agent the operator controls the system thanks to instructions of a load ofthe steam generator on this Agent system.

  The disturbing agent communicates with the Agent system by sending the instructions.

- *The feedwater tank group:* This group contains a set of agents in interaction to ensure the operation of the water supply boiler.

- *Agent(15LIC05):*Is in charge of the level of the tank, its role relates to the regulation of the tank, by using the necessary values, provided by the other agents of the system, the Alimentation agent(15LIC05) sends the orders of opening and closing thanks to the agent Valve-tank(15FVC) in order to modify the flow of water, therefore, modifies the level of the tank(15B01).

- *Agent(15B01):* It represents the variation of the level of water inside the tank, it communicates with the Alimentation agent, by periodically sending the level in order to be regulated, and on the other hand it receives orders of the Alimentation agent(15LIC05).
- *Agent(15FVC)*:This agent controls the flow of water entering the condenser(15E01), it is in communication with the tank agent(15B01) and condensation agent(15LIC12) by providing the flow of water.

- *The condensation group :* This group contains a set of agents in interaction to execute the water condensation operation.
  - *Agent(15LIC12):*It is the responsible for the level of the condenser (15E01), its role relates to the regulation of the condenser, by using the values provided by the other agents of the system, the Condensation agent(15LIC12) sends the orders of opening and closing using the condenser valve agent(15FVA) in order to modify the flow of water and to modify the level of the condenser.
  - *Agent(15E01):*It represents the variation of the level of water in the condenser, it communicates with the Condensation agent(15LIC12) by sending this level periodically for which is regulated on the other hand it receives orders of the Condensation agent.
  - *Agent(15FVA):*This agent controls the flow of water flowing out to the tank(15B01); it is in communication with the Condenser agent(15E01), the Condensation agent(15LIC12) and the Alimentation agent(15LIC05) by providing the flow of water.

- *The combustion group:* This group contains a set of agents in interaction making possible to execute the operation of combustion.
  - *Agent(15HIC01):*The role of this agent is to control the combustion and to regulate the measured sizes which it constantly receives from various agents of the system. Indeed, if these measurements are not compatible with the load of the boiler it periodically sends orders of regulation to wards the Ventilator agent (15KT01) and the Gas valve agent that is to say agent(15FVG)in order to reach desired sizes.
  - *Agent(15KT01):* Its role is to control the air flow; it periodically sends this flow towards the combustion agent(15HIC01) and receives the orders coming fromt his agent.
  - *Agent(15FVG):* This agent controls the gas flow; it periodically sends this flow towards the combustion agent (15HIC01) which in turn transmits orders to it(opening, closing)in order to modify the gas output.

- *The hydraulic group* :This group contains:
  - *Agent(15LIC01A):* Its role is to regulate the level of the balloon by using values provided by the various agents of the system, the Hydraulic agent sends the orders of opening and closing towards the water valve agent that is to say agent(15FV03) till this measured level become equal at the desired level(50%).
  - *Agent(15FV03):*The role of this agent is to control the flow of feed water tank coming from the feed water station, it periodically sends this flow towards the agent balloon (15H01) and the hydraulic agent (15LIC01A) and receives the orders(opening, closing) coming from the latter.
  - *Agent(15H01):*Its role is to calculate the level of the ballo on by the use of the sizes provided by APM agent and the water valve agent (15FV03); it periodically sends this leveltowards the hydraulic agent (15LIC01A) to be controlled.

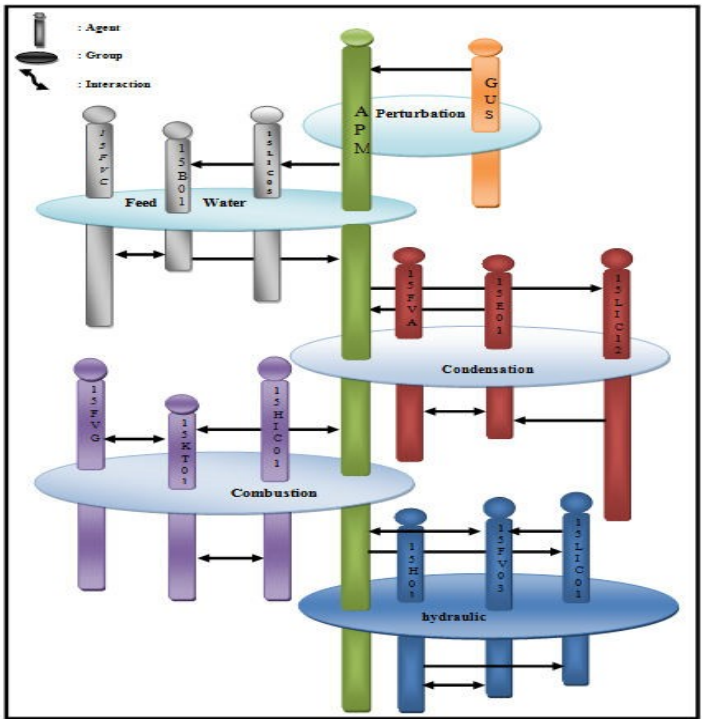

Fig.3. The organizational structure of the simulator

5. The system implementation

The simulator was developed by using the Mad Kit agent platform based on AALAADIN model. The two main interface so four project are presented in Figures 4 and 5. These two interfaces concern the steam generator section and the interface of the feed water station section. They allow the user to drive there generation steam operation and supply boiler with demineralized water by publishing guidance to various regulatory bodies and follow the operation of the process functioning.

Figures 6 and 7 show some examples of the java and MADKIT source codes.

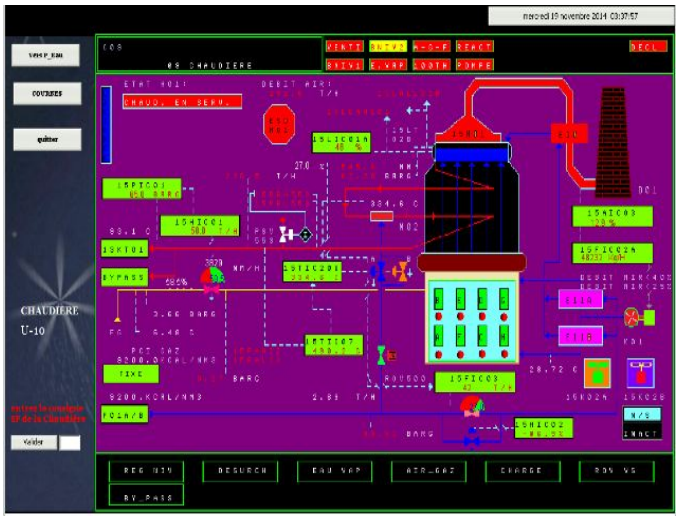

Fig. 4. The interfaceofthe boilersimulator.

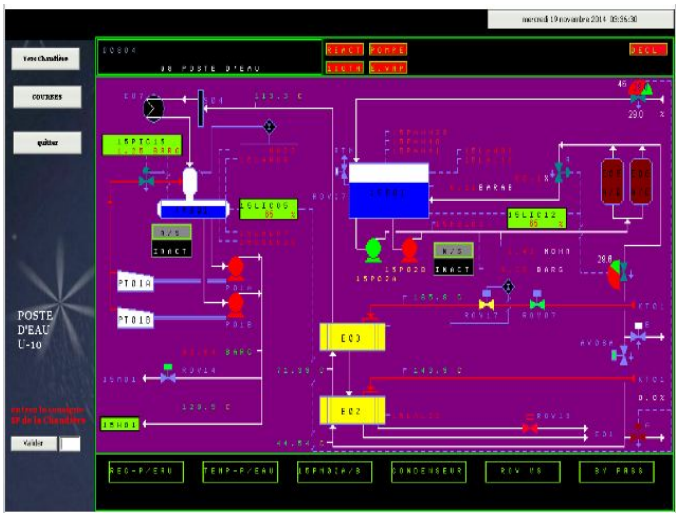

Fig. 5. The interface of the water station section simulator.

```
import java.awt.*;
import javax.swing.*;
import madkit.kernel.*;
import madkit.lib.messages.ObjectMessage;

public class Agent_vanne_eau extends AbstractAgent implements ReferenceableAgent
{
ObjectMessage message_eau;
synoptique_class eau_synoptique;
grav eau_frame;
//andeur_class consigne=new grandeur_class();
int débit_eau;
int débit_eau2;

int vanne;
//int remplacer=0;
//String fermer="oui";

 Graphics2D eau_graphics_chaudière;
 Graphics2D eau_graphics_synoptique;
 grandeur_class tempon_eau;
int Dvapeur;
int niveau;
float op_eau;
float changement;
boolean bms;
//-------------------------------------------------------------------\\
```

```
import javax.swing.*;
import madkit.kernel.*;
import java.awt.image.*;
import java.awt.event.*;
import madkit.lib.messages.ObjectMessage;
import madkit.lib.messages.StringMessage;
import java.util.*;


public class activateur_perturbation extends Activator

{
    public activateur_perturbation(String group, String role)
    {
      super(group, role);
    }
//-------------------------------------------\\
public void execute()
  {

    if(!agent_simulation.stop)
    {
      agent_simulation.perturbateur.walk();
    }
}
//-------------------------------------------\\

}
```

Fig. 6. Parts of the simulator code.

```
//-----------------------------------------------------------------\\
 public Agent_vanne_eau(grav ge,synoptique_class ss)
 {

    //consigne.valeur=20;
    eau_frame=ge;
    eau_synoptique=ss;
    eau_graphics_chaudière=(Graphics2D)eau_synoptique.image_chaudière.getGraphics();
    eau_graphics_synoptique=(Graphics2D)eau_synoptique.getGraphics();

 }

//-----------------------------------------------------------------\\
void initialiser()
{
    débit_eau=51;
    vanne=40;
    op_eau=28f;
    changement=0.5f;
    bms=false;
}

//-----------------------------------------------------------------\\
 public void activate()
 {
    initialiser();
    foundGroup("ballon");
    requestRole("ballon","controler_vanne_eau");
```

Fig. 7. Code fragment of the balloon control.

6. Conclusion

Our work can be considered as an assistant of training and learning for beginner operators, workers new recruits and trainees enabling the m to understand and simulate the boiler without acting on the real system and without stopping processes and generate losses of money and time. So we can consider our simulator more as a teaching aid explaining the

Multi-Agents approach and treats one of its domains of use which is the simulation of systems and more particularly complex industrial systems. It can be considered as a tool to learn and understand the functioning of the machine in reality for all involved.

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Detecting IoT Botnet Attacks Using Deep Learning Approach

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Abstract

Recently, Network Intrusion Detection (NIDS) has emerged as an essential part of cyber security, with a focus on protection Internet of Things (IoT) systems from unauthorized use and attacks. Nevertheless, NIDS techniques are facing several challenges due to the emergence of new numerous sophisticated attacks. Using Deep Learning approaches, the main objective of this research is to automatically learn useful feature representations, extracted from large amounts of unlabeled raw network traffic data. Therefore, we propose an effective Network Intrusion Detection System STL-NIDS based on the self-taught learning (STL) framework. The proposed model is build using the deep AutoEncoder neural network, which is an effective learning technique for reconstructing a new feature representation in an unsupervised manner.After the pre-training stage, the new features are fed into the SVM algorithm to improve its detection capability for intrusion and classification accuracy. The proposed method is validated experimentally and a comparison between competitive methods using IoT Bot dataset is conducted. Hence, results of the evaluation using several appropriate metrics show that the proposed method outperforms the related works' results. Moreover, it is proven that our model is effective for large-scale and real-world network environments.

1. Introduction

The incredible growth of insecure Internet of Things (IoT) devices with high computation power has led to a rapid development of highly sophisticated and targeted malicious activities and attacks [1]. A botnet is one of the most dangerous malware in IoT environment. The botnet is a robot network of infected machines (compromised machine) or bots, also called zombies, that has a command-and-control infrastructure which is used for various malicious activities such as: email spam delivery, password cracking, key logging, crypto currency mining, and distributed denial-of-service (DDoS) attacks [2]. Bots can automatically scan entire network ranges and propagate themselves using weak passwords and known vulnerabilities on other compromised machines. Once a machine is infected, a small program is installed for future activation by the botmaster. This program at a certain time can instruct the bots in the network to execute actions such as sending requests to a target website with the intent of rendering it unable to serve requests by legitimate users, brute force and resulting in DDoS [3]. Thenceforth, a secured IoT network is necessary and requires immediate attention for the protection from different types of attacks. Systems such as Anti-Virus and Firewall have been developed to establish various security solutions and protect the IoT network. However, weaknesses caused by anti-viruses architectures and Firewall are not updated and new (unknown or unseen) attacks or botnet can be created. For this reason, significant research has been focused on developing Intrusion Detection Systems (IDSs) to improve software and system security in IoT [4]. Thus, Intrusion Detection Systems (IDSs) play a vital role in the IoT network security. The IDS approaches can be categorized into two main classes: Host-based Intrusion Detection Systems (HIDSs) and Network Intrusion Detection Systems (NIDSs). Where the HIDSs detect intrusions in an individual host. While, the NIDSs detect attacks by observing various network activities, and help determine and identify unauthorized usage, duplication, alteration as well as any destruction of data. Depending on the detection techniques, NIDSs techniques can be examined in two separate categories: misuse-based detection and anomaly-based detection. Misuse-based detection discovers attacks based on the patterns extracted from known intrusions. While anomaly-based detection are designed to identify and capture attacks

based on the deviations from the established profiles of normal behavior.

Behaviors that exceed thresholds of the deviations are detected as attacks. The misuse detection techniques has low false positive rate but cannot detect new types of attacks. Therefore, the NIDSs based anomaly detections are more suitable than misuse detection systems. Anomaly based detection are efficient for detecting unknown or novel types of attacks without any prior knowledge and under a basic assumption that attacks deviate from normal activities [5]. For this reason, we focus in our study on NIDS based anomaly detection. The NIDSs based anomaly detection has a relationship with different attacks threaten IoT network security, such as: DDoS such as SYN Flood and Scan Flood, Information Theft, and Probing attacks. In addition, the NIDS has been successfully applied to various fields such as: computer network security, automatic speech recognition, credit card fraud detection, natural language processing, environmental disaster analysis, military applications, health care systems [6], and cyber-physical systems [7].

In recent years, the NIDSs based anomaly can be trained used machine learning models to separate abnormal and normal features. The schemes are able to detect patterns of known and unknown attacks in unsupervised, supervised, [8] or semi-supervised manner [9]. In supervised training, the detection model is trained with using both anomalous and normal features. The goal of this type of training is to label the test features as normal or anomalous by using the trained model. There are various studies which applied supervised techniques such as Bayesian networks, Random Forest, artificial neural networks (ANN), support vector machines (SVM), and Random Forest (RF) for anomaly detection [10]. Compared to misuse based approaches, the supervised techniques perform better performance in anomaly detection, but these methods are not very successful on the detection of zero-day attacks [11]. On the other hand, semi-supervised or unsupervised techniques are more suitable for network intrusion detection issues. In semi-supervised training, the model is obtained by training it with normal features only. Then this model is used to classify features which do not fit the model as anomalous [12]. In addition to afore mentioned techniques, in unsupervised training, the model is trained using completely unlabeled features. Thereafter, in the test stage, the trained model tries to cluster the normal features and anomalous into separate clusters [13].

Deep learning based unsupervised techniques have gained interest recently as they can efficiently learn a model and improve the NIDS performance. With deep learning approaches, we can expect to tackle issues in anomaly-based network intrusion detection, such as, ability to adapt to dynamic network environments, capabilities to extract automated complex data representation at high levels of abstraction, unavailability of labeled features and high intrusion detection rate. The most popular deep learning based unsupervised techniques include, convolutional neural network [14], long short term memory recurrent neural network [15], deep belief networks with restricted boltzmann machine and autoencoders (AEs) neural network [16] have been used for network intrusion detection system. Hence, the AEs as the automatic feature learning models can provide more discriminative features in contrast to other feature engineering approaches and they achieve a promising performance in contextual categorization by reducing the testing and training times. On the basis of a self-taught learning framework and inspired by the success of deep autoencoder based unsupervised techniques in number of challenging classification issues [17] [18], we propose a deep learning based Intrusion Detection System STL–NIDS (a self-taught learning based intrusion detection system). Our approach consists of three autoencoders for good data representation and SVM for the classification task. The output of first deep autoencoder in the current layer is used as the input of the second autoencoder in the next layer. In addition, training an autoencoder is started when training the previous one is completed. Then, the trained parameters of the second autoencoder will be saved to train the last autoencoder. After that, the output features have passed to the support vector machines (SVM) classifiers. The SVM classifies the attack classes from the input dataset. Since, a manual search optimization method was studied to find suitable hidden layer number, weight decay parameter μ, and neuron number in each layer.

The proposed models were trained in an unsupervised manner using the up-to-date NIDS benchmarking dataset Bot IoT-dataset [19]. The Bot-IoT dataset is a common benchmark for network intrusion detection consisting of real network data in IoT. In addition we compared the obtained results with the results of the most successful previous studies which applied basic single SVM for the classification task. We also compared our model to random forest and Naïve Bayes algorithms with a similar evaluation techniques [20], [21], and [22].

In summary, the major contributions of this paper are the following:

1) We develop a novel deep learning approach STL–NIDS based on the STL framework by combining deep autoencoder and SVM for network intrusion detection.

We study the potential of our approach to achieve effective representation and dimensionality reduction for the improvement of the classification results of traditional supervised machine learning techniques.

2) Our model is pre-trained using an unsupervised learning algorithm to avoid overfitting and decrease the amount of training and testing times of SVM.

3) The performance of the proposed DAE is evaluated using Bot-IoT dataset and compared with single SVM and other classification algorithm on binary classification. Moreover, a series of preliminary experiments is conducted to explore the performance of DAE based on different number of hidden layers and units. To the best of our knowledge, we are the first to apply autoencoders to IoT bot dataset for network intrusion detection.

The rest of this paper is organized as follows. Section 2 briefly describes some previous relevant works on attacks intrusion detection using machine learning models and deep learning approaches. Section 3 describes our proposed methodology for NIDS implementation. The experimental results are demonstrated in Section 5 and the conclusions follow in Section 6.

2. Related works

Several studies have been conducted to develop tools for the detection of different attacks types in the IoT infrastructure. The network intrusion detection has become the most important part in IoT security. Various machine learning algorithms and approaches are applied in IDS to distinguish between normal traffic and attacks or anomalies. These approaches include naïve Bayes network [23], k-nearest neighbor (K-NN) [24], decision tree [25], SOM [26], artificial neural network (ANN) [27], and SVM [28]. In [27] authors compared the performance of ANN using a set of classifiers such as: ZeroR, OneR, JRip, RF, PART, J48 and SVM on IoT botnet dataset. The results showed that the detection results of ANN are better than those of RF.Authors in [24] tested several classifiers for IoT botnet attacks detection, namely decision tree (DT), probabilistic neural network (PNN), k-nearest neighbor (kNN), support vector machine (SVM) and discriminant classifiers; he PNN classifier gave a better accuracy of 98.8%.In [28] [29], authors employed an efficient machine learning techniques based on ANN and SVM classifiers with feature augmentation to classify the input network features into two specific class: normal and abnormal traffic. They used in their approach both ISOT [30] and ISCX [31] which are the two well-known datasets in the literature of botnet detection. The proposed approach increases the quality of intrusion detection rate of the ANN classifier, and reduces the required training time. However, the weakness of this approach is the insufficiency of its detection accuracy. In addition, the time factor was not considered. In [32], authors presented a new method for the classification of network traffic in IoT applications. The proposed methodology is based on the insertion of new neurons into the hidden layer. The classification rate is 93%. In [33], researchers proposed an automatic system for the detection of DDoS attacks in IoT based on the N-Bot dataset by merging the results of the fuzzy and genetic algorithms. In [34] researchers proposed a bot host detection system (BHDS) for detecting bot infected hosts and their malicious network traffics in IoT environment. The proposed BHDS relies on the profile of each host including their behavior during a period of time. A machine learning approach was used by combining the SVM classifier with neural network machine learning classification techniques and random weights which they plays an important role in the detection rate of BHDS because it decreases the computational cost. The model was evaluated on the IoT botnet dataset but the performance of the model was studied on the binary classification task only. In [35][36], many unsupervised learning algorithms (clustering) like K- means and BIRCH (balanced iterative reducing and clustering using hierarchies) were combined with SVM and a neural network (NN).The combination aims to enhance the intrusion detection system performances and reduce the time training. Recently, in [37] unsupervised learning techniques has been used recently with SVM to detect DDoS attacks in IoT networks with non-stationary traffic. Consequently, this leads to an increase in the detection rate and a decrease in the processing time SVM machine learning algorithm. In [38], authors presented a network attack detection system using a large-scale clusters with SVM. The purpose of this proposition is offering the power to process high-dimensional network traffic data detection and to improve the detection rate.The KDD CUP 99 data was used as train and test dataset to evaluate the performance of the proposed approach. The performance of their model was compared against shallow and traditional machine learning approaches.

Approaches mentioned above need a prior artistic step of extracting the characteristics of the network traffic before the main recognition step. Hence, they are not applicable in real time that auto encoder AE. According to our knowledge, this is the first work using deep autoencoder neural networks for detecting DDoS attacks in IoT using the Bot IoT dataset.

3. Proposed Methodology: STL-NIDS:

In this section, we describe how the network intrusion detection problem is addressed through our Self-taught Learning. The Self-taught Learning (STL) is a deep learning techniques that consists of two stages for the classification [39]. The first stage, a good feature representation is learnt from a large collection of unlabeled data, x. termed as Unsupervised Feature Learning (UFL). In the second stage this learnt representation is applied to labeled data, X_L, and used for the classification task. Although the unlabeled and labeled data may come from different distributions, there must be relevance among them. The data in the first stage is obtained from IoT bot dataset without label, ***xu***. However, the data in the second stage is combined with labeled data, ***xl***which can be described as fellow : we are given a labeled training set of m records $\{(x_l^{(1)},y^{(1)}), (x_l^{(2)},y^{(2)}),.....,(x_l^{(m)},y^{(m)})\}$ where input feature vector $x_l^{(1)} \in \mathbb{R}n$, (The subscript "$l$" indicates that it is a labelled record), $y^{(i)} \in \{0,1\}$ are the corresponding labels for binary classification. There are different approaches used for UFL, such as Sparse Autoencoder, Restricted Boltzmann Machine (RBM) [40], Gaussian Mixtures and K-Means Clustering [41]. For our model, we used a deep autoencoder based feature learning due to its relatively easier implementation and good performance [42]. Autoencoder neural network is an unsupervised learning algorithm that applies back propagation to train, it tries to copy its input to its output. It can be used for dimensionality reduction and features learning instead of PCA to achieve a significantly nonlinear generalization. Its output and input layer have the same number of neurons. As shown in Figure 2(a), the output and input layers contain K units, and the hidden layer contains N units. The input values xi in the input layer is similar to the output values $xi\hat{}$ in the output layer. Internally, dimensionality reduction and Feature extraction process in deep autoencoder involves two steps: encoding and decoding. The encoding function h = $f(x)$ and decoding function r = $g(x)$ produce a reconstruction of x.

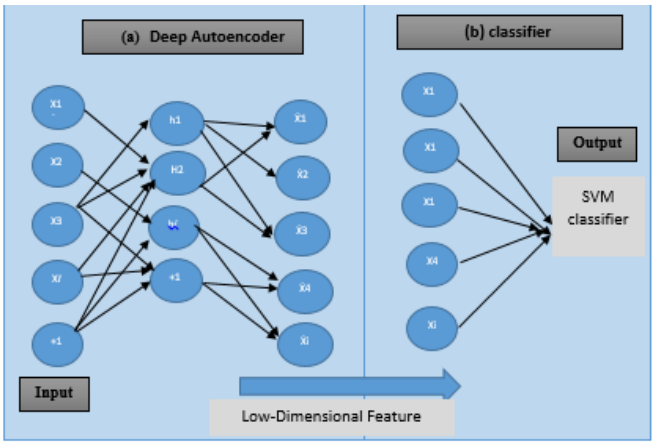

Figure 1: The Self-taught learning stages.

In the autoencoder, we expect the output sample $\dot{X}$ is the same as the input sample X. The encoder encodes the input feature X into a new expression and it is used to find a latent layer h that can represent the input feature. Then it transforms an input X $\in \mathbb{R}n$ into a hidden layer representation h $\in \mathbb{R}n'$ with the deterministic mapping:

$$h = f(x) = s(Wx + b) \quad (1)$$

Where, $X = (x1,x2,x3,x4,....,xi)$ is the high-dimensional input data vector, b is the bias value of the hidden layer, h = $(h1,h1,h1,....,hk)$ is the low-dimensional vector output from the hidden layer, w is the weight matrix between input layer and hidden layer (d * d') and s is the activation function of hidden layer.

The decoder layer is the opposite of the encoder layer, it decodes the input (latent vectors) produced by encoder into a reconstruction of the original input (output). A transformation g maps back the resulting hidden representation h to a d-dimensional reconstruction of x denoted by r:

$$r = g(x) = s(W'h + b') \quad (2)$$

Where r = $(x1\hat{},2\hat{},x3,.....\hat{},xm\hat{})$ is the reconstruction vector of the input data, w is a d × d weight matrix, s is the average activation value of hidden layers over all training inputs, and b is the corresponding bias vector.

The back propagation algorithm is used our deep autoencoder to obtain the optimal values for its bias vectors b $\in \Re^{K\times 1}$ and b' $\in \Re^{N\times 1}$ and weight matrices W$\in \Re^{K\times N}$ and W' $\in \Re^{N\times K}$ witch attempt to reconstruct and learn its input value $xi\hat{}$ to be equal to its output values $xi\hat{}$. In other hands, a nonlinear activation functions is learned to make the output values similar to the input values; such as softmax, sigmoid, tanh and rectified linear functions [43]. Hence the deep autoencoder can extract more useful features when it uses an optimal

non-linear activation function. In our model, the activation function is chosen to be the sigmoid function, and its output range is [0,1]. This function is used for the activation (W,) of the nodes in the output and hidden layers based on a series of preliminary experiments.

Sigmoid function: $S(x) = \frac{1}{1+e^{-x}}$ (3)

To improve the performance of our STL-NIDS, our deep autoencoder also applies back propagation to minimize the loss function (reconstruction error) or the difference between the input x and reconstruction r (output) [44]. The first term is the average sum-of-square errors for all m input data. Therefore, the optimal parameters of the decoder and encoder networks can be trained together to minimize the objective function:

$(\theta^*, \Phi^*) = \operatorname{argmin}_{\theta\Phi} \frac{1}{N} \sum_{i=1}^{n} L(xi, ri)$

$(\theta^*, \Phi^*) = \operatorname{argmin}_{\theta\Phi} \frac{1}{N} \sum_{i=1}^{n} L(xi, g(f(xi)))$

$(\theta^*, \Phi^*) = \operatorname{argmin}_{\theta\Phi}$

$\frac{1}{N} \sum_{i=1}^{n} L(xi, \mu (s(\sum(W'h + b')(s (\sum(Wx + b))))$ (4)

Where L represents the loss function and n represents the number of training features. According to the distribution assumptions on the input, the loss function can take many forms. The conventional one is mean squared error (RMSE):

$$L(x, r) = || x - r ||^2 \quad (5)$$

If the interpretation of r and x is either vector of number probabilities or number vector, the cross-entropy can be an alternative:

$$L(x, r) = -\sum_{K=1}^{d} [x_k \log r_k + (1-x_k) \log (1-r_k)] \quad (6)$$

The second term is a weight decay parameter (μ) used for tuning the weights between the output and hidden layers to improve performance and classification while helping avoid and check over fitting.

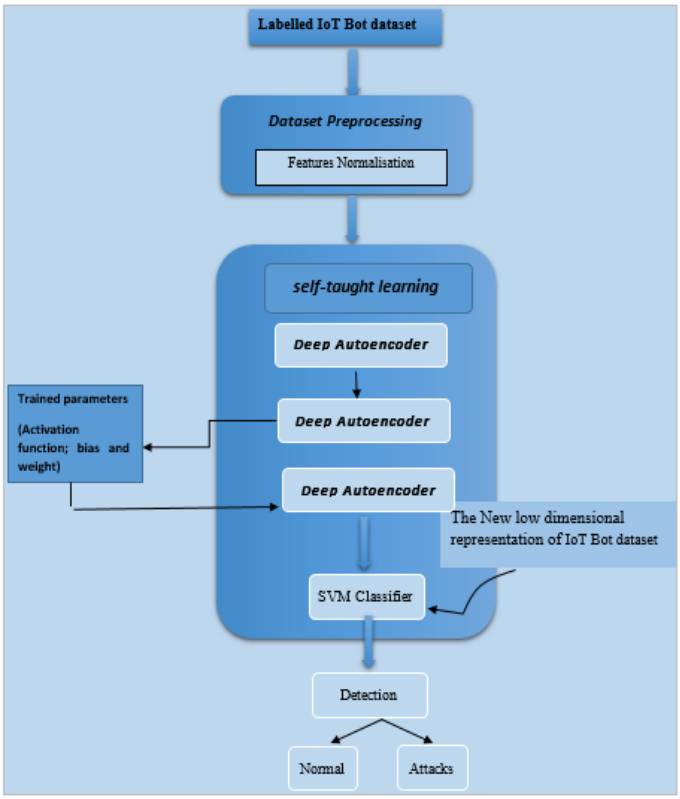

Figure 2 : Block diagram of the proposed STL-NIDS

3.1 Training Process:

Our model is performed after several performance tests. We start through the encoder layer creation, a batchnormalization step is applied after each hidden layer to decrease the number of feature maps. A stochastic gradient descent is used with a momentum value of 0.9. L2 regularization method is also applied for weight and biases with a threshold equal to 0.000001 and 0.002 respectively. Finally, a low learning rate is fixed at 0.0001 to train our deep autoencoder neural network. We use two layers of hidden layer and one latent layer using each one the sigmoid activation function. Stride parameters are fixed at 8 and 2 for hidden layer and latent layers respectively. For the dense layer, we use the widely used sigmoid function. The table 1 summarized the above Multi-layer parameters.

Model type	**Multi-layer Parameters**
Layers	5
Total parameters	1000001
Hiddenlayers	3
Epoche	1000

Batchsize	300
Learning rate	[0.05-0.1]
Weightdecayparameter μ	0.000001
bias	0.002
Latent vector dimension	2
Activation function	Sigmoid

Tab 1. The autoencoder Model and training information

After learning the optimal values for weight W and bias b, batch size and epoch by applying deep autoencoder on unlabeled data $\boldsymbol{xu}$, we evaluate the feature representation a = h for labeled data (xl, y). We used this new feature representation, h, with the label vector, y in SVM for the classification task. For our study, we apply the STL based deep autoencoder for good data representation because of its unpretentious and simple implementation and its capability to learn the original expressions and structures of data. In addition, the wide range of STL applications has been successfully applied to various fields such as: image identification and SVM for classification tasks and detection different types of intrusion because combining efficacy and solid classifiers, such as SVM, with deep autoencoder leads to improved performance in intrusion detection. Furthermore, the features extracted from the DAE algorithm are passed to the SVM classifier for intrusion detection. Figure 2 shows an architectural diagram of the proposed STL. The SVM classifier is employed at the second stage in our STL-NIDS to determine the class of network traffic features and distinguish between the normal and abnormal network traffic. It takes the output of the last autoencoder as input and then tries to classify the features. The performance accuracy rate of our method is better than that of SVM alone, and the training and testing times of SVM are reduced.

3.2 SVM:

Support vector machine (SVM) is the most binary classifier used in STL classification process. It has gained popularity in machine learning community. SVM works in combination with a RBF kernel (Gaussian kernel) that automatically realizes a non-linear mapping to a feature space. SVM was originally developed for offering good generalization performance to new data and solving the optimization problem in classification fields. The SVM process was divided into two phases, namely the optimal phase and the decision phase. In the first phase, having a set of labeled vectors L = {xi, yi} |1<i< lwhere xi ∈Rn, and yi∈ {−1, +1} represents two distinct categories. The SVM constructs a hyper plane or a set of hyper planes in a space of high or infinite dimension; it separates a given set of binary labeled training data with a hyper-plane that is maximally distant from these binary classes (known as the maximal margin hyper-plane). Finding h requires minimizing ||w||2, where w is a vector normal to h.

$$\sum_{i=1}^{n} \boldsymbol{ai} - \frac{1}{2}\sum_{i=1}^{n} \quad \sum_{j=1}^{n} \boldsymbol{ai\ aj}\ , \boldsymbol{yi\ yj}, \boldsymbol{xi\ xj}\ , \boldsymbol{w} = \sum_{i=1}^{n} \boldsymbol{aiyixi} \quad \text{With}: \quad \boldsymbol{ai} > 0 \quad \text{and} \sum_{j=1}^{n} \boldsymbol{aiy\ i} = 0 \quad (7)$$

where αi and αj are lagrange multipliers . After that, in the second phase and based on the hyper-plane, a classification of the vector was done according to their position in the n-dimensional space. The decision function was based on the following relation:

$$F(\mathrm{x}) = Min_i y_i \{< w, \varphi(x^2) > - b\} \quad (8)$$

The margin f(xi) is maximized, when the hyperplane (w,b) input the data xi with the corresponding label yi. The quantity (w,φ(xi)− b) corresponds to the distance between xi and the decision boundary. While the SVM consumes much time for training and testing, numerous studies are adressed in SVM to reduce the required processing time for classification tasks. The computational complexity and storage requirements of the SVM with RBF kernel depend on both input dimensionality (d) and the number of support vectors (nSV). In this study we was stressed on reducing the features dimensionality based on deep autoencoder to recude the SVM traing and testing time

4. Experimental results

In order to evaluate our STL-NIDSbased approach for the classification of different types of attacks in IoT, we use the Bot–IoT dataset. The implementation of the proposed work was done with Deeplearning4j, the first commercial-grade, open-source, distributed deep-learning library written for Java and Scala. In the sub-sections that follow, the details of the experiments and their results are represented.

4.1 Dataset Used:

The Bot–IoT dataset was recommended in Sunday 05/22/2019 by NickolaosKoroniotis [19]. This dataset is a collections of varied data types of network attacks in Internet of Things environment. It incorporates legitimate and simulated IoT network traffic, along with various types of attacks. The Bot–IoT dataset was

Category	Type of Category	Sub-category	Number of Packets
Denial of Service (DoS)	DDoS attacks	TCP	19547603
		UDP	18965106
		HTTP	19771
	DoSattacks	TCP	12315997
		UDP	20659491
		HTTP	29706
Information theft	Key logging	-	1469
	Data theft	-	118
Information gathering	Service scanning	nmap, hping3	1463364
	OS Fingerprinting	nmap, xprobe2	358275

developed on a realistic testbed environment precisely at the Research Cyber Range lab of UNSW Canberra, and has been labeled, with the label features indicated an attack flow, the attacks category and subcategory for possible multiclass classification purposes. The researchers used four Kali Linux VMs to launch cyber-attacks in parallel for implementing different botnet scenarios. In addition, the Bot–IoT dataset contains approximately 1GB of pcap files. Cyber-attacks and their tools considered in the Bot-IoT dataset are described as follows:

Probing attacks: also so-called, fingerprinting are malicious activities that gather information about victims through scanning remote systems. Depending on the actions performed, probing attacks goal can be examined in two separate categories: OS fingerprinting and port scanning: in the port scanning category, the researchers used the Nmap and Hping3 tools in order to perform a number of different types of port scans. On the other hand they used the Nmap and Xprobe2 tools to launch different types of OS fingerprint scans.

Denial of Service attacks: A DDoS attack is exemplified by the direct attempt of attackers to prevent legitimate users from using a specific service. Also, DDoS attacks is distributed in the way that the attacker is using multiple computers as attack platforms to launch DDoS attacks on one or more targets (the victim or related network) with the help of Control & Scan server technology. In addition, several types of DDoS attacks namely, UDP-flood, TCP-flood, and HTTP flood, was been performed in the Bot–IoT dataset. In addition, the researchers used the Hping3 toool for both DDoS, DoS for TCP and UDP. The hping3 indicates the type of attacks such as: SYN TCP attack, the type of the packets is sent as fast as possible, it specifies the packet body size, and indicates the targeted port. In other hand, for HTTP DDoS and DoS attacks, the researchers used the Golden-eye tool, to indicate the targeting Port number and IP address of Ubuntu server, the method type such as post, number of sockets, and number of concurrent workers.

Tab 2: Statistics of attacks in Bot–IoT dataset

Information Theft: is a group of attacks where an attackers seeks to compromise the security of a machine in order to obtain sensitive data. Based on the target of the attack, the information theft can be split into two major subcategories. The first subcategory is Key logging and the second one is Data theft. The researcher used Metasploit framework to exploit weaknesses in the target compromised devices in both keylogging activities and Data theft. The aim of this framework is established an ssh connection and access the logkeys software, record a user's keystrokes, potentially stealing sensitive credentials in the compromised host and then download the recordings.

4.2 Features Normalization

Several of the features of the Bot–IoT dataset have very large ranges between the maximum and minimum values, such as the difference between the maximum and minimum values in "flow duration" [0, 785673], where the minimum is 0 and the maximum value is 78, 5673. This large difference also exists in other feature values, such as Stime (Record start time) drate (Destination-to-source packets per second) and srate feature (Total packets per second in transaction). Thereby making the feature values incomparable and unsuitable for processing. Hence, these features are normalized by using standardization data process based on calculating the mean absolute difference for mapping all feature values to the range [0, 1] according to:

$$S_f=\frac{1}{N}\left[(Xi_f - M_f) + (Xi_f - M_f) + (Xi_f - M_f) + (Xi_f - M_f)\right] \quad (9)$$

Where N denotes the total number of features, xi denotes the maximum value from all data points for each feature and mi denotes the minimum value from all data points. After that, we calculate the standardized measurement (Z score function) of the features

according to the following equation: $Zi_f = Xi_f + M_f$

S_f(10)

4.3 Evaluation Metrics

The following parameters were calculated for evaluating the performance of the proposed intrusion detection system. Through these metrics, the proposed NIDS can decide which technique is best suited for this study. These metrics were defined as follows:

Accuracy: is the proportion of correctly predicted events. This metric is one of the machines learning metrics for evaluating classification model. The accuracy value is given in the following equation

$$\textbf{Accuracy} = \frac{TP+TN}{TP+TN+FN+FP} \quad (11)$$

Precision: isthe number of positive predictions divided by the total number of positive class values predicted. It is a measure of the number of true positives the model claims compared to the number of positives it claims. The precision value is given in the following equation:

$$Precision = \frac{TP}{TP+FN} \quad (12)$$

Recall: is the number of positive predictions in the model divided by the number of positive class values in the testdata. The recall value is given in the following equation:

$$Recall = \frac{TN}{TN+FP} \quad (13)$$

The True Positive (TP) indicates the correct predictions of attacks and False Positive (FP) refers to the normal traffic incorrectly classified as attack. True Negative (TN) refers to the normal data correctly classified as normal data (the number of true normal traffic). False Negative (FN) refers to the attack traffic incorrectly classified as normal traffic (the number of false normal traffic).

4.4 Performance evaluation: impact of the low-dimensional features and different hidden layers and hyper parameter on SVM classifier:

Our experiments aim to evaluate the performance efficiency of the proposed approach. In addition, we stressed on the effectiveness of the low-dimensional features extracted by our approach for binary classification based on IoT bot dataset. Furthermore, the training and testing times were calculated to evaluate the efficiency of our approach. In addition, we also stressed on addressing network intrusion detection system requirements that have lower and faster computational costs by reducing computational complexity and storage requirements of SVM classifier.

4.4.1 Impact of the low-dimensional features on The Binary Classification

The training and testing process use a training and testing data separately when we evaluate the performance efficiency of the low-dimensional features extracted by our approach for two-category classification (binary classification). Figure 3 shows the experimental results. Our STL-IDS performs better than single SVM However, STL-IDS performs better in all performance metrics compared with single SVM. The experimental results also show that the proposed approach STL-IDS reduces training and testing times of SVM as shown in table 3.

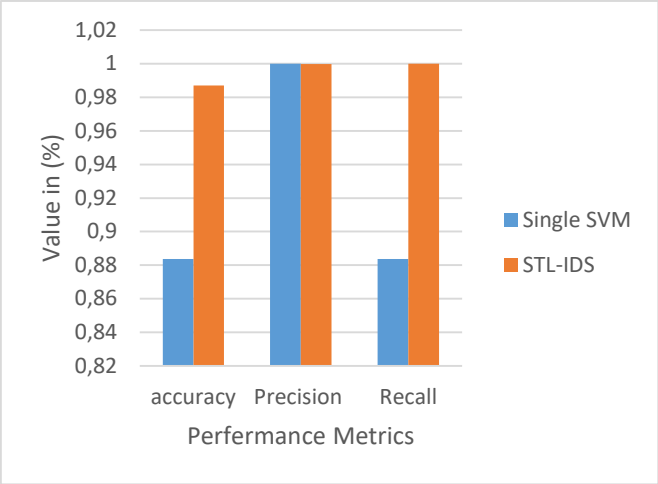

Figure3: Performance metrics values for STL-IDS and single SVM for binary classification.

Methods	Single SVM	STL-IDS
Training Time	1270.48	1009.56
Testing time	1070.48	90450
N(SV)	2756	2723

Tab 3: The performance of our model STL-NIDS compared to single SVM.

4.4.2 The effect of hyper-parameters and different numbers hidden layer number and hidden neurons setting in our Model efficiency

The number of hidden layer and deep autoencoder hyper parameters are the main parameters influencing the classification performance and time training speed.

Thus, developing an efficient deep model for NIDS involves a crustal challenging issue called hyper-parameters optimization. The optimization of our STL-NIDSbased approach was performed over key hyper-parameters and their values are given in Table 4. In addition, how to investigate the effect of hidden layer number and the Deep autoencoder and SVM hyper parameter on the performance of our deep learning model and decrease the testing and training time is another challenge in NIDS.

In order to tune the hyper parameters for all STL-NIDSmodels, in this paper, we used 900,001 instances for training and the remaining 100,000 instances for validation. After that, we selected the best value of hyper parameters based on manual search optimization method. When using Manual Search, we choose some model hyper parameters based on our experience. Then, we train the model, evaluate its accuracy and start the process again. This loop is repeated until a satisfactory accuracy is scored. Moreover, we investigate the effect of both number of hidden neurons and hidden layers size on the STL-NIDSperformance. This method optimize some of our DAE and SVM parameters such as: how many neurons to use in each layer and which hyper parameter and optimizer to use. The final model is trained with all 1 0000,001 instances. Moreover, the STL-NIDSmodel achieves the best result of accuracy when batch size and epochs of pre-training are 300 and 1000, respectively. Moreover, the model got highest accuracy for SVM Classifier with 0.50 bias, μ= 0.000001, 300 batch size and 1000 epochs of fine-tuning. In another hand, we investigate an impact the number of hidden neurons and hidden layers on the performance of STL-NIDS.

Hyper parametername	Values	The Best Value
training DAE batch size	20,4060,80,120,300	300
Pre-training DAE epoch size	10, 500, ,800 1000	1000
Weightdecayparameter μ	0.02,0.002,0.04,0.000001,0,0005,0.000003 ,0.000005	0.000001
training SVM batch size	20, 40 60 80,120,300	300
training SVM epoch size	10, 500, ,800 1000	1000

Tab 4: The tested values of hyper parameters for our STL-NIDS for binary classification.

The STL-NIDS-with five hidden layers and 32 hidden neurons at each layer is superior to other deep networks in testing accuracy for our model based intrusion detection system. Table 5 shows test classification accuracy of STL-NIDSwith different numbers of hidden neurons and layers.

Number of hiddenlayers	Neurons	Testingaccuracy (%)
3	(32,32,32)	97,701
	(64,64,64)	98,323
	(100,100,100)	98,567
5	(32,32,32, 32,32)	**98,718**
	(64,64,64,64,64)	97,656
	(100,100,100)	98,326
7	(32,32,32,32,32,32,32)	97,786
	(64,64,64,64,64,64,64)	94,678
	(100,100,100,100,100,100,100)	89,767
9	(32,32,32,32,32,32,32,32,32)	91,555
	(64,64,64,64,64,64,64,64,64)	92,432

Tab 5: The performance of the STL-NIDS with different number of hidden neurons and hidden layer.

4.5 Comparison

In order to investigate the effectiveness of our STL–IDS model on intrusion detection performance, we compared our approach to the traditional classification methods. Table 6 shows that the performance of STL–IDS is better than other benchmark algorithms. The outperformance can be noted in terms of accuracy and precision and recall. Due to the fact that deep autoencoder can learn a set of features with better classification capability and dimensionality reduction. Another reason for achieving the better accuracy by deep autoencoder is unsupervised pre-training task. Unsupervised pre-training gives substantially higher test classification accuracy than no pre-training.

Table 6: The performance of our model STL-NIDS compared to machine learning algorithms.

Methods	Support Vector Machine	Bayes Naive	Random Forest	STL-IDS
Accuracy	0,883727 02	0.9657 9	0.97579	0.987123
Precision	1	0.9111 998	0.94119 9	0.99989
Recall	0,883711 9	0.9478 90	0.97789 0	1
Training time	1270.48	3034,4 3	2885,34	1009.56

5. Conclusion and Future Work

In this paper, we proposed an unsupervised features learning based approach for developing an efficient and flexible network intrusion detection system (STL-NIDS) in IoT. A deep autoencoder DAE and SVM classifier based NIDS has been carried out. The deep autoencoder is one of the most interesting models to extract features from the high-dimensional data in the context of deep learning. The proposed approach offers a solution to combine the advantages of unsupervised and supervised learning in the context of intrusion detection. In addition, we used the benchmark IoT network intrusion dataset-Bot–IoT to evaluate our intrusion detection accuracy. In all the cases, we observed that the proposed STL-NIDSperformed very well compared to single SVM implemented in NIDSs for the normal/anomaly detection when evaluated on the test data. The proposed approach achieved detection accuracy 98.71% on the total 10 test dataset. To the best of our knowledge this is the only framework which has the capability to collect network-level activities in a distributed manner using a combination of DAEs and SVM classifier to detect attack more accurately using Bot–IoT dataset. In future, we plan to implement a real-time NIDS for actual IoT networks using deep learning technique. Additionally, on-the-go feature learning on raw networktraffic headers instead of extracted features can be another high impact research in this area.

Notes

1. https://scikit-learn.org/
2. https://cloudstor.aarnet.edu.au/plus/s/umT99TnxvbpkkoE?path=%2FCSV%2FTraning%20and%20Testing%20Tets%20(5%25%20of%20the%20entier%20dataset)
3. https://deeplearning4j.org/

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Accelerating Quasi Periodic Dynamic Time Warping For Similarity Search in ECG Time Series

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Informations

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Reçu, Révisé, Accepté.

Abstract

Several methods have been proposed for similarity search in time series (TS). Our previouslypublishedmethodQP-DTW(QuasiPeriodicDynamicTimeWarping)has beenproposedasarivalmethodtoDTWforquasiperiodicTSalignment.However the method is expensive in terms of time complexity. Consequently it is not appropriateforsimilaritysearchinTS,wherethemethodswithlesstimecomplexity areneeded.InthispaperweproposeanacceleratedversionoftheQP-DTWmethod and we use it to solve the problem of searching similar ECG (Electrocardiogram) time series in a data base. We have focused on ECG TS for its utility in various medical domains, including Diagnostic of cardiac disease and biometry. The proposed Accelerated QP-DTW (A-QPDTW) used Haar Wavelet Transform as a techniquetoreducethedimensionalityoftheTSandtheKNN(Knearestneighbor) approach to search for TS that are similar to a given query. Experimental results show that the proposed method is more efficient than QPDTW method with comparativeaccuracy.AllresultshavebeenobtainedusingtheECGTSoftheUCR (University of California at Riverside) time series Dataset, universally admittedas the first Benchmark in time series analyses.

1. Introduction

There are many phenomena that are representedintimeseriesforms(TS)suchasthe values of stock exchange (companies shares), prices of goods and services, the ECG signal (Electrocardiogram), the traffic density in a computernetwork,multimediadata,etc..

A time series is a collection of data obtained sequentially in time. Formally, a time series is a continuation of couples $<(v_1,t_1),(v_2,t_2),\ldots,(v_i,t_i),\ldots>$ where v_i is a value or a vector of values taken at time index t_i. This notation can be abbreviated in $<v_1, v_2,\ldots, v_i,\ldots>$when the reference to the time does not need to be clarified **[1]**.

Proximity or *similarity searching* is the problem of, given a data set and a similarity measure, findingtheelementsfromthesetthatarecloseto a given query. This is a natural extension of the classicalproblemofexactsearching**[2]**.

Ithasmanyapplications.Someexamples are: speech recognition **[3]**,handwriting recognition **[4]**, content-based image retrieval **[5]**, slice music similarity search **[6]**, etc.

Literature shows that the most used types of similarity search queries are: (a) range query and (b) nearest neighbors query. Range query consists in retrieval of all time series in a data base within a certain distance r from the query object, while k nearest neighbors query returns the k time series most similar to the query time series **[7].**

In both cases, the performance of similarity search depends highly on the distance measureusedtocomparethetimeseries**[8]**.Itis knownthatDTW(DynamicTimeWarping)isthe most suitable measure for many applications of timeseries,includingsimilaritysearch**[9]**.Chen etal,forexampleadaptDTWatIndividualQuery for Electrocardiogram Analysis in Cardiology **[10]**.

In another context, our previously published method QP-DTW (Quasi Periodic Dynamic Time Warping) has been proposed asa rivalmethodtoDTWforECGalignment.However the method is expensive in terms oftime

complexity.Consequentlyitisnotappropriatefor similaritysearchinECGTS,wheremethodswith less time complexity are needed, particularly in large databases. In this paper we propose an accelerated version of the QP-DTW method and we use it to resolve the problem of searching similar ECG time series within a given database. We have focused on ECG for its utility invarious domainsincludingDiagnosticofcardiacdiseases andbiometry.

Diagnostic applications for people with risk of heart dysfunctions are more and more usednowadays.Forinstance,peoplewithcardiac high risk factors bear wearable sensors in their daily lives. These sensors continuously monitor health conditions like ECG and send the data to Automatic Diagnostic Systems, where they are processed in quasi real-time diagnosis **[11]**. Regarding the field of biometry, it is suggested thatECGtraceisuniquetoeachpersonandithas been introduced as one of the most powerful biometric tool for personal identification **[12], [13]**.

The proposed AQP-DTW (Accelerated Quasi Periodic Dynamic Time Warping) uses Discreet Wavelet Transform (DWT) as a techniquetoreducethedimensionalityoftheTS. The obtained TS are fed to QP-DTW and finally, theKNN(Knearestneighbor)approachusesthe AQP-DTW procedure to search for the K TS that are most similar to a given query. Experimental results show that the proposed method is more efficientthantheQPDTWmethodinthecontext ofTSsimilaritysearchforacomparableaccuracy.

All results have been obtained using the ECG TS of the UCR (University of California at Riverside) time series Dataset, universally admitted as the first Benchmark in time series analyses.

The rest of this paper is organized as follow. Section 2 presents related works, while Section 3 describes our proposed method. The 4th section is devoted to application of our method to similarity search and to experiment tests.Finally,Section5concludesthispaperand gives perspectives of ourresearch.

2. Materials andmethods

The search for similarity is limited becauseofthelargesizeofthetimeseriesBDDs. The best solution, according to **[14]**, would beto use a dimensionality reduction technique on the data such as DFT(Discret Fourrier Transform) **[1]**, DWT (Discret Wavelet Transform **[15]**,PAA (Piecewise Aggregate Approximation) **[14]**, SAX (Symbolic Aggregate approXimation)**[16]** orto use index structures. Echihabi et al. **[17]** compared these methods in terms of efficiency under a single, unified experimental framework. Their work indicates that there is no single best method that outperforms all the rest. Recently Gogolou et al. **[18]** provides progressive whole-matching similarity search results on large time series collections. They show that there is a gap between the time the 1st Nearest Neighbour (1-NN) is found and the time when the search algorithmterminates.Inotherwords,usersoften wait without any improvement in their answers. Theyfurthershowthathigh-qualityapproximate answers are found very early with their method. In our case, we will use the wavelet transform to acceleratethesimilaritysearchwithQP-DTWand KNNmethods.

2.1. Discrete Wavelet Transform(DWT)

DWT or Discrete Wavelet Transform **[15]** is a mathematical tool for signals and time series modeling based on a hierarchical decompositionfunction.Meanwhile,itisusedas an effective characterization and dimensional reduction technique for similarity searching in timeseries.

The basic idea of DWT is similar to that usedbyAgrawalfortheDFTtechnique**[1]**inthe sense that a time series can be represented only by a discrete wavelet transform, but by taking only the first N coefficients. This way, we can reduce the dimensionality and keep a large part oftheinformationwithintheoriginaltimeseries. DWThasseveraladvantagessuchasitsabilityto search at different scales and its temporal complexity which is O (n), compared to that of DFT which is $O(n^2)$.

2.2. Quasi-Periodic Dynamic Time Warping (QP-DTW)

Quasi-Periodic Dynamic Time Warping is a similarity measure proposed by Boulnemour& Boucheham **[19]**. It combines the SEA **[20]** and the DTW **[21]**, **[22]** methods. It was especially designed for alignment of quasi-periodic time series and specifically for heartbeats time series providedfromECG(Electrocardiogram)records. It is argued that Quasi-periodic time series are very complex TS for they are concatenations of quasi-similarformscalledperiods(Cycles).Such that,thealignmentoftheseseriesisnotpossible beyond the SEA method and its derivatives (includingQP-DTW)**[20]**.Itwasdemonstratedin **[20]**and**[19]**,thatDTWcompletelyfailswhenit comes to align quasi-periodic time series containing each a different number of quasi similar and phase shiftedperiods.

Fig.1(a)showstheoriginaltracesXand Y.Fig.1(b)illustratesthealignmentdonebyQP-

DTWforXanditsreconstructedtimeseries(left of Fig. 1(b)) and for the time series Y and its reconstructedtimeseries(rightofFig.1(b)).Fig. 1 (c) presents the alignment done by the DTW methodforthetimeseriesXandY.Notethatthe twotracesarefromthesametimeseriesbutthat they are of different lengths. They are alsophase shifted because they are not taken at the same time (offset of 35 seconds for Y). Fig.2, illustrate the QP-DTWdiagram.

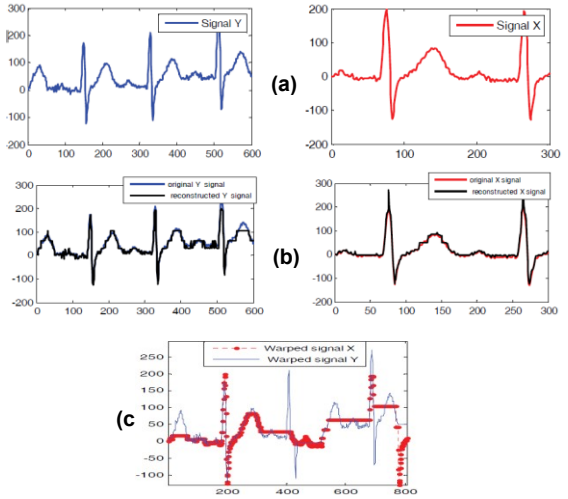

Fig.1. Comparison of the QP-DTW and the DTW methodsforthecaseofquasi-periodictimeserieswith phase shift (rec.215). (a) Original signals. (b) Original signals vs. reconstructed signals by QP-DTW (c) Original signal vs. warped signal by DTW **[19]**.

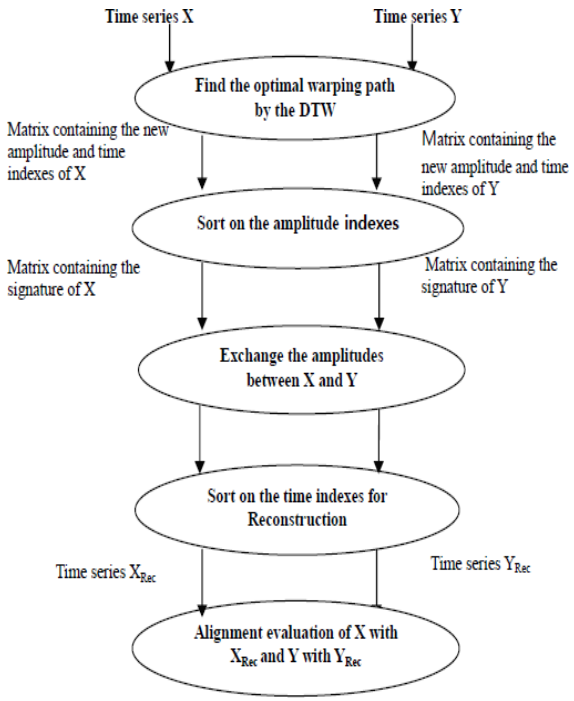

Fig.2. Illustrative diagram of the QP-DTW method.

3. Accelerated Quasi Periodic Dynamic Time Warping(A-QPDTW)

Inthissection,wedescribeourproposed method: Accelerated Quasi Periodic Dynamic TimeWarping(A-QPDTW).A-QPDTWismainly composedoftwosteps.ItisdescribedinFig.3.

A. FeatureExtraction

In literature, there are several types of wavelet transforms. We have used the OneLevel Haar Wavelets Transforms due to its simplicity, efficiency (Linear order of complexity) and effectiveness in extracting the discriminate features and reducing the dimensionality of quasi-periodic time series(QP-TS).

TheHaarwaveletransformisaseriesof matching and differentiation operations. In the matching operations, we obtain the approximationcoefficients.Inthedifferentiation operations,wegetthedetailcoefficients.Tohave an idea of how the Haar wavelet transform works,let'sconsiderthefollowing 4-dimensional TS:

X=[10,6,5,7].Weobtainthedetail(cD)andthe approximate coefficients (cA) asfollows:

$$cA=\left\{\frac{10+6}{2},\frac{5+7}{2}\right\},\ cD=\left\{\frac{10-6}{2},\frac{5-7}{2}\right\}$$

The one level Haar Wavelet transform ofXusingcAisthen[2,-1]andusingcDis[8,6]. Fig.3, shows the original TS and its reduced TS using approximation coefficients of Haar wavelets Transform. We see that, the length of thereducedTSisthehalfoftheoriginalTS.

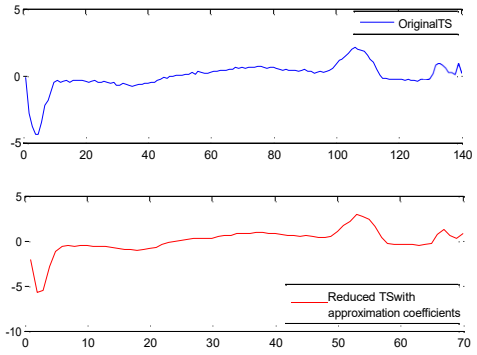

Fig.3. Original TS vs. Reduced TS with approximation coefficients.

B. SimilarityMeasure

The second step consists in applying the QP-DTW similarity measure on the reduced data and to search for the similar TS to a given query within a given database, using KNN

approach.Fig.4,describestheAQP-DTWgeneral diagram.

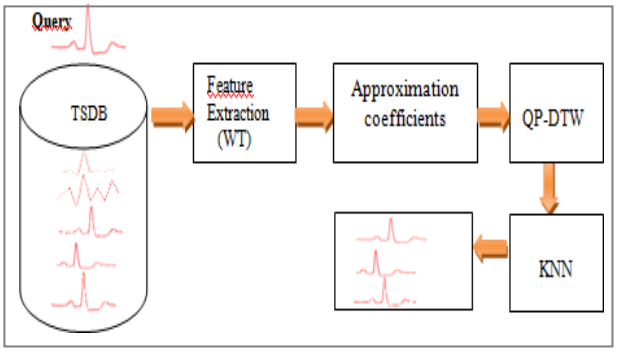

Fig.4. Illustrative diagram of the AQP-DTW method.

4. Experimentation

4.1. Experimentalconfiguration

Inthissection,weevaluatetheefficiency and the effectiveness of our algorithm on the problem of similarity search on ECG timeseries. The ECG time series dataset, for experiment are selected from the UCR Time Series DataArchive [Chen,201523].Thisdataarchiveisadmittedasa benchmarkfortestingandevaluatingtimeseries similarity measures. The UCR contains 7 ECG timeseriesdatasetandeachonehaveastandard partitions of training and testing set. A description of the dataset used in our study is presented inTable1.

Table1. Description of the used ECG datasets

Dataset Name	Numberof Classes	Size of Training Set	Size of Testing Set	Time Series Length
ECG200	02	100	100	96
ECGFiveDays	02	23	861	136
ECG5000	05	500	4500	140
CinC_ECG_torso	04	40	1380	1639
TwoLeadECG	02	23	1139	82
NonInvasiveFatalECGThorax1	42	1800	1965	750
NonInvasiveFatalECGThorax2	42	1800	1965	750

All applications in this study have been performedonanexperimentalenvironmentwith thefollowingcharacteristics:PCIntel(R)Core™ i7 CPU, 2.10 GHz, 4Go of main memory, OS Windows 7 (64 bits) and MATLAB 2014 environment.

4. 2. Experimentalresults

First we start by evaluating the proposedmethodAQP-DTW,intermofefficiency (run time) with regard to the QP-DTW, on the problem of similarity search. The executiontime is obtained by calculating the average execution timeofallthequeriesinthetestingdataset.Fig.5, shows the execution time in seconds for both A-QPDTW and QP-DTW, on all ECG time series in UCR. We notice that, the method AQP-DTW is moreefficientthantheQP-DTWmethod.Infact, it is about three times faster than QP-DTW method in all datasets. Moreover, in the case of long time series, we show that our method is even faster. As an example, for the dataset CinC_ECG_torso,thetimeexecutionoftheAQP-DTW is 1046, 20 seconds while it is 4228,75 seconds for the QP-DTW (four times faster). Another example, for the small datasetECG200, the time execution of the AQP-DTW is 0, 37 secondsanditis1,12secondsfortheQP-DTW.

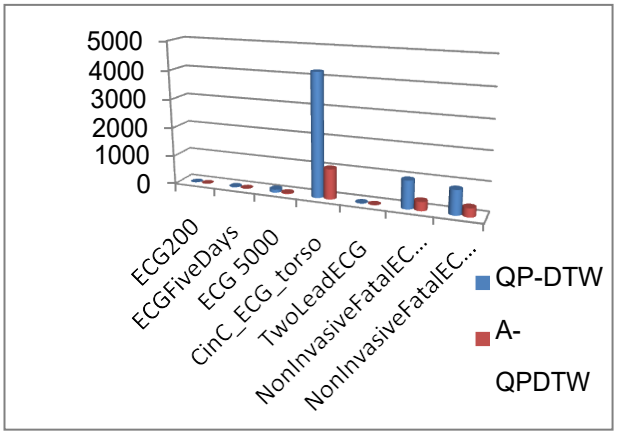

Fig.5. Execution times for AQP-DTW Vs QP-DTW.

On the other hand, wecomparetheprecision of our method AQP-DTW with regardto the QP-DTW method within the problem of similarity search. In that respect, we mention that the precision criteria measures the fraction of relevant objects returned in a given query in relation to the total of returned objects[Garcia, 201424]. Fig.6, shows an example of a givenquery andthe20returnedsimilarTSusingourproposed method. the parameter k = 20 hasbeenchosenempirically. We clearly see that all the returnedTS havethesameshapeasthequeryshape.

Table2 shows experimental results of the precision comparison for both A-QPDTW and QP-DTW on all ECG time series in UCR. Results show that the precisions of the two methods are comparable to each other. For the dataset, "CinC_ECG_torso",theprecisionofQP-DTWis0.275 and the one of AQP-DTW is 0.273. For the dataset "NonInvasiveFatalECG_Thorax1", the precision of QP-DTWis0.698andtheoneofAQP-DTWis0.693.

Indeed,AQP-DTWwinsintwodatasetsandlosesin fivedatasetswithcomparisontoQP-DTW.

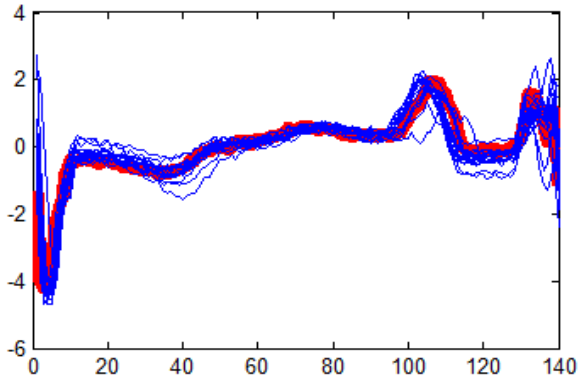

Fig.6. PrecisionofAQP-DTWmethod.TheredTSis thequeryobjectandthebluesTSarethe20returned objectswhicharesimilartothequery(k=20).

Table2. Precision of QPDTW Vs AQP-DTW

Data sets	QP-DTW	A-QPDTW
ECG200	0.693	0.632
ECGFiveDays	0.576	0.552
ECG 5000	0.720	0.728
CinC_ECG_tors	0.275	0.273
TwoLeadECG	0.532	0.578
NonInvasiveFatal ECG_Thorax1	0.698	0.693
NonInvasiveFatal ECG_Thorax2	0.730	0.712

5. Conclusion

In this paper, we have focused on the problemofsimilaritysearchinECGdatabase.In this regards, we have developed an efficient similarity measure. The obtained AQP-DTW is based on Haar Wavelet Transform and QPDTW similarity measure. Experimental results show that the proposed method is about three times faster than QP-DTW with practically no loss of precision. As future work, we aim to apply the proposed method in biometricfield.

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Fast and efficient Preprocessing Algorithm for Removing Highly Impulsive Noise in Digital Images

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Information

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VM3224K2 Daughter Kit

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Abstract

This work proposes a new approach to enhance corrupted images. Digital images suffer from different type of degradations. However, the main objective is to remove low and high impulsive noise density using a new developed median filter. The employed filter performs spatial information processing to determine which pixels in the image have been affected by impulsive noise. Thereafter, replace those pixels by the median value of the proposed 2-D areas that have the low variance value. The proposed algorithm has been optimized and implemented on a float-point TMS320C6713 Digital Signal Processor of Texas Instruments. A display module (LCD screen) is also used and connected to the DSP kit to display the output enhanced image. Performance of the proposed algorithm is compared with others nonlinear filters. The improved median filter is successfully tested with multiple grayscale images and gives better Peak Signal-to-Noise Ratio (PSNR) and Mean Square Error (MSE) results..

1. Introduction

Image processing is a method for performing certain operations on a digital image to obtain an enhanced image or to extract hidden information that can be interpreted and used for several purposes. Impulse noise is one the most severe noise which usually affects the images. So, the researchers focus on the removal of this impulse noise. The Nonlinear filters have widely been exploited due to their success in removing the impulsive salt-and-pepper noise while preserving the fine details of the image **[1]** and can be performed more effectively with the front-end and subsequent processes, such as edge detection, segmentation, classification and recognition **[3]**.The general impulse noise removal process can be expressed in figure 1.

In this research, we will first explain the objective of image preprocessing, where the developed algorithms can reduce the effect of impulse noise and intensity inhomogeneities by using the modified median filter. The rest of this paper is structured as follows: Sections 2, 3 and 4 explain some related methods and materials used in this work. The Section 5 is dedicated to our proposed approach and system design, the hardware implementation is given in section 6. All experimental result and their optimizations were presented in the Section 7 and 8. Finally general conclusion is noted.

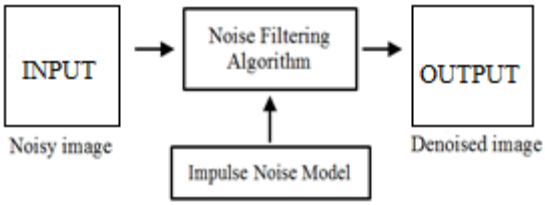


Fig. 1 : A General Impulse Noise Removal Process.

2. Literature Review

Various enhanced median filters are cited in the literature for removal of high density impulse noise in image. Recently, many improved techniques have been considered for that issue: Sharma et al propose a novel recursive median filter that detects noise and then it will be removed by using the two thresholds values (Minimum threshold and maximum threshold) **[5]**. Also Zheng-yang et al develop an adaptive median filter which determines a possible noise pixel according to the characteristic of the salt and pepper noise **[7]**. Lots of important enhanced methods have been done and executed as Li et al[8], Jubair et al

[9] **[6]**, Tafti et al. **[10]**, Anitha et al. **[11]**, Sakthivel et al. **[12]**, Varshney et al. **[13]**, Das et al. **[14]**, Arastehfar et al **[15]**.

3. Image De-noising Based on Median Filter

3.1. *Impulse Noise Model*

Impulse noise is a phenomenon that affects an image during some process like acquisition, formation, storage and transmission. This type of noise is modeled as salt-and-pepper noise or random valued noise where if noisy pixels take just 0 or 255, the impulse noise will be called salt-and-pepper noise. Otherwise, the noise is called random valued noise. The impulse noise is mathematically expressed in the first equation (1):

$$w(i,j)=\begin{cases} R(i,j) & \text{with propability B} \\ I(i,j) & \text{with prpability } 1-B \end{cases} \quad (1)$$

Where B is Noise density, I is a noise-free image, W represents noisy image and R takes random numbers 0 or 255 generated with the equal probability in the image.

3.2. *Median Filter Overview*

There are two basic techniques to image de-noising: the spatial filtering and the Transform domain filtering methods; we are very interesting by the first technique. The Standard median filter is one type of spatial filtering technique that replaces the center value in the mask with the median of all pixels values [2].So in 2-D if Xij is the input, the output Yij is given by:

$$Y_{ij}=\text{med}\{X_{ij}\}=\text{med}\{X_{(i+r)(j+c)}(r,c)\in A, (i,j)\in I\} \quad (2)$$

The Recursive Median Filter is developed from the median filter using previous output of median filter rather than pixel values of input image; also we can develop it to adaptive filter.

4. Digital Signal Processor Tools

4.1 *TMS320C6713 DSK*

The TMS320C6713DSK is an embedded platform of low-cost autonomous development and also is based on the high-performance that enables users to evaluate, develop and implement applications or new algorithm on hardware Kit. The simplified architecture of the TMS320C6713DSK is shown in the figure 2.

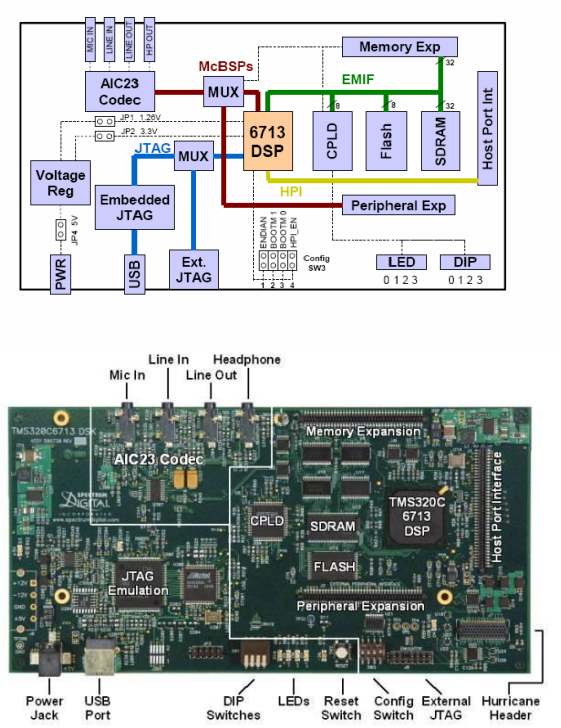


Fig. 2 : TMS320C6713 Development Starter Kit.

This platform contains various components that support some interesting features, the C6713DSK architecture include:

- JTAG (Joint Test Action Group) emulation through on-board JTAG emulator with USB host, external emulator
- A Texas Instruments TMS320C6713 DSP Core 32 Bit floating point processor that operating at 225 MHz
- Software board configuration through the registers implemented in CPLD, HPI boot mode, 32 Bit EMIF.
- 512 KB of non-volatile Flash memory (256 KB usable in default configuration) and 264KB of internal memory
- Standard expansion connectors for daughter card use
- Single voltage power supply (+5V),
- 04 user accessible LEDs and DIP switches, boot options
- An AIC23 stereo codec, Interface or external emulator
- 16 Mbytes of the external synchronous DRAM

4.2 *VM3224K2 LCD Daughter Card*

The Video Daughter card like VM3224K2 kit is a video in/out hardware module that provides developers to evaluate and develop image processing algorithms based on Texas Instruments' TMS320C6000 DSP Starter Kit. This product VM3224K2 acquires NTSC/PAL

analog video signal and displays digital video data on TFT LCD display screen. The VM3224 is embedded over to see the results of processing done in TMS320C6713 hardware. The daughter card is also compatible with Image processing algorithms, as we are able to display input and output segmented images. The TFT LCD panel uses an RGB565 pixel expression that is 320x240 in size. The LCD panel must provide pixel data periodically according to the pixel array pattern. Thus, the DSP stores image data in the RGB565 format, in order to display it on the TFT LCD. So, output obtained in the project is RGB which is first converted into RGB565 format which is a mandatory for this daughter kit in order to display the output image in the respective kit.

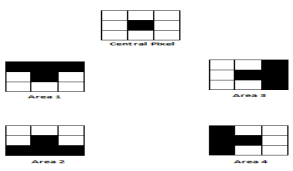
Fig. 3 : VM3224K2 Display Module..

4.3 *Embedded Target For Texas Instrument C67x*

Embedded IDE Link provides a connection between Matlab and CCS which the Simulink Embedded Target converts our Simulink model into a CCS Project. With IDE we can use Matlab and Simulink to analyze, shape and correct the behavior of running code. Another possible use for automation is to create Matlab scripts that verify and examine the algorithms running in their final run. The Relationship between MATLAB, CCS and DSP Texas Instrument.

5. Proposed Method

In this section, we are going to describe the different steps of our proposed algorithm that performs spatial information processing to determine which pixels in an image have been affected by impulse noise then replace this corrupted pixel only by the median value of selected area that have low variance value. The nine proposed areas are represented as:



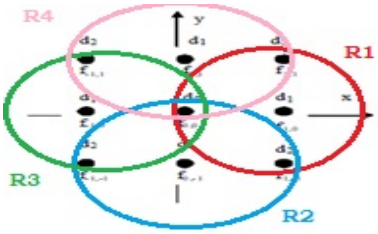


Fig. 4 : The fourth Proposed Neighborhood Areas.

The main various steps involved in our proposed method can be explained as follows:

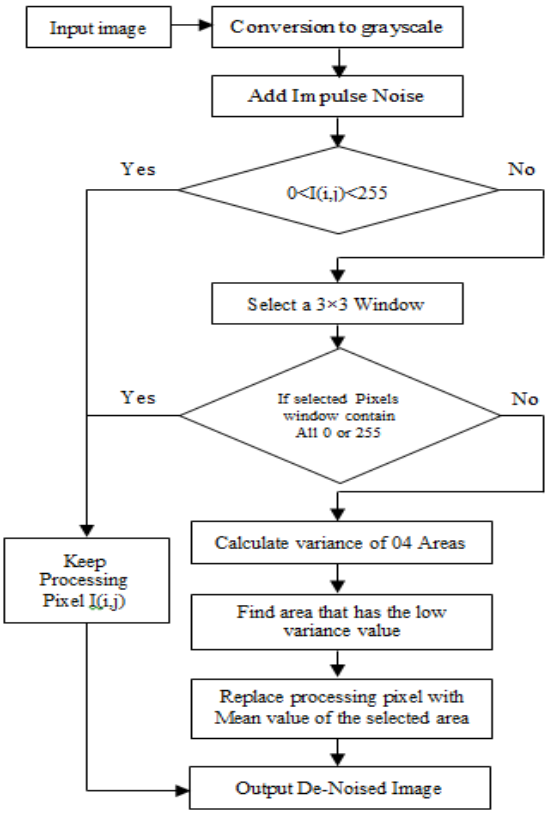


Fig. 5 : Flow Diagram of the Proposed Algorithm.

Step 1: Read noisy grayscale image I[M N] that are corrupted by salt and pepper impulse noise.
Step 2: Check the processing pixel value in the whole image, if their value is between 0 and 255 ranges then keep the same processing value I(i,j) else go to step 3.
Step 3: Select a 2-D moving window with 3×3 size.
Step 4: Check a 3×3 selected pixels in the current window, if all these selected pixels have as 0 or 255 values then keep the same processing value I(i,j) else go to step 5.
Step 5: Calculate variance value of the fourth selected areas showed in figure 5.
Step 6: Find the area that has low variance value
Step 7: Replace the current processing pixel I(i,j) with the Mean value of the selected area that have low variance value.

Step 8: Repeat steps two to seven until all pixels are processed and get better de-noised image as final output.

6. Hardware Implementation

In this work, a novel approach is implemented in real time on TMS320C6713 DSK and displayed by the VM3224K2 Daughter card Kit which is fully automatic and does not need any user interaction. Figure7 showed the proposed hardware implementation.

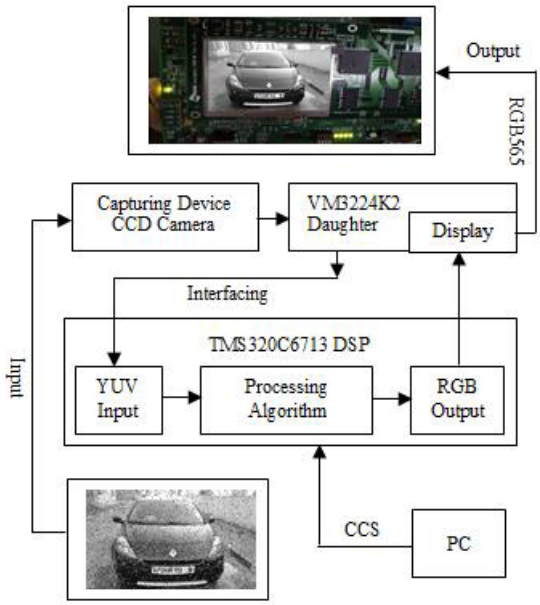


Fig. 6 : Proposed Hardware Implementation.

Once proposed algorithm was developed, it was completely verified in Matlab with multiple input images. Then the in-built functions of MATLAB were replaced by the user-defined functions in Matlab Simulink Model that he uses different Blocksets of "Video and Image Processing Blocksets" library. The proposed C6713DSP Simulink model is shown in the figure

Blocks	Library	Quantity
Image from file	Sources	01
Median filter	Enhancement	01
Video viewer	Sinks	02
Embedded MATLAB function	User-Defined Functions	05
Image data type conversion	Conversions	04
Color space conversion	Conversions	01
PSNR	Statistics	03
Display	Sinks	06

Table 1. Matlab Simulink Blocks Set Used.

On Matlab Simulink, there is a library containing a specific blocks for each type of DSP card, from this library we add the C6713 block then we selects processor type and also clock frequency value. Concerning the passage from DSP Simulink Model to the Code Composer Studio, MATLAB has developed a tool ''Link for code composer studio'' which allowed him to communicate with the Code Composer Studio for compilation, real time debugging, and linking program in Integrated Development Environment (IDE). So with using these tools, the proposed Simulink is translated into CCS project written in C language that could be compiled using a highly optimizing C/ C++ Compiler and run on the TMS320C6713 DSP. The next step is to compile C code creating, so the Build command will compile all the files that are included in this project and make an executable file then we load the executable file (.out).

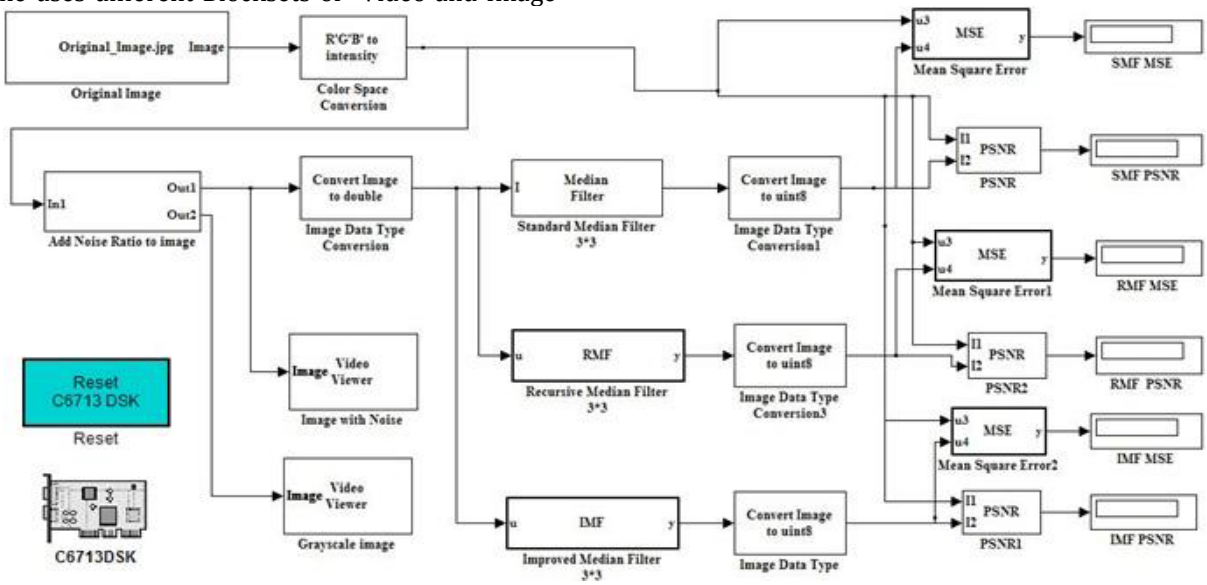


Fig. 7 : Flowchart of the Proposed Simulink Model.

4. Results and Discussion

In this work, two performance indicators have been used for comparison. Tables 2 and 3 show the Peak Signal-to-Noise Ratio and Mean Squared Error results. Figures 7 presents debugging results after successful execution in Code Composer Studio v3.1 and hardware implementation on TMS320C6713 DSP Processor.

In order to measure the quality of the filtered image, a comparison is made by using two performance metrics: Mean Squared Error (MSE) and Peak Signal-to-Noise Ratio (PSNR). PSNR is the ratio between the maximum possible power of a signal and the power of corrupting noise and it expressed as:

$$\text{PSNR}=10log_{10}\left(\frac{R^2}{MSE}\right) \quad (3)$$

In the previous equation, R equal 255 if we use image as uint8 data. The M and N are the numbers of rows and columns in image. MSE represents the square of the cumulative error and he is calculated according to the following equation:

$$\text{MSE} = \frac{\sum_{M,N}\left[I(i,j)-I_{noisy}(i,j)\right]^2}{M*N} \quad (4)$$

Peak Signal to Noise Ratio (PSNR)					Mean Square Error (MSE)			
Noise Ratio	SMF	RMF	AMF	IMF (Proposed)	SMF	RMF	AMF	IMF (Proposed)
0.00	27.33	29.50	30.77	32.30	119.29	72.30	53.72	38.03
0.02	26.79	29.12	30.21	32.09	135.01	78.98	61.14	39.99
0.04	26.37	28.70	29.84	30.91	148.81	87.09	66.72	52.51
0.06	25.41	27.71	28.53	29.96	185.81	109.60	90.33	65.46
0.08	25.08	26.84	27.79	28.99	200.82	133.92	107.24	81.88
0.10	24.85	26.96	26.89	28.61	211.98	130.19	132.42	89.31
0.12	24.73	26.26	26.35	28.08	217.53	153.10	150.05	100.88
0.14	24.09	25.63	25.51	27.24	252.76	177.46	181.95	122.49
0.16	23.03	24.66	24.84	26.52	322.32	221.55	212.37	144.54
0.18	22.20	24.49	24.38	26.05	391.11	230.51	236.49	161.26
0.19	21.75	23.75	23.90	25.27	433.27	273.87	263.91	192.87

Table 2. PSNR and MSE Values for Various Noise Density.

The proposed filter IMF is tested with digital images of size 512 x 512. These images are corrupted by Salt and Pepper noise at various noise ratios. For comparison purposes, lot of methods were chosen and indicated as follows: SMF_ Standard Median Filter, RMF_ Recursive Median Filter **[5]**, AMF_Adaptive Median Filter **[7]**. Also the experimental results obtained were well compared with the several previously published research methods.

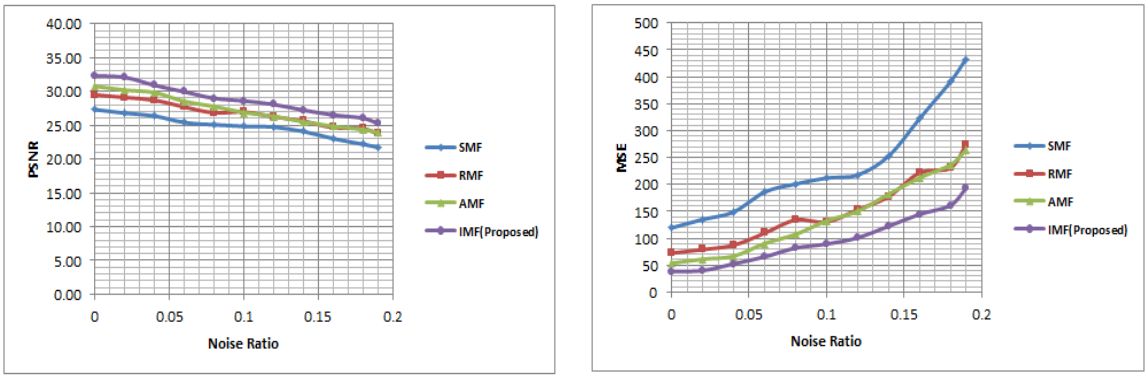


Fig. 8 : Graph comparison in terms of PSNR and MSE.

5. Optimization

For analyzing the performance of the proposed algorithm various optimization techniques were used in term of the DSP implementation as:

- Speed optimization done using Temporary variable to avoid repeated computations
- Code optimization using short data type instead of word data type
- Change Complier setting to –g –o3.
- Inbuilt Instruction using instrinsic operators like ADD2, SUB2, LDW and STW

Fonctions	No. of CPU Cycles (Without Optimization)	No. of CPU Cycles (With Optimization)
RGB to Intensity	3923732	3026222
Convert image to uint8	3401868	2718414
Convert image to double	3401868	2718414
Add Noise Ratio	727897	648206
Improved Median Filter	6203673	5946233
Total	17659038	15057489

6. Conclusion

In this paper, an enhancement algorithm has been proposed to remove impulsive noise from corrupted digital images. The method is based on an improved median filter. The proposed scheme has been implemented practically on TMS320C6713 DSP and VM3224K2 Daughter Kit using integrated development environment (IDE) via code composer studio. The experiment results carried out are consistent and satisfactory compared with other nonlinear filter methods..

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Contextual Collaborative Filtering Recommendation Using Bio-inspired Algorithm

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Informations

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Movielens

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Abstract

Collaborative filtering algorithm has been successfully employed in e-commercial and academic application. However, traditional collaborative filtering methods use only users' evaluations and do not consider the change of the users' preferences over context. They give a same treatment on user's score in different contextual situations. In order to solve above problem, this paper proposes a new item-based collaborative filtering algorithm in order to incorporate contextual information of users and items. The proposed algorithm endows the rating of a user on an item with a weight function which takes into account the importance of each contextual information for users. Experimental results from Movielens data set show that the proposed algorithm outperforms the traditional item-based collaborative filtering algorithm.

1. Introduction

Nowadays, it is very difficult for users to find the most desirable information in a short time due to the increasing information in the world **[1]**. A recommender system offers a feasible solution to this problem. It aim to provide information or items (such as music, movie, books, etc.) that are likely of interest to a user, it has been successfully employed in e-commerce and academic applications **[2]**. Recommender systems can be largely divided into two categories: content-based recommendation and collaborative filtering recommendation. Content-based approach tries to predict the utility of items for a particular user based on the significant features describing the content of an item **[3, 4]**. Whereas, Collaborative Filtering approach ignores the contents of the item, and makes recommendations only based on the items previously rated by other users **[5]**. Despite its success and popularity, this technique suffers from several limitations including sparsity, system scalability, and synonymy. Moreover, the traditional collaborative filtering method does not incorporate contextual information in the recommendation process. They ignore the changes of user's interests over context because they suppose that user's preferences are stationary **[6]**. However, in the real world, item's evaluation can be influenced by additional and varying contextual information. In addition, every user has a different importance or priority on each contextual feature. For instance, in many situations, evaluation time, user's gender or item's genre plays an important role in defining a user's preference for an item. In this paper, we propose a Context Aware Collaborative Filtering algorithm to incorporate the contextual information in the recommendation process. Firstly, the proposed algorithm uses the Genetic Algorithm to calculate the influence of each contextual parameter on users' preferences. Then it computes the weight function for each rating when calculating user predictions. The proposed weight function is a simple linear combination that reflects the similarity between two user's contexts.

The rest of the paper is organized as follows. Section 2 presents related works. Section 3 describes in details the proposed

algorithm. Section 4 presents experimental works. It provides data set details, evaluation metric and results of different experiments. The final section provides a conclusion.

2. Related works

More recently, a number of researches attempted to improve the quality of recommendation systems by taking contextual information into account. Such systems are called Context aware system **[7-10]**. Context is a multifaceted concept; it includes any information that can be used to characterize the situation of an entity **[11]**.

Si et al. **[12]** present a system that incorporates user's dynamic contexts into the traditional Collaborative Filtering algorithm. Instead of using ratings, the authors use a dynamic profile vector. Park and Kahng study the temporal dynamics in users' music listening behaviors by considering periodicity of the time dimension and popularity change **[6]**. Sun et al. **[1]** divide the user's rating history into several periods, then analyze user's interests distributing in these periods by a phrased forecast method. To integrate context into Collaborative Filtering, Chen determines relevant ratings for a given context using the similarity of context proposed **[13]**.

At the same time, several researchers use machine learning methods to ameliorate recommender systems. Genetic algorithms are randomized search and optimization technique based on the evolutionary ideas of natural selection and genetics. It has mainly been used in two aspects of a Recommender System: clustering **[14, 15]** and hybrid methods **[16, 17]**.

Abdul Hameed et al. propose a method combining Genetic Algorithms based clustering algorithm with Collaborative Filtering **[18]**. Salehi et al. consider weights of implicit or latent attributes of materials for learner as chromosomes in Genetic Algorithm and according to historical rating they optimize the weights **[19]**. Then, they generate recommendation by Nearest Neighborhood Algorithm using the optimized weight vectors. Karatzoglou et al. present a Genetic Collaborative Filtering model that is based on a generalization of matrix factorization to address contextual recommendation problems **[20]**.

3. Proposed algorithm

The challenge of collaborative filtering system is to improve the quality of recommendations for the users. Traditional collaborative filtering methods do not exploit any contextual information about the users or items. They ignore the changes of user's interests over context because they suppose that user's preferences are stationary. Thus, ratings produced at different contexts are weighted equally. Nevertheless, in real life, to say that two people are similar is not based solely on their opinions on a specific topic, but also on other factors such as their age and profession. Under the framework of item-based collaborative filtering, this paper proposes a new hybrid algorithm which considers the influence of each contextual parameter on users' preferences. The weight function is introduced to endow each score with a weight value according to context. In order to assign the optimal value for each contextual information, the proposed algorithm uses a genetic algorithm.

3.1 String Representation

The chromosome is a string of length 5. It is encoded with real numbers between 0 and 1; the number of genes in each chromosome is equal to the number of features (user's age, user's gender, user's occupation, movie's genre, time evaluation). A simple chromosome may look like as follows:

W1	W2	W3	W4	W5

Where *w1* is the weight associated to the user's age.
*w2*is the weight associated to the user's gender.
w3 is the weight associated to the user's occupation.
w4 is the weight associated to the movie genre.
w5 is the weight associated to the time evaluation.
the sum of the weights in a chromosome should be equal to 1.

$$\sum_i w_i = 1 \qquad (1)$$

The initial population is formed by generating N random strings represented in figure 1.

3.2 Fitness function

In this paper the fitness function will be the Mean Absolute Error (MAE) of the Recommender System. The fitness function used for evaluating the fitness of our Genetic Algorithm is determined by equation (2):

$$\text{fitness} = \frac{\sum_i |p_i - q_i|}{n} \qquad (2)$$

For each prediction-rating pair <pi,qi>, the fitness function treats the absolute error between pi and qi,
The lower the fitness value is, the more accurately the recommendation engine predicts user ratings.

In order to calculate the fitness value, it is necessary to follow the next steps for each user x:

- Calculating the set of K neighborhood of user u:

The most important phase is to measure the similarities between users [4]. Firstly, the proposed algorithm collects those users who shared common items with the active user. Then, the similarity weight between the active user and his neighborhood is computed by Pearson correlation coefficient:

$$corr_{u,v} = \frac{\sum_I \left(R_{u,i} - \overline{R}_u\right)\left(R_{v,i} - \overline{R}_v\right)}{\sqrt{\sum_I \left(R_{u,i} - \overline{R}_u\right)^2 \sum_I \left(R_{v,i} - \overline{R}_v\right)^2}} \quad (3)$$

Ru,i denotes the rating of user u on item i.
*I*denotes the set of common items for users*u* and *v*.
$\overline{R}_u$ is the average ratings of user *u*.

- Calculating the prediction :

The predicted value of the user *u* to unrated item *i*is computed using the following equation:

$$p_{u,i} = \overline{R}_u + \frac{\sum_{j=1}^{K}\left(R_{j,i} \times corr_{u,j} \times f(u,j)\right)}{\sum_{j=1}^{K}\left(corr_{u,j} \times f(u,j)\right)} \quad (4)$$

Where $corr_{u,j}$ is the similarity weight between users*u* and *j*.
*Rj,i*is the rating of user *j* for item *i*.
K is the number of neighborhood of user *u*.
f(u, j) representsthe degree of similarity between the contexts of user *u* and *j*.
$0 \le f(u,j) \le 1$ is the weight function defined as:

$$f(u,j) = \sum_l w_l f_l(x_u, x_j) \quad (5)$$

$$f_l(x_u, x_j) = \begin{cases} 1 & \text{if} \quad x_u = x_j \\ 0 & \text{if} \quad x_u \neq x_j \end{cases}$$

Where *wl*, is the weight for contextual feature $l \in$ [user's age, user's gender, user's occupation, movie's genre, time evaluation].

xu and *xj* are the feature's value of users *u* and *j*, respectively.

3.3 Selection

Selection is a genetic operator that gives preference to better chromosome. The goodness of each individual depends on its fitness which is be determined by an objective function. The probability of an individual to be selected is computed using the following equation:

$$Pi = Fi \; / \sum_{j=1}^{N} Fj \quad (6)$$

N is the size of the population.
Fi represents the fitness degree of an individual *i*.

3.4 Crossover

Crossover is a genetic operator that exchanges genes between two chromosomes for generating two new chromosomes. In this work, single point on both parents' chromosome is selected(figure 1). All data beyond that point in either string are exchanged to produce two children for the next generation.

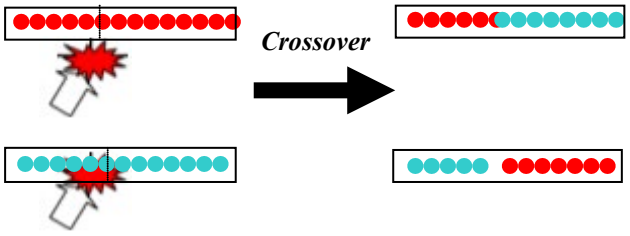

Fig. 1 :Single-point crossover

3.5 Mutation

Mutation is a genetic operator that alters one or more gene values in a chromosome (figure 2). A random position is chosen in the chromosome and all data beyond that point are replaced by a random number between 0-1. Each chromosome applied mutation with a probability pm.

Fig. 2 :Single-point mutation

3.6 Termination criterion

In this paper the processes of fitness computation, selection, crossover, and mutation

were evolved for M number of iterations or stopped when no change had occurred for over 10 generations. The best chromosome seen up to the last generation provides the solution to our problem.

4. Experiments

In order to evaluate the effectiveness of the proposed algorithm, we compare the results of the proposed system to those traditional Collaborative Filtering algorithms. We repeated the experiments by using different parameters to show how the feature weights affect the fitness accuracy and performance.

4.1. Dataset

In order to evaluate the recommendation quality, the algorithm was tested using Movielens1, a data set widely used to evaluate collaborative filtering algorithm. This data set is provided by the University of American Minnesota GroupLens project group. It contains 10000054 ratings on a scale from 1 to 5 and 95580 tags applied to 10681 movies by 71567 users. Users were selected at random for inclusion and each one had rated at least 20 movies.

MovieLens dataset contains much contextual information (such as age, gender, occupation and postal code) which can be exploited to improve the prediction accuracy of Recommender Systems. The information of a user includes: UserID, Gender, Age and Occupation and those of the item are MovieID, Title, Genres.

4.2. Prediction and recommendation results

Experiments were performed to show the performance of the proposed recommendation method. The Pearson correlation coefficient is used for finding the neighbor users with different values for the number of neighbors k. Table 1 informs about the MAE error obtained for Movielens when applying Pearson correlation. The results show that each recommendation method has obtained its best result for a different number of neighbor users. Moreover, for any value of K (the number of neighbors for each user) the results obtained with our genetic algorithm are better that the ones obtained with the traditional collaborative filtering algorithm.

[1] http://www.grouplens.org/

So, experimental result from Movielens data set validates that the weight function proposed in this paper improves the quality of recommendations. In fact, this function incorporates the contextual factors that influence the users' decisions. It integrates also a degree of importance for each contextual parameter.

Tab. 1 : Mean absolute error comparison of different number of neighbors

K	TraditionalCollaborati f filtering	Proposedalgorith m
8	2,32	1. 21
9	2,03	1.15
10	1,75	1. 29
11	1,39	1. 20
12	1,14	1. 08
13	0,91	0. 83
14	0,83	0.75

Moreover, parameters setting for the Genetic Algorithm could be found that gives better results. The values of Genetic Algorithm parameters are listed in table 2.

Tab. 2 : The parameters of the Genetic Algorithm

Population Size	80
Crossover Rate	0.8
Mutation Rate (pm)	0.2
Crossover method	Single point
Selection method	Tournament

Table 3 shows the best approximate weighting values generated by the Genetic Algorithm. Obviously, we assume that time evaluation, gender and occupation still play an important role in preference prediction.

Tab. 3 : The weight of each contextual parameter

Weight of age	0,22
Weight of gender	0,20
Weight of occupation,	0,10
Weight of genre	0,15
Weight of time evaluation	0,33

5. Conclusion

Collaborative filtering based item has been known to be the most successful recommendation technique [4]. However, Traditional collaborative filtering methods are

only rely on the user's preferences, which is insufficient in real world problem. In recent years, contextual information is more and more important in collaborative filtering. Thus, Several researchers try to exploit contextual features to improve the prediction accuracy of Recommender Systems.

This paper proposes a new hybrid collaborative filtering algorithm that takes contextual information into account. Genetic Algorithm is used to find an optimal combination of weight features. Then, The weight function is introduced to endow each score with a weight value according to context. Experimental results from Movielens data set show that the new algorithm outperforms the traditional item-based collaborative filtering algorithm.

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E-learning platform based on Recommender System

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Abstract

With the considerable growth of information available on the web, users have difficulty to select the information that *best suits their needs*. In this context, recommender systems have been developed to predict users' interests and recommend product items that quite likely are interesting for them.
In this paper, we propose the integration of a Book Recommender System into E-learning spaces such as Moodle.

1. Introduction

With the proliferation of the amount of information available on the web, it is difficult for user to find what he is looking for and what may be of interest to him **[1]**. Access to relevant information has become a real challenge.

Recommendation systems provide a solution to the problem of information overload and are able to estimate a user's interest based on some information about his neighbourhood or based on item's properties.

Several recommender systems have been proposed to filter and adapt the information for each user **[2-4]**. They can be *divided* into two categories: content-based approaches and collaborative filtering approaches.

In this paper, we propose the improvement of E-learning platforms, such as Moodle, by integrating a recommendation engine based on collaborative filtering algorithm. The proposed system suggests books adapted to the needs of users. We also propose the creation of a pedagogical space between administration and professors which allows the management of some pedagogical activities

The rest of this paper is organized as follows. The second section will discuss collaborative filtering methods. In the third one, we will present similarity measures used in collaborative filtering. The database used as well as the proposed system will be presented in the fourth section. Finally, the fifth section presents our conclusion.

2. Collaborative filtering

Collaborative filtering is one of the most popular recommendation methods. It is based on the idea that people who share an interest in certain things will probably have similar interests in other things as well **[5]**. Thus, it recommends items to a given user that other persons who are similar in their preferences have appreciated. This method does not take into account item information; it only uses the evaluation matrix to calculate the prediction.

In order to suggest an item to a user, the collaborative filtering algorithm determines which users have similar preferences to that user on certain items. The available data is then used to calculate the prediction.

Formally, collaborative filtering is defined by a set $U = \{u1, u2, \dots, um\}$ of m users and a set $I = \{i1, i2, \dots, in\}$ of n items. Each user uk evaluates a subset of items $I_{u_k} \subseteq I$. Ru,i is the appreciation given by user u to item i. It can be acquired implicitly by observing the user's behaviour. In this case, any interaction of the user with the system is considered as an estimate of his interest judgment **[6]**. We can also obtain the evaluation explicitly by inviting users to give simple annotations based on a fixed rating scale (e.g. from 1 ≡ very bad to 5 ≡ very

good). The user evaluations are stored in a matrix called *user×item*.

Collaborative filtering techniques are grouped into two main categories: memory based algorithms and model based algorithms.

2.1. *Memory based algorithms*

Memory-based algorithms operate directly on the *user×item* matrix to make the recommendation. The prediction for an active user is estimated using his votes and a set of weights calculated from the judgments of users with the same preferences as him. These techniques mainly apply statistical methods, such as the k-nearest neighbors method, to identify users who are similar to the active user. They offer the advantage of being reactive by dynamically integrating new users or items. However, the complexity of processing increases with the increase of user's number and items.

Memory based approaches are based on the calculation of similarities from the user×item matrix. They estimate the similarities between the columns of the evaluation matrix in item-based collaborative filtering. However, in the case of user-based filtering, they calculate the similarities between the rows of the matrix.

Item-based filtering identifies items that have been measured by the same user. To suggest an item *i* to a user u, the ratings of user u on objects which are similar to item *i* are used. Each evaluation will be weighted by a degree of similarity to item *i* (equation 1).

$$P_{u,i} = \overline{R}_i + \frac{\sum_{j=1}^{n} \left(R_{u,j} - \overline{R}_j\right) \times corr_{i,j}}{\sum_{j=1}^{n} corr_{i,j}} \qquad (1)$$

Pu,i is the prediction of user u for item *i*.
Ru,j is the rating of user *u* for item *i*.
$\overline{R}_i$ and $\overline{R}_j$ represent the average of the ratings for items *i* and *j*, respectively.
corri,j represents the degree of similarity between item *i* and item *j*.

User-based filtering finds users who are similar. To predict an item *i* to a user *u*, the ratings from users with the same preferences as user *u* are used. Each evaluation will be weighted by a weight representing a measure of similarity to user *u* (equation 2).

$$P_{u,i} = \overline{R}_u + \frac{\sum_{k=1}^{m} \left(R_{k,i} - \overline{R}_k\right) \times corr_{u,k}}{\sum_{k=1}^{m} corr_{u,k}} \qquad (2)$$

Pu,i is the prediction of user u for item *i*.
Rk,i is the evaluation of user *k* on item *i*.
$\overline{R}_u$ and $\overline{R}_k$ represent the average of user ratings *u* and *k*, respectively.
corru,k represents the degree of similarity between user *u* and *k*.

2.2. Model-based algorithms

The model-based approach responds to the problem of calculations complexity of memory based approach when it faced with a large number of users and items. This method uses the matrix of user evaluations to develop a model that will be used for prediction. The model is built in the learning phase from a training corpus in order to be used online to calculate recommendations. Unfortunately, this method is not dynamic enough and its update is costly in computing time. Several techniques are used in model-based recommendation systems, such as probabilistic models, clustering methods, decision trees, neural networks, linear regression, etc. **[7]**.

3. Similarity calculation

The calculation of similarities is a key element in the prediction process. It consists of measuring the similarity between the descriptive variables of the items or users in order to select the best neighborhood which is used to calculate predictions. Neighbourhood identification is generally based on a distance between two vectors using the most appropriate measure for the type of descriptors **[8]**.

Several measures of statistical similarity have been exploited in recommender systems. These measures are based only on the common judgements of users. They allow building either an item×item matrix or a user×user matrix according to rows or columns. The two most commonly used measures are Cosine similarity and Pearson similarity.

3.1. Euclidean distance

The Euclidean similarity measure calculates the distance between two vectors x and y of dimension n according to equation 3. This measurement is very sensitive to the values of the vector descriptors **[9]**.

$$d(x, y) = \sqrt{\sum_{i=1}^{n} (x_i - y_i)^2} \qquad (3)$$

3.2. Cosine similarity

The Cosine similarity uses vector representation. Thus, each user (or item) is represented by a vector of votes. If the two clients (or items) are similar, their vectors are

confused; otherwise they form an angle whose cosine corresponds to the degree of similarity. The cosine of the angle formed by the two vectors i and j is calculated according to equation 4. The denominator terms are used to normalize evaluations so that users who have evaluated multiple items are not favoured **[10]**.

$$sim(i,j) = \cos(\vec{i},\vec{j}) = \frac{\vec{i}\cdot\vec{j}}{\left\|\vec{i}\right\|_2 \times \left\|\vec{j}\right\|_2} \quad (4)$$

Cosine similarity does not take into account individual differences between users when indicating their preferences. Indeed, some users are very generous in their evaluations compared to others. This problem is corrected by taking into account the averages of each user's scores.

3.3 Pearson Correlation Coefficient

The Pearson correlation coefficient is a famous similarity measure because of its performance in calculating predictions. It is used to calculate the distances between the active user (item) and other users (items) **[10]**. The Pearson correlation coefficient between the two users*u* and *v* (the two items *i* and *j*) is calculated according to equation 5 (equation 6):

$$sim(i,j) = \frac{\sum_{u\in U}(R_{u,i}-\overline{R}_i)(R_{u,j}-\overline{R}_j)}{\sqrt{\sum_{u\in U}\left(R_{u,i}-\overline{R}_i\right)^2}\sqrt{\sum_{u\in U}\left(R_{u,j}-\overline{R}_j\right)^2}} \quad (5)$$

Ru,i and *Rv,i* represent the evaluation of user *u* and *v*, respectively, on item *i*.

$\overline{R}_u$ and $\overline{R}_v$ are the average of user's ratings *u* and *v*, respectively.

$$sim(u,v) = \frac{\sum_{i\in I}(R_{u,i}-\overline{R}_u)(R_{v,i}-\overline{R}_v)}{\sqrt{\sum_{i\in I}\left(R_{u,i}-\overline{R}_u\right)^2}\sqrt{\sum_{i\in I}\left(R_{v,i}-\overline{R}_v\right)^2}} \quad (6)$$

Ru,j is the evaluation of user u on item j.

$\overline{R}_i$ and $\overline{R}_j$ represent the average of the ratings for items i and j, respectively.

The similarity value *sim(u, v)* (*sim(i, j)*) is between -1 and 1. If this value is equal to -1 then the two users (items) are strongly opposed. If the value is equal to 1, the two users (items) are strongly similar. The two users (items) are independent if the value is equal to 0.

4. Description of the proposed system

4.1 Database

In order to develop this system, we used the BookCrossing dataset. This latter was collected in 2004 by Cao-Nicolas Ziegler using an online book platform. It includes 1,149,780 evaluations, between 1 and 10, made by 278,858 anonymous users on 271,379 books. This corpus also contains a short description of the books (title, year of publication, author and publisher) and some demographic information about the users (age and city) **[11]**.

4.2 Offered Services

To improve the quality of the e-learning platform, we propose the integration of a book recommendation system as well as the management of some pedagogical activities such as automatic request generation, automatic QR code generation and notification **(Fig.1)**.

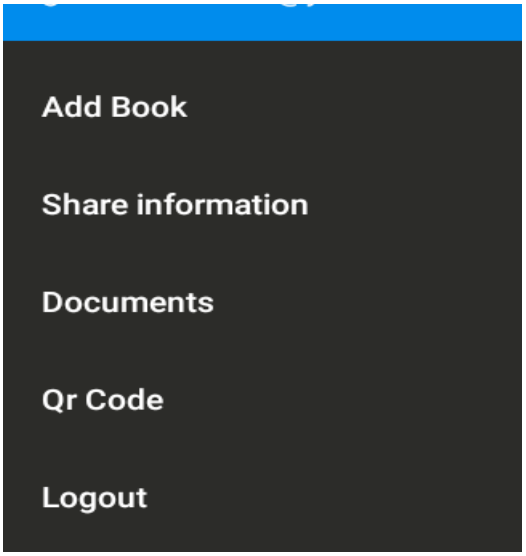

Fig. 1 : Navigation windows

Book Search Service

This service allows the research of books from BookCrossing dataset by entering keywords **(Fig. 2)**. Once the resource has been found, the information about his title, description and publication date will be displayed. The user will have the option to view or download the resource.

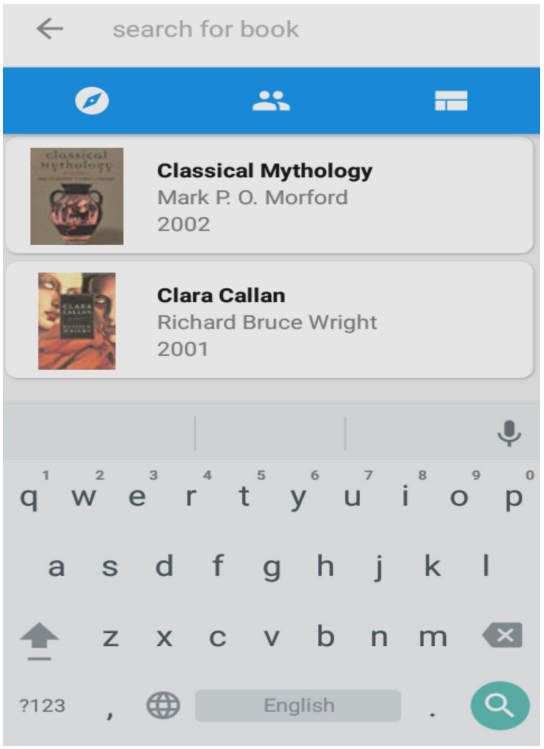

Fig. 2 : Search for work

Referral Service

The application provides to users a book recommendation service that allows them to adapt and personalize their search according to their preferences.

Book evaluation service

This service allows users to give their opinion on books by choosing ratings to be given so that the system learns user's preferences **(Fig. 3)**. The score varies between 1 and 10.

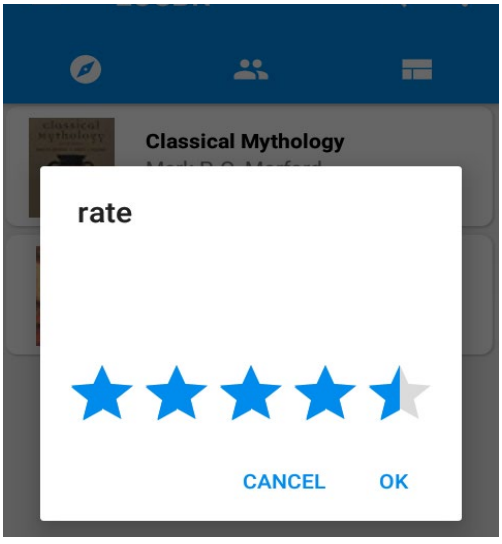

Fig. 3 : Book evaluation window

Suggested book service

This service allows users to suggest books to their colleagues by sending their description in the form of a QR code.

Information Service

This service allows user to get and share the latest news or events that are going to take place within the departments (important dates, for example.) by informing professors through notification service **(Fig. 4)**.

Fig. 4 : Information sharing interface

QR code generator

This service allows the administrator of this application to generate QR code for a resource such as URL **(Fig. 5 and Fig. 6)**. After creating QR code, it can be shared via the same interface.

Fig. 5 :QR code generator

Fig. 6 : Example of a QR code

Document generator

This service allows users to generate documents automatically such as work certificates of, documents concerning the Pedagogical Council (PC) or the Departmental Scientific Committee (DSC), etc. **(Fig. 7)**.

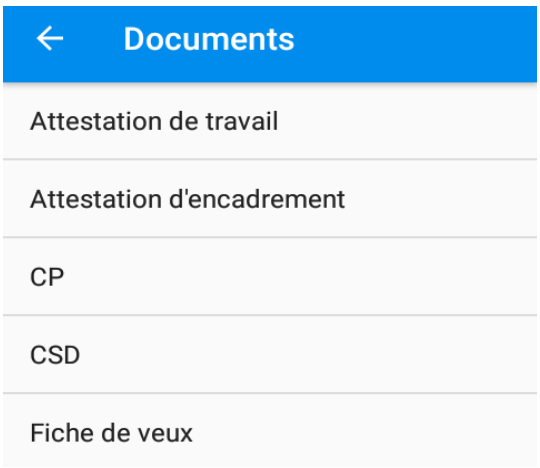

Fig. 7 : Document Generator

5. CONCLUSION

Recommender systems have become essential tools for any website that focuses on a certain type of items available in a rich catalogue. These items can be objects, cultural products (books, films, music, etc.), information items (news) or pages (hyperlinks).

The objective of these systems is to select, from their catalogue, the items that interest a particular user. They provide relevant suggestions within a large set of information.

In this paper, we have proposed the integration of book recommender system based on collaborative filtering algorithm within e-learning platforms such as Moodle. The developed system also allows the management of some pedagogical services.

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Scale Invariant Features Transform for Content-Based Medical Image Retrieval Systems: an overview on recent application

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Abstract

Content based medical image retrieval systems (CBIRs) represent a special case of Content based image retrieval systems. Medical images are the information the user seeks to retrieve from the database using these systems. Content Based Medical Image Retrieval Systems (CBMIRs) are very interesting tools that help and assist doctors in diagnosis and decisions by extracting similar cases and images from medical databases. Several features have been used through the process of developing CBMIRs. Scale Invariant feature Transform (SIFT) technique has been widely used in the context of general and specialized CBIRs. We present in this paper a set of recent works that have been used the SIFT technique in a context of CBMIRs. The results from these works have illustrated the utility of this technique and the relevance of its features.

1. Introduction

The rapid development in the field of digital cameras as well as the tools for acquiring, transferring and storing images poses a major challenge for users. This challenge is the need to access and efficiently use the large amount of available images.

The development of tools allowing the optimal use of image databases and satisfactory manipulation by users is ensured through the various works in the field of image indexing and retrieval. This field constitutes one of the applications of image processing techniques and several fields of information technology.

Central to this area of research is Content Based Image Retrieval Systems (CBIRS). These systems are an effective tool for users in their research and their needs. The main focus of indexing research is on the performance of these systems, therefore the objective is to develop efficient systems to allow the effective and efficient satisfaction of the needs of different users.

The rapid escalation of medical information and quick comprehensibility to the tools for medical imaging makes it significant to store multimedia information. This advancement requires the advancement in computer vision methods to allow the improvement of equipment that allows medical diagnosis to achieve higher accuracy. Content Based Medical Image Retrieval Systems (CBMIRs) aids doctors in making quick and accurate decisions by exploiting similar cases and images from medical databases. [1]

Several features have been used through the process of developing CBMIRs. They can be from different types including color based features, texture based features, and shape based features and local features. Among the techniques of the last type, Scale Invariant feature Transform (SIFT) technique has been widely used in the context of general and specialized CBIRs.

We focus in this paper on the presentation of an overview of the use of SIFT features in the field of CBMIRs. The overview covers the recent period that contains a set of scientific contributions that were published between 2010-2021.

2. Content based medical image retrieval systems

Content based medical image retrieval systems represent a special case of Content based image retrieval systems. Medical images are the information the user seeks to retrieve from the

database using these systems. The basic architecture of CBIRs is illustrated in figure 1. The system is generally viewed to be composed of two phases, an offline phase which concerns the database indexing and an online phase which process the query.

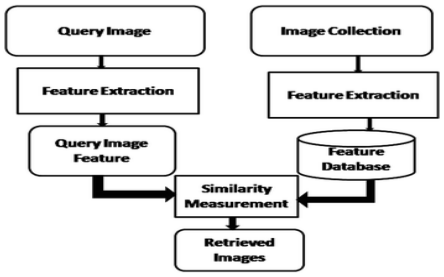

Fig. 1 : The basic architecture of CBIRs [5]

The offline phase is an indexing phase where the images found in the database are indexed using a set of characteristics generally extracted from these images. This representation of the content of the image by using the set of extracted characteristics makes it possible to reduce the dimension used during the search, the relevance of these characteristics is essential to ensure the correct representation of the content of the images in the database.

The image search phase is an online phase; the request provided by the user must be processed in order to transform it into an adequate representation similar to that of the characteristics of the images in the database.

The system performs a similarity calculation between the index of the user's query and the images indexed in the base in order to respond to the user with the list of images most similar (relevant) to his request in the base.

3. Image features

Image features are a set of numerical characteristics that are calculated from the image. The extraction of these features is a main step and part of the CBIRs systems. The image features could be calculated for the whole image or a whole part of it called a region. In this case they are called global features to differ them from local features that are generally calculated on specific local point in the image. There are three types of image global features, color based image features, texture based image features and shape based image features.

- **Color based image features**

Color is an important characteristic and widely used to characterize images in the field. The color characteristics are calculated for a chosen system, the most used color systems are RGB (Red, Green, Blue) and HSV (Hue, Saturation, Value), more details on color systems are included in[9]. Image color can be characterized by the covariance matrix, color histogram, color moments, and color consistency vectors.

- **Texture based image features**

Texture can be defined as a visual pattern having characteristics of homogeneity which are absent in the case of single intensity. Texture is a useful characteristic for many types of images; it is widely used with medical images since many types of them are grey level images. Human perception uses texture for the recognition and interpretation of the content of images.

The texture is calculated for a set of pixels. Several techniques have been proposed for the extraction of texture characteristics, they are generally classified into two categories according to the field of extraction. These two broad categories are the spatial extraction of texture features and the spectral extraction of texture features. In the first approach, features are extracted by calculating pixel statistics in the spatial domain of the image. In the second approach, the image is transformed in the frequency space which constitutes the source of calculation of the characteristics. Among feature extraction techniques, Haralick's functions, Gabor filters and Tamura features have been widely used.

- **Shape based image features**

Shape can be seen as an important element used to identify and differentiate between different objects. Techniques for extracting shape features can be broadly classified into two categories [10]. The first category of techniques is contour based where shape features are extracted only from the contours, while the second is region based with features extraction from the entire region.

- **Image local features**

Local features and their descriptors, which are compact vector representations of a local neighborhood, are the building blocks of many computer vision algorithms. Their applications include image registration, object detection and classification, tracking, and motion estimation. Using local features enables these algorithms to better handle scale changes, rotation, and occlusion. [11]

SIFT (Salient Invariant Feature Transform) [12] and SURF (Speed Up Robuste Features)[13] are two local characteristic image extraction techniques. They have been used by many contributions in

image processing applications. SIFT calculates histograms of the gradient orientations as a feature, and SURF uses Haar wavelet approximations.

The next section will present the SIFT technique as it is the main subject of this paper. We aim to provide an overview of the use of SIFT features in the context of Content Based Medical Image Retrieval Systems (CBMIRs) and this for the period 2014-2021.

4. Scale Invariant Features Transform

Scale invariant features transform are a set of local features [14], those features are calculated at interest points in images, DoG (Difference of Gaussian) detector is used to detect such interest points and their associated regions. The DoG is scale-invariant region detector which first detects a set of interest points, then it filters this set to preserve only points that are stable under a certain amount of additive noise. First, keypoints (interest points) are identifying by scanning the image over location and scale. It detects localization and scale of keypoints as scale-space extrema of the function $D(x, y, \sigma)$, which is the difference-of-Gaussian function convolved with the input image $I(x, y)$:

$$D(x, y, \sigma) = \big(G(x, y, k\sigma) - G(x, y, \sigma)\big) * I(x, y) \quad (1)$$

Where k indicates a constant multiplicative factor and

$$G(x, y, \sigma_i) = \frac{1}{2\pi\sigma_i^2} e^{-(x^2+y^2)/2\sigma_i^2} \quad (2)$$

is a Gaussian kernel.

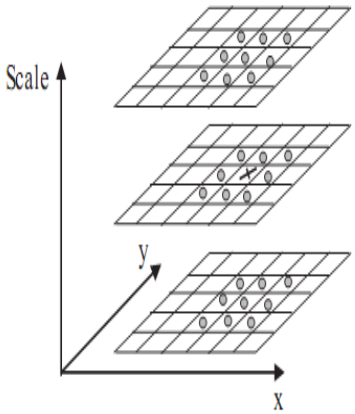

Fig.2 : Detection of extrema in scale-space by comparing a pixel(x) to its neighbors (◦) in the current and adjacent scales [12].

Local 3D extrema of D(.) are detected by comparing each pixel to its 26 neighbors, 8 neighbors in the current scale space level and 9 from both above and below space levels (see Figure 1). A point is selected only if it is larger or smaller than any of these neighbors.

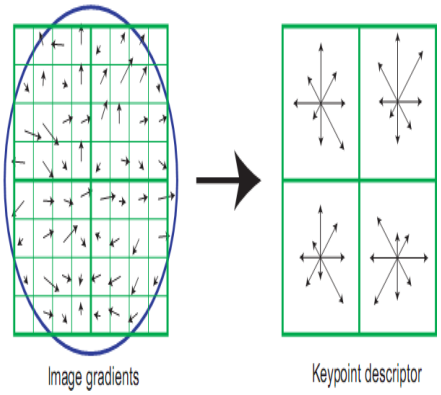

Fig.3: 2x2 descriptor array computed from an 8x8 set of samples [12].

Computation of features for keypoints detected by DoG detector is realized with the Scale Invariant Feature Transform SIFT [12]. First, an orientation, scale, and location are assigned to keypoints. The scale and location are determined by DoG detector, while one or more orientation are assigned to the keypoint based on the dominant gradient orientation of the local image patch surrounding the interest point.

An orientation histogram is used to identify dominant gradient directions by selecting peaks within. This histogram is formed from the gradients' angles of sample points within a region around the keypoint, weighted by each gradients' magnitudes.

An interest point is created with that orientation for each dominant orientation (multiple interest points might be created for the same location and scale, but with different orientations)[14].

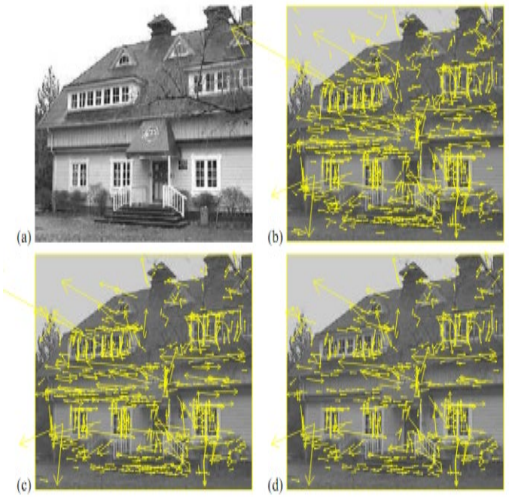

Fig.4 : Stages of keypoints selection [12].

The descriptor is formed from a vector containing the values of all the orientation histogram entries, a 4x4 array of histograms with 8 orientation bins in each is used, that means 4x4x8=128 element feature vector for each keypoint [12]. The vector is normalized to ensure invariance to illumination conditions. SIFT features are also invariant to small geometric distortions and translations due to location quantization [14]. More details about SIFT technique are available in [14].

5. SIFT for content based medical image retrieval systems

Authors in [8] have mentioned that [2] proposed a Content-Based Image Retrieval system for Computer-helped determination (CAD) of mammographic masses. Using Scale-Invariant Feature Transform (SIFT) to built vocabulary tree. Extensive experiments are carried out on a large dataset which demonstrate the precision and scalability of the approach.
In [3] a scalable image-retrieval technique was proposed to cope intelligently with massive his to pathological images for breast tissues. The article present a supervised kernel hashing technique employing SIFT extractor technique. The classification accuracy in the presented model achieves about 88, 1%.

[4] Propose a medical images retrieval method based on a bag-of-visual-words (BoVW) with a "Pruned Dictionary" for lung nodules detection, SIFT features have been used in this work as features for the images of the ELCAP database of the lung nodules. The best overall accuracies were scored with the combinations including SIFT features

In [5] a genetic algorithm (GA) approach is presented for the selection of dimensionality reduced set of features. SIFT was one of four algorithms used in feature extraction step. This model based feature selection method is used to reduce the existing system dimensionality problem and shows that the GA driven image retrieval system selects optimal subset of feature to identify the right set of images.

Authors in [6] have proposed a retrieval system of Hepatobiliary .SIFT features have been used along with Hu-moments and GLCM. Authors illustrated that the combination of SIFT features with GLCM has achieved the best precision score in most cases.

[7] Propose a medical image retrieval system using Topic and Location Model. Scale Invariant Feature Transform (SIFT) is employed to describe the image patches represented by the keypoints. The proposed model achieved better Mean Average Precision (86.74%), and better Precision (97.5%) compared to the recent medical image retrieval systems.

Table. 1 : results from different works.

works	MAP (Mean Average Precision)	Precision (%)	Recall (%)	Accuracy (%)	Ref.
W1	-	88.1	-	88.4	[2]
W2	-	83.0	-	88.1	[3]
W3	0.6	-	-	70	[4]
W4	0.8	80.0	30	-	[5]
W5	-	98.2	60.9	-	[6]
W6	0.86	97,5	97	-	[7]

5. Results and discussion

Works presented in this paper noted promise results for the CBMIRs, as shown in (Table 1). The scores of systems precision demonstrate utility of SIFT features extraction in CBMIRs due to its efficiency with medical images proprieties and the increasing datasets.

In W1 the precision of the proposed system changes following the change of the K (the vocabulary tree branch factor): k=1 precision=88.1%; k=5 precision=88.4%; k=20 precision=85, 4%.
SIFT features are extracted from region of interest (ROI) of mammographic, then searched in a vocabulary tree, which stores all the quantized features of previously diagnosed mammographic ROIs. Contextual information in the vocabulary tree (of depth L and branch factor k) is employed to refine the weights of tree nodes.

In W2 the precision scored 88.3%, when classification accuracy achieves about 88.1%. A kernel-based supervised hashing model is introduced to encode a high-dimensional image feature vector, extracted with SIFT method, to short binary bits using only a limited number of labeled images. Promising time and computational efficiency are noticed in this work too.

The work W3 scored 74% of accuracy, where SIFT extract features to construct the BOVW. Based on Latent Semantic Topic description a Pruned Dictionary is implemented: first, a topic-word significance value for each visual word is calculated to evaluate the connection between word and the latent topic. Then, compute an overall-word significance value to evaluate the significance of a

visual word within the entire dictionary. The words with higher values are considered meaningful with more significant discriminative power in differentiating medical images

The work W4 the MAP scored 83% and the system precision 80%, the improved SIFT was used to extract features while hybrid approach selects a reduced number of features.

The Work W5 note 98% of system precision when SIFT was combined with GLCM approach compared with another combination (SIFT + Hu-moment) wherein the precision scored 94.71%.

The work 6 has scored over 0.86 of MAP when SIFT is used to generate LDA topic model, experiments on a large dataset shows the efficiency of the system.

A remarkable improvement in the precision's scores when SIFT was combined with another methods, such in work (W5).

6. Conclusion

Content Based Medical Image Retrieval Systems (CBMIRs) are very interesting tools that help and assist doctors in diagnosis and decisions by extracting similar cases and images from medical databases.

Scale Invariant Features Transform technique (SIFT) is a powerful technique that extracts useful local features that better handle different image transformations such as scale changes, rotation, and occlusion.

We present in this paper recent works that have been used the SIFT technique in a context of CBMIRs. The results from these works have illustrated the utility of this technique and the relevance of its features.

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The tools of Artificial Intelligence applied to monitoring

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Informations

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Diagnostic
Artificial Intelligence (AI)

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Abstract

The purpose of this work is the presentation of the different tools of Artificial Intelligence for monitoring. These methods are divided into three major families: behavioral models, pattern recognition methods and explanatory models.
Monitoring can be defined in several ways; this monitoring is composed essentially of two phases: flaw detection and fault diagnosis. The diagnosis is divided into two functions: location and identification of causes.

1. Introduction

The problems of great importance in industrial monitoring are constituted by the possibility of detecting false alarms and eventually predict failure.

The field monitoring needs mainly artificial intelligence either to exploit a know-how or to bring distributed intelligence to the lowest operational levels.

The methods by symbolic tools rely heavily on Artificial Intelligence (AI) techniques, familiar or at least shareable by the operator. Indeed, the use of Artificial Intelligence overcomes the complexity of the systems to be monitored. Moreover, in general, Artificial Intelligence due to these characteristics is relatively well suited to monitoring problems. Indeed, AI can be characterized by the ability to treat **[1]**:

- A large amount of information,
- non-homogeneous data, (numerical / Symbolic),
- dependent data context,
- incomplete data.

Overall, these methods will be grouped under the expression: « Symbolic modeling methods ». They are characterized by keywords that better reflect their objectives and their respective characteristics. A distinction is therefore made between symbolic models, recognition methods, methods based on behavioral models and methods based on explanatory models, see **[1]**.

2. Defining monitoring

Monitoring is a passive device and / or dynamic, informational, which analyzes the state of the system and provides indicators. Monitoring particular is to detect and classify failures by observing the evolution of the system, then diagnose by locating faulty elements and identifying the root causes, see **[3]** and **[4,5]**.

2.1. *Detection*

To detect system failures, you must to be able to classify observable situations as being normal or abnormal, **[5]**.

2.2. *Diagnostic*

The diagnostic system **[6]** suggests to the operator the possible causes of this problem, as well as fuzzy interpretations of these causes. The objective of the diagnostic system is to search for the causes and locate the organs that led to a particular observation. This function is broken down into two elementary functions: localization and identification. The localization makes it possible to determine the faulty functional subset, while identification involves

determining the causes that led to an abnormal situation. These causes may be internal (faulty subassemblies that are part of the equipment), or external to the equipment. See **[7,8]**.

Monitoring has two main functions: fault detection and fault diagnosis, figure **(Fig. 1)**.

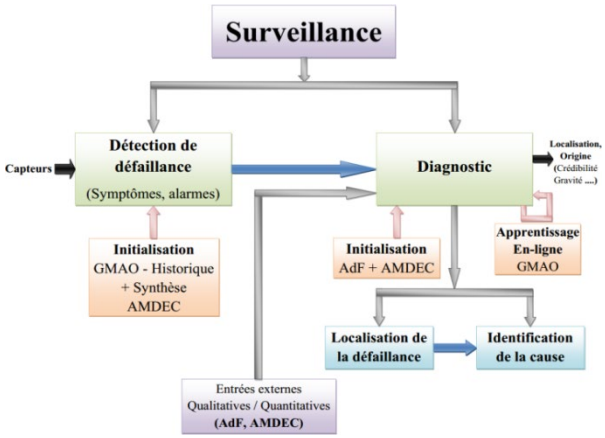

Fig.1 : The components of monitoring.

3. Purpose and objective monitoring

Monitoring is responsible for collecting permanently all signals, through indicators, from the production system, and monitors in real time the evolution of the controlled system. It thus includes all the tools to monitor the evolution of the system behavior in relation to normal operation, and to detect any anomaly or failure. In this last case, a diagnosis is established in order to locate the subsystem responsible for the malfunction and to identify the cause of the failure. This makes it possible to specify the maintenance operations to be carried out in order to restore the production system to working order. See **[2]**.

4. Industrial Monitoring: Methods and Models

The methods of monitoring are generally divided into two groups: monitoring methods with model and without model. See **[3,10]** and **[11] [12,13]**.

The figure **(Fig. 2)** illustrates the methods most used in industrial monitoring.

4.1 *Monitoring methods with models*

These are the methods most used by industrialists today; they are based on the existence of a formal equipment model and generally use automatic techniques. Are likely to diagnostic methods by functional and material modeling: The principle of these methods consists in establishing a priori and as completely as possible, the links between the initial causes of the failures and their measurable effects.

The most commonly encountered methods are Failure Modes, Effects and Criticality Analysis (FMECA) and Fault Trees (FT). These methods are used mainly for diagnosis, see **[3]**. And physical modeling surveillance methods: Surveillance methods with physical model have the principle of comparing the measurements made on the system to the information provided by the Frank model **[14,12]**. Any deviation is then synonymous with a failure. The tools of decision theory are then used to determine if this difference is due to normal hazards, such as measurement noise or if it reflects a system failure. Methods with physical model are the methods most familiar to automation engineers. In general, these methods can be separated into two techniques: physical and analytical redundancy techniques, and parametric estimation techniques, **[3]**.

4.2 *Monitoring methods without models*

There are many industrial applications whose model is difficult, or even impossible to obtain due to increased complexity or numerous stakeholder reconfigurations during the production process. For this type of industrial applications, only operational monitoring methods are those without model, they are distinguished on monitoring using signal processing statistical tools: Statistical tools fault detection are to assume that the signals provided by the sensors have certain statistical properties. A few tests are then carried out which make it possible to check whether these properties are present in a sample of the measured signals. A wide variety of tests is applicable on a sample of measurements. Among the most important, we mention: threshold-crossing test, average test and test of variance, found in **[3,12]** and **[15]**. And monitoring using Artificial Intelligence (AI) techniques, according to the bibliography studied, different categorizations monitoring methods by IA are given in general; Artificial Intelligence (AI) and use symbolic knowledge, familiar or at least shareable by the operator **[16]**, artificial intelligence due to these characteristics are relatively well suited to monitoring problems. From our point of view, we propose a classification of these methods according to 3 types, **[3]**:

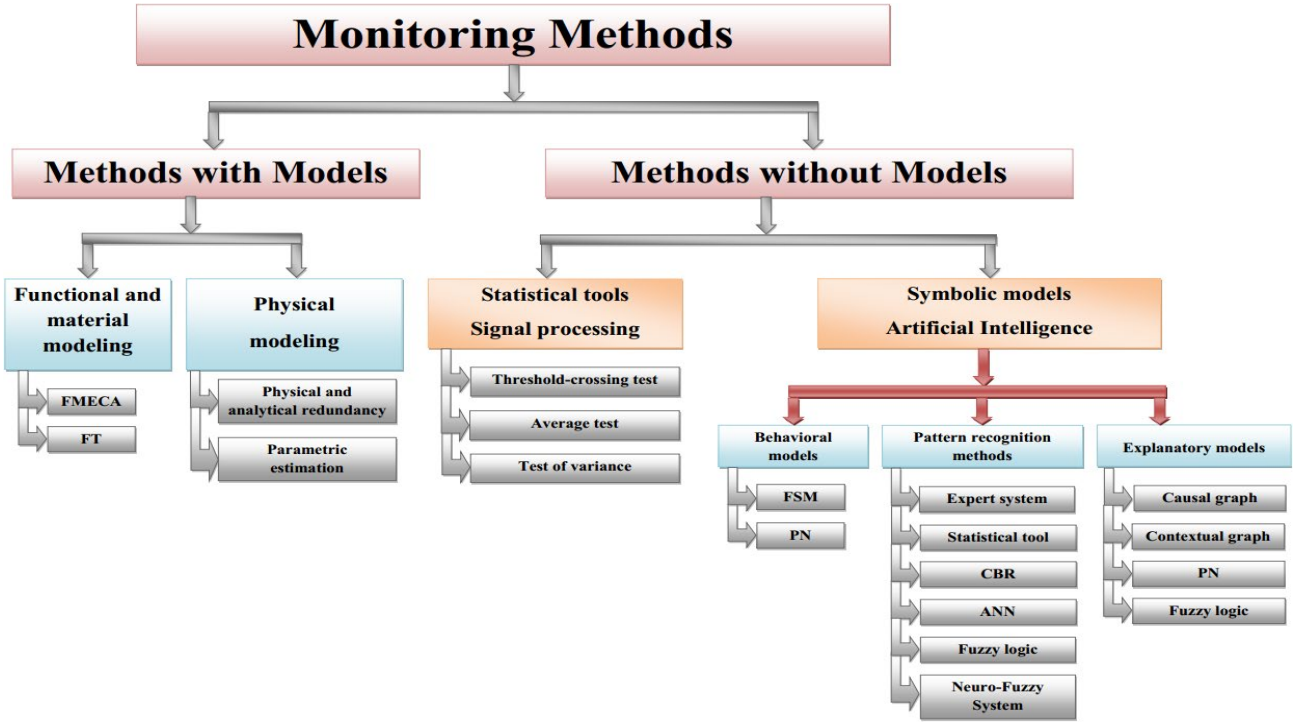

Fig. 2 : Classification of monitoring methods.

a) Method of modeling behavioral: These methods are characterized in particular by the possibility of simulating the behavior of the system, from a modeling of its behavior. Most often these are models "of proper functioning" which, unlike digital models, are not based on the physical system but on a consideration in terms of mode of operation. These methods include tools such as Petri nets (PN) and the finite-state machine (FSM). In these methods, the associated keywords are: modeling / simulation, **[3]**.

b) Method of pattern recognition: These methods comprise the associative models and method of pattern recognition in the sense that they are characterized by the terms learning and recognition which apply to both pattern recognition and rule-based systems such as expert systems **[3]**. These techniques are more elaborate compared to simple statistical tests and are able to detect and diagnose failures **[8]**. These methods include: expert systems, statistical tools, case-based reasoning (CBR), Artificial Neural Network (ANN), Fuzzy logic, Neuro-Fuzzy systems, **[3]**. In these methods, the key words that best characterize these approaches are: learning / recognition **[3]**.

c) Method of modeling explanatory: These methods introduced by **[16]** are mainly based on the representation of relationships between the different states failures and their effects (possibly observable). They are therefore based on a deep analysis of the system, so as to have sufficient knowledge in the expression of these relationships of cause and effect. The models thus obtained allow for a certain adductive approach which consists in going back to the causes of breakdowns from observations corresponding to the symptoms. Several tools of Artificial Intelligence allow such a formalization of the knowledge available on a system. These include causal graph, contextual graph, we also find approaches based on fuzzy logic or Petri nets. In these methods, the associated keyword is: causal analysis, **[3]**.

5. Conclusion

In this work, a bibliographic review for industrial monitoring was presented. We addressed the most commonly used techniques in this field. The use of techniques and models is difficult, expensive and offering less and less satisfaction with more and more complex systems. The use of techniques without models is more suited to this problem and, more particularly the techniques related to Artificial Intelligence. Finally, we proposed a classification of these techniques into three classes.

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3D reconstruction methods

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Informations

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object
model geometric

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Abstract

3D Reconstruction consists of generating a model 3d from information of the real scene. It is a very interesting alternative, because it aims to improve the modeling of environments 3D, in terms of precision and speed of design, as well as in terms of realism.
The representations based geometry build on the use of a model geometric based on a mesh surface [7], a model volumetric [8] or a cloud point [9].
In this article we have given a study comparative of 3D reconstruction methods from an object.

1. Introduction

A system of vision artificial replacing the eye with a camera and the brain with a computer, and which uses one or more digital images acquired using a camera.

Vision by Computer (VA) reproduce the results obtained by vision human on a computer using data processing in order to extract the maximum amount of information relating to the scene to be recognized [17].

The possibilities for exploiting images (whatever their origin) have multiplied significantly following the recent emergence of new technologies for processing and acquiring information. These images represent, in fact, a considerable support of information whether as a support for reflection (decision-making aid, design, etc.) or as a support for communication (production, representation, etc.).

New and adorable manipulation tools allowing to directly exploit these images in an almost exclusively digital way, were born thanks to the evolution of processing capacities, both hardware and software. Thus providing a quality equivalent to that obtained by more traditional techniques.

Several methods of 3D reconstruction are proposed including the literature. And the effective stake is then to minimize the computing times as much as possible or to improve the quality of the modeled scenes.

Applications that can benefit from 3D reconstruction are: CAD, Virtual Reality, Augmented Reality, training, simulation, commerce, leisure, and compression of data.

[1]Computer-aided design (CAD) includes all the software and geometric modeling techniques allowing to design, to test virtually - using a computer and digital simulation techniques - and to produce manufactured and the tools to make them.

[2]Virtual reality is an immersive interactive visual, visual, sound and / or optical, computer simulation of real or imaginary environments.

[3]The concept of augmented reality designates the systems that make it possible to superimpose a 3D or 2D virtual model on the perception that we naturally have of reality and this in real time.

The contributions of this article are as follows: First, We try to make an overview of stereoscopic vision and the interest of 3D reconstruction, in the second section, we quote the most known methods in the literature, and this for get an idea about the techniques used for 3D reconstruction. In the third section we end our article with a conclusion and perspective.

2. Interests of 3D reconstruction

3D Reconstruction consists of generating a model 3D from information from a real scene. We have one or more representations 2D of an object and we want to determine the coordinates of the elements visible on these representations in a coordinate system of real space 3D; because it aims to improve the modeling of environments 3D, to facilitate design [4].

3. Stereoscopic vision

An image obtained with a pinhole camera is the result of a transformation geometric [5]. The latter changes from a representation three-dimensional of the scene to a representation two-dimensional (image).

The Stereoscopic Vision [16] aims to reconstruct the 3D structure of a scene. In order to carry out this reconstruction it is necessary to know the 3D coordinates of all the points of a scene. The scene is represented by a couple of stereoscopic images. These images are two representations of the scene taken from different angles. Each point of the scene is projected in the images (left and right) of the stereoscopic pair at different positions. The coordinates of these two projections of the same 3D point are obtained through a matching phase which aims to find, for a given point in one image, its corresponding point in the other image. These two points are the respective projections of the same 3D point in the right and left images.

The principle of the vision stereoscopic is represented in figure 1. In the phases of rectification and calculation of the 3D positions of the points it is necessary to carry out the calibration of the stereoscopic system so as to have intrinsic and extrinsic parameters of the system.

Stereoscopy proceeds by pairing then triangulation

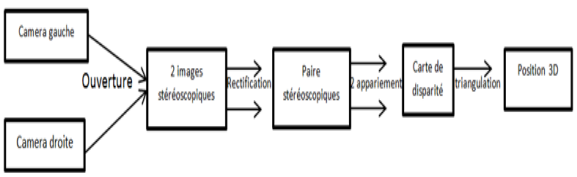

Fig. 1: the principle of vision stereoscopic

3. *Methods of 3D reconstruction*

There are many techniques of reconstruction 3D, We can classify in these three categories:

Reconstruction from epipolar geometry [18]: This is the most classic method since we already use epipolar geometry for the extraction of 3D points from objects and use visual control as a means of estimating camera positions.

Reconstruction from contours [19], [20]: 3D reconstruction based on the object's contours seems to be difficult to envisage on a natural object of any shape with very irregular contours.

Reconstruction from the movement of the camera (Factorization of Tomasi and Kanade) [21].

3.1 Reconstruction from epipolar geometry

The main steps are shown in Figure 2. The extraction of points and the matching are done exactly as for the visual servo, unlike and that one works on a sequence of images. The stereo pair calibration step must be done on images taken from the site without changing the intrinsic and extrinsic parameters of the cameras. The intrinsic parameters vary depending on the focal change. We will use a test pattern because the self-calibration is more restrictive, requiring specific movements of the camera. It will be assumed that the intrinsic parameters do not vary during the entire image acquisition phase. A first projective reconstruction is then carried out to initialize the rest of the reconstruction, using a bundle adjustment method. [12]

Then a dense pairing of the points belonging to the structure is calculated from, pairs of rectified images (The rectification of the images is also used for the pairing of the points used to control the cameras. Finally, a dense depth map is calculated for each paired point, then the 3D points are connected to each other by triangulation (Delaunay) [13]. Plating textures on surfaces finishes giving a photo-realistic aspect to the reconstructed object.

This reconstruction method must be applied to each subset of sequence of images corresponding to each position of the robot around the object, then the different reconstructed parts are then assembled. It is common to reconstruct from subsets of images

and then to merge the partial models thus obtained by a 3D alignment phase. The reconstruction and alignment algorithms are based on point or line correspondences between the images. The location of these points or lines in the images is affected by measurement noise, influencing the quality of the reconstructed 3D models. [14].

3D images are images that represent a three-dimensional scene. The pixel "is then called a voxel, [15] and represents an elementary volume.

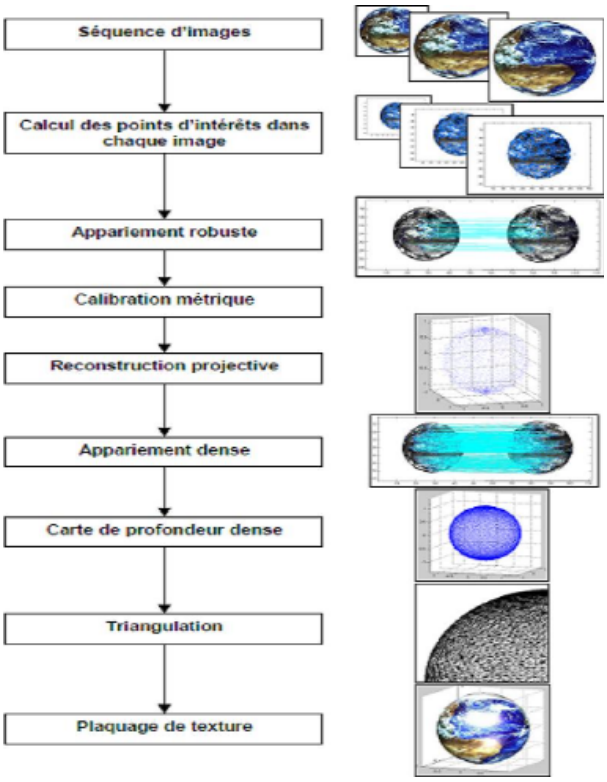

Fig. 2: Reconstruction method [3].

3.2 reconstruction using shape from contour (Shape from contour

The principle (of Shape from contour) [1] is to reconstruct the normals of visible surfaces from their contours. It is then possible to reproduce the surface from a field of normals.

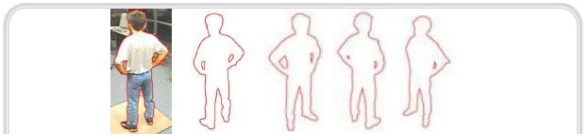

Fig. 3: contours of an object [1]

3.3 reconstruction using shape from silhouette

The purpose using these methods is to recover an object of interest in the scene. A silhouette image is a binary image whose value bat a point indicates whether a ray from the camera center to this point intersects the object of interest or not. An example of a silhouette image is shown in Figure 4 [11] [10].

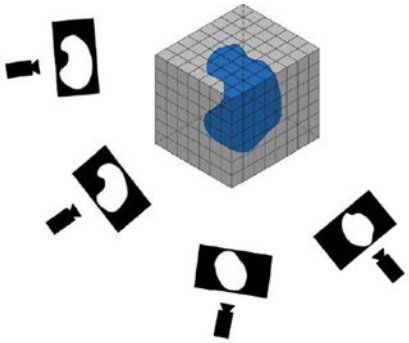

Fig. 4: reconstruction using shape from silhouette[11]

3.4 Reconstruction using Shape from shading

As its name indicates, it is a question of extracting a form starting from the variations of lights observed on the surface of an object [22], [23] at the beginning it was very little used in the systems of vision, one of the reasons for this state of affairs is the absence of robust algorithms capable of finding the fine and discriminating details of the surfaces of objects (see FIG. 5). Recently studies have been made on the possibility of using the shape from shading SFS in the recognition of 3D objects [23].

This category of techniques [2] uses strong hypotheses about the nature of the objects or the lighting conditions to reconstruct the shape of the surfaces.
The light intensity that an object reflects can be used to calculate its three-dimensional structure. If we know; the positions of the camera and the light source, the object's reflectance laws, it is possible to calculate the shape of the object.

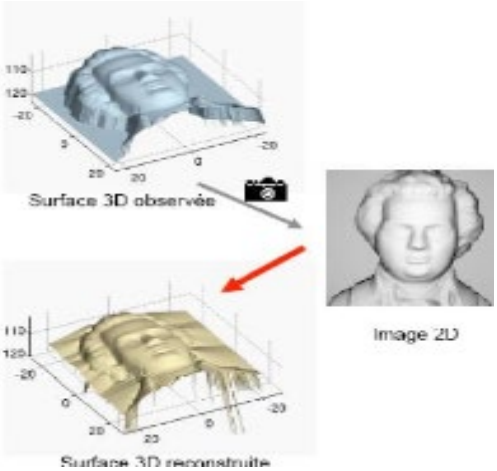

Fig 5 : application of the SFS on a 2D image. [2]

3.5 Representation by detection of shape deformation

This approach describes a new representation of deformable forms based on triangular polygons (see Figure 6), [24] [25] [26] it seeks a correspondence structure of deformable caliber, where we want to find a non-rigid transformation which draws the card of a model has a picture. The problem posed is the correspondence of the form to the image, the latter is defined in terms of an energy function. This energy function associates a cost with each potential transformation of the model. Typically the energy function is a sum of two terms; the first brings the distorted model closer to the image characteristics, while the second penalizes the large deformations of the model. Research on transformations is done efficiently by exploiting the properties of this representation for deformable forms.

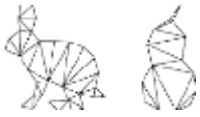

Fig 6: triangular polygons of a rabbit and a pear.

3.6 Methods based on skeleton extraction

The representation of skeleton forms is introduced by Blum [27]. It has the possibility of preserving in compact form a large number of topological and geometrical information of the initial form. Another advantage that should be noted is the fact that the skeletons have a graph structure (see Figure 7) which allows the use of the powerful tools from graph theory. The skeleton of an object is a representation of the shape in a lower dimension. For a surface object (2D), the skeleton is a set of lines centered in the shape, on the other hand for 3D objects there are two types of skeletons. The surface skeletons which are a set of surfaces centered in the shape and the curvilinear 3D skeletons which are a set of lines centered in the shape.

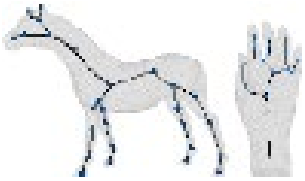

Fig 7: Topological skeletons of some objects.

4. Comparative analysis

Reconstruction from epipolar geometry is the most used method and must be applied to each subset of sequence of images corresponding to each position of the robot around the object, and then the different reconstructed parts are then assemblies.

The reconstruction by contour Even if they give rather good results in very precise situations, the assumptions requested by this method is in general too severe for a general use.

Reconstruction from shading is very little used due to the absence of robust algorithms capable of finding the surfaces of the object.

Reconstruction by detection of deformation of shapes gives an optimal global solution to the correspondence problem which allows detecting deformable objects without any kind of occlusion and background disorder.

5. Conclusion and perspective

In this article we discussed the concept of computer vision and the definition corresponding to the computer vision system and the classification of these systems according to a criterion of depth. We also introduced an overview on some 3D reconstruction method showing their definitions and principles.
3D reconstruction essentially aims to provide synthetic images at the lowest cost and best quality. Indeed, 3D reconstruction offers a double advantage: The elimination of the difficult problem of complete geometric and photometric modeling of the real world and the acceleration of the rendering stage.

Among these perceptual is to propose a new hybrid method for 3D reconstruction that

combines two methods of reconstruction of 3D images.

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The impacts of Zoom technologies with flipped classroom on students' academic performance, cognitive load and satisfaction

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Informations

Mots clés :

Flipped classroom
Google application
Covid-19
Zoom
cognitive load
motivation

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Abstract

Flipped classroom, a form of student-centred instruction, promotes interaction and discussion. In contrast, traditional teacher-centred teaching activities make it difficult to control the learning situation in the classroom and prevent students expressing their ideas during COVID-19. Flipped classroom with zoom meeting can allowing students to instantly express their ideas or respond to the teacher. In the class, Zoom technologies were used to discuss and clarify ambiguous ideas in the topic, present the model answers for the tasks and assessment. Teachers can provide interactive activities and can more deeply understand students' learning processes. Therefore, this research used a comparative quasi-experimental design to investigate the impacts of flipped classroom with ZOOM technologies on students' cognitive load and motivation.

1. Introduction

Covid- 19 virus, which arose in China in December 2019 and has prevailed all over the world since then, has not only affected the healthcare field but also the educational field. In order to decelerate infection speed and spread of Covid-19 virus, to reduce the deaths that may occur, and to gain time for treatment studies, face to face education was suspended in many countries around the world, or hybrid educational models in which face-to-face education and distance education were carried out together began to be used [24]. In this context, it becomes more and more substantial to apply most appropriately face-to-face training and online learning opportunities together through different models such as flipped classroom model [1]. Flipped classroom model allows students to practice and collaborate more in the classroom, and it eliminates the "knowledge transfer" role of the teacher in traditional education by replacing the place and the time of lecture with homework [25]. With this model, since students learn the subject at home more time is allocated for individual and group studies, problem solving activities, and exercises in the classroom [2]. Further, conducted studies showed that when the students took part in their learning processes, not only their success and learning performances increased but also their interests in peer learning processes [3] [4] [5]. [2] stated that with flipped classroom applications, students managed to spare more time for classroom activities and practices, and therefore an environment, necessary for students to speculate and examine, could be developed. In this context, the purpose of this research is to investigate whether using zoom technologies with a flipped classroom, could solve the teaching problems encountered during COVID19 and result in students' improved lower cognitive load and higher motivation by using a quasi-experimental method.

The following hypotheses guided our analysis and are postulated in this study:
H1: The cognitive load of students who learn with Zoom technologies and flipped classroom will be higher. H2: Students will be more motivated with the class when they learn with a Zoom technologies and flipped classroom.
The rest of this paper is organized as follows:
In Section 2, we present the basic concept of the flipped classroom. Section 3 is devoted the design of the proposed flipped classroom during Covid 19. In Section 4 we present the main characteristics defining the teaching experience that was carried out, describing in detail the procedure followed, the development of the measurement scale, and the method used to test the scale empirically. The

analysis and results obtained are described in Section 5. Finally, Section 6 draws conclusions and outlines future work.

2. Background

Flipped classroom is described as devoting more time for material usage in classroom by moving lecturing process out of classroom through videos, that is, the shifting between in-class training and homework [6] [7]. According to [8], flipped classroom system means to take the teaching, in which students are inactive, out of classroom through videos and to spend classroom hours with a learning process in which students are active. Similarly, [9] regarded flipped classroom as performing of a narrative education out-of-class and performing of the activities in classroom under the guidance of the teacher. On the other hand, [10] described it to be a perspective in which lecturing takes place out of classroom via videos or other resources in the light of a notion that the learning responsibility belongs to learners and active learning is carried out through classroom activities. The flipped classroom model enables students to learn without time and place limitations. In addition, it provides the opportunity to get ready for the activities to be done in the classroom by building their own knowledge outside the school. It is also aimed to eliminate note-taking monotony of the student in classroom and to get full efficiency from teachers in applications [11]. The flipped classroom model allows students to do more problem solving activities individually or with a group on subjects that they explore on their own in a classroom setting. Moreover, it allows concentrating on issues that many students face in the self-learning process, and gives opportunity to a teacher to give one-on-one attention to each learner [2]. The advantages of flipped classroom model for both teachers and learners can be sorted as follows;

- ✓ It enables students to attend the lessons even if they could not go to school because of various reasons such as social occasions or illness [6][12][13].
- ✓ It eliminates unnecessary time consumption for the subjects that students can learn easily on their own and instead of this, they can repeat the subjects that they hardly learn as many times as they need [14][15].
- ✓ It provides students with an opportunity to take responsibility and to gain self-knowledge. It also enables students to gain a skill through which they can apply knowledge that they learned to real life conditions [14][16] [13].
- ✓ Independent of the place and time, it helps students to learn in accordance with their individual learning pace during the non-class period [6][17] [18].
- ✓ Flipped classroom model, based on constructivist learning approach, increases students' participation and interests to the course by means of student-centred learning [29] [30] [16].
- ✓ It facilitates classroom management, as it offers one to one or small group study opportunities to teachers [6].
- ✓ It contributes to develop and efficient and creative time management in classroom and to increase communication between teacher- student and student- student [6][16][30].
- ✓ It helps teachers to do more activities instead of teaching something in classroom and therefore they can focus on students' learning processes [19].
- ✓ By offering learning experience, peer learning and teacher guidance, it makes possible to run active learning and individual learning together [17].
- ✓ It leads students to present their knowledge and skills during the activities conducted in classroom [20].
- ✓ Students do their homework in the classroom so that teachers can easily recognize students' learning difficulties and their learning styles [16].

There are also some disadvantages of flipped classroom model besides its advantages. One of its common disadvantages may be regarded as the lack of technologic devices that are need for its application and technologic faults [21] [22]. Another disadvantage of this model is to give extra responsibility to the students [23]. This disadvantage shows itself in the possible inconsistency between students' learning habits and learning style of flipped classroom embedded technology. That, in contrast to those prefers to keep their own learning under control; other students may need extra assistance as they cannot manage their own time and studies [23]. To sum up, when the previous studies were investigated, it could be understood that its advantages predominated over its disadvantages.

3. Proposed flipped classroom

The main working strategy of flipped classroom is organizing three activities one after one, as shown in figure 1.

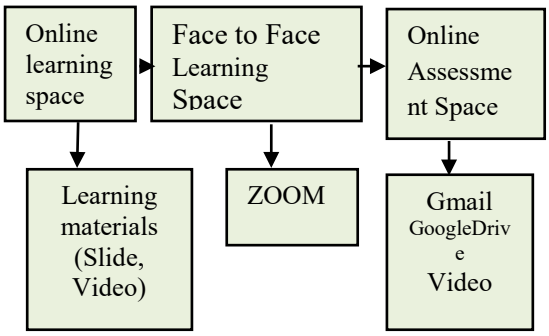

Figure 1: Proposed flipped classroom during Covid 19

- Teachers should share (upload) lecture materials to the students before organizing face-to-face class. Students will go through the lecture materials to understand the contents. During this time, students should identify their difficulties (content/topic that may not be clear to them) which could be asked to teachers during face-to-face class.
- During face-to-face class, teachers make themselves available to receive questions from students. Students' confusion (this confusion/ may arise during first stage that is in individual learning) will be clarified at face-to-face teaching. The teacher will receive students' questions until all students understood the lecture.

3.1. Online learning space

The aim of organizing an online platform is to provide learning spaces to individual and group students for achieving better learning outcomes via flipped classroom. Initially, the flipped classroom technique needs an online platform; By using online platform, different student-centered activities could be arranged. This platform facilitates teachers uploading their class lectures, and other required learning materials that should be prepared by the teachers following the course contents (curriculum), as shown in figure 2.

Figure 2: Learning material

3.2. Face to face learning space

The face-to-face classroom component of flipped classroom is shifted to online session due to lockdown (COVID-19). The aim of online classes is same as to face-to-face component of flipped classroom. For online classes, Zoom platform (https://zoom.us/) could be used free of cost and with few limitations.

- Teachers sign in Zoom platform for online classes;
- Teachers will invite all students to the Zoom classroom by using group Gmail from Zoom;
- Since students are aware of the online class time, within few seconds, students accepted invitation and join to the online session. Initially, teachers invite all students to ask questions (the questions should come from the lecture which sent to students two days before), and thereafter, teachers clarify issues (questions) raised by the students.
- The session (class) is ended when there are no more questions.
- Teachers may request students to provide few suggestions on how to improve next session. Lastly, teachers should provide information (instruction) to students on what will be sent for the next class.

The aim of including face-to-face classes is to clarify the issues (topics) which students may not understand at their own individual learning and apply the learned knowledge (online space). Teachers will organize regular classes at a face-to-face context with the intention of not conducting regular teaching (lecture presentation) but rather offering students the opportunity to ask questions and seek clarifications regarding the uploaded contents. Therefore, the teachers' main task is to clarify students' understanding by solving students' questions. This session is highly interactive between teachers and students to enhance students' understanding about the topic (lecture materials which teachers uploaded to the students at first stage). In the case of more practical subjects, the teacher assists students to correctly apply their new knowledge through various exercises and practical activities.

3.3. Online assessment space

To assess the learner it is necessary to use additional tools:

- *Gmail Group*

The main aim of creating this Gmail group is to organize communication with all students. Teachers will create a common Gmail Group including all students email address on it. It's could send any information to all students by sending one email. All students could communicate to the teachers after receiving email from the teachers.

- *Google drive*

The main aim of using Google Drive is for sharing assessment materials to teachers. Students upload assessment materials and videos for clarifying the ideas using group Gmail. Teachers will be able to access these materials and save these at their computer, as shown in figure 3.

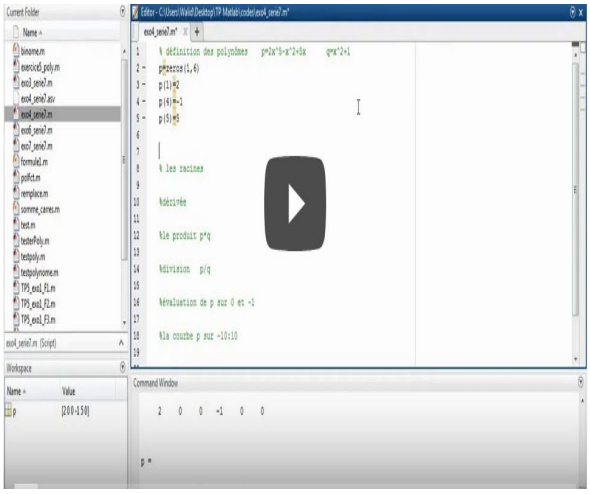

Figure 3: Student's feedback

4. Methodology

4.1 *Participants*

The teaching experience presented in this paper was conducted at the Faculty of Sciences in the University of Annaba (Algeria). The participants were 56 students (first Year LICENCE) enrolled in the Matlab course. This module consists of 30 teaching hours during the 15 weeks of the course. During this time, seven topics related to the module were dealt with as well as an introductory topic zero which was devoted to familiarizing the students with the Flipped Classroom method and with the necessary Information they would need to appropriately follow the course.

4.2 Research tools

The tools for assessment in this study included the questionnaire for measuring the students' learning motivation and cognitive load.
The Course Interest Survey (CIS) was to measure students' motivational reactions to the classroom instruction based on ARCS motivation model [26]. The CIS is considered a valid and reliable instrument with a documented reliability coefficient of 0.95 and four factors reliability (Cronbach's α = 0.80, 0.82, 0.79, 0.84 for attention, relevance, confidence, and satisfaction, respectively) [27]. The questionnaire of cognitive load [28], it was consisted of two factors: mental load and mental effort.

5. Results

In this study, the collected data was examined by descriptive statistics to explore the group numbers, means and standard deviations. The paired-sample t-test was conducted on the learning motivation and cognitive load. In addition, learning motivation and cognitive load were analyzed.

5.1 Analysis of learning motivation

Table 3 shows the results of the CIS motivational questionnaires conducted before the intervention and after the intervention of the course. Means and standard deviation are provided for dependent variables attention, relevance, confidence, and satisfaction

Variable	Test	N	Mean	SD	T
Attention	Pre-questionnaire	56	3.21	.61	-7.01*
	Post-questionnaire	56	3 .85	.48	
Relevance	Pre-questionnaire	56	3 .87	.59	-3.99*
	Post-questionnaire	56	4 .03	.50	
Confidence	Pre-questionnaire	56	3 .73	.51	-5.90*
	Post-questionnaire	56	4 .07	.52	
Satisfaction	Pre-questionnaire	56	3 .42	.66	-6.15*
	Post-questionnaire	56	4 .05	.69	

Table 3*: *t-Test result of the motivation

*p< .05

A paired-sample t-test was conducted to compare motivation to determine the effect of our model on the motivation of students. The results of a paired-sample t-test of CIS motivational questionnaires carried out afterwards are presented in Table 3. As shown in Table 3, the results of the paired-sample t-test indicated a significant difference between the pre-questionnaire and post-questionnaire for attention ($p < .05$, t =-7.01), relevance ($p < .05$, t

=-3.99), confidence (p < .05, t =-5.90), and satisfaction (p < .05, t =.-6.15).

The results of the paired-sample t-test revealed that there was a statistically significant increase in the motivation of students.

5.2 Analysis of cognitive load

The study also compares the two aspects of cognitive load: mental load and mental effort, as shown in Table 4.

Table 4: *t-Test result of the cognitive load dimensions*

Variable	Test	N	Mean	SD	T
Mental load	Pre-questionnaire	56	3.46	.84	.34*
	Post-questionnaire	56	2.71	.77	
Mental effort	Pre-questionnaire	56	3.54	.81	-7.31*
	Post-questionnaire	56	2.61	.78	

*p< .05

For the mental load dimension, the means and standard deviations were 3.46 and .84 for the pre-questionnaire, and 2.71 and .77 for the post-questionnaire. The paired-sample t-test result shows that the mental load before intervention is significantly higher (t = -5.34, p < .05). On the other hand, for mental effort, the means and standard deviations were 3.54 and .81 for the pre-questionnaire, and 2.61 and .78 for the post-questionnaire. The paired-sample t-test result shows significant difference between the mental effort ratings (t = -7.31, p < .05).

The way of structuring and presenting the learning resource or the strategy adopted for guiding the students to learn have positive impact on the reduction of cognitive load [28]. Flipped classroom reduces the cognitive load by providing a visualized way of helping students organize their knowledge.

6. Conclusion

The study findings show that flipped classroom provides a meaningful improvement in the motivation of students. Under COVID-19 conditions, students are dedicated and inspired to their studies and they accept flipped teaching classroom. Flipped teaching classroom helps a large part of the students, because it is a fresh but happy experience for them. Via flipped training, they seem pleased to learn. When they study and take part in lectures via flipped teaching they express their comfort. According to them, teachers are easily available, they can ask questions through Facebook or zoom and they are answered on the spot by the instructor when online courses are performed or in leisure time afterwards. In addition, they can manage a certain amount of time for the online class in collaboration with their teacher and other colleagues, which is convenient for them. To end all this, it can't be an exaggeration to suggest that flipped teaching can make students feel relaxed, happy and confident, and eliminate anxiety and frustration.

Similarly, on the other hand, it has certain drawbacks as well. Not all pupils are professionals in the use of technology. An introduction and orientation with regard to the use of technology can be given to students. But over time these weaknesses can be resolved.

Flipped classroom offer an excellent opportunity for individuals to extend their educational opportunities and stay competitive in the ever-demanding field of education. Students of self-motivation, independence and responsibility must be students who access higher education through online courses. Understanding their learning style and skills allows students to determine more easily if online studying is acceptable for them. Teachers and course designers will also benefit from understanding the dimensions of a course that increases student awareness and participation. Communication in terms of encouraging feedback, positive feedback and instant input from teachers to learners is a key aspect of flipped classroom. Clear instructions and a readily accessible course are also components of a well-structured course. Overall, flipped teaching allow learning to take place in an atmosphere that is not limited to space or time; flipped classroom has the potential to reduce barriers generated by poverty, location, disability, as well as other factors.

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Flipped classroom for algorithmic teaching based on ontology and bloom's revised taxonomy

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Infirmation

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Abstract

Today's society requires new skills and competencies, the university has an important role in their acquisition. The educational environment is undergoing profound transformations due to the integration and exploitation of the new Information and Communication Technologies Applied to Education. The use of these technologies in training environments allows new learning approaches to be considered. However, the quality of these approaches depends on their ability to provide learners with pedagogical content adapted to their needs.

This research work concerns the use of ontologies in Computer Environments for Human Learning generally, and in particular the integration of a flipped class learning system in the algorithms teaching to beginners.

The proposed approach consists in implementation of flipped class learning system based on Bloom's revised taxonomy and exploiting an algorithmic. This method allows for the fragmentation of learning sessions into two stages and six phases that improve the transmission of knowledge for better assimilation.

1. Introduction

Nowadays, technology occupies a very large place in the lives of students who already spend a good part of their free time on the Internet to learn or exchange information. This is why higher education institutions can no longer meet the needs of their learners by offering only traditional (lecture) courses in the classroom.

Currently, pedagogical methods are changing and include in their practice e-learning, blended learning and various synchronous, asynchronous or collaborative learning environments that are increasingly becoming an integral part of higher education.

Computer environments for human learning; defined as cooperative learning systems that integrate teachers (or trainers) and learners as actors, and that offer good conditions for interaction through networks between human and artificial agents, as well as good conditions for access to distributed, human and/or mediated training resources; which are based mainly on computer tools that aim to disseminate knowledge and its acquisition by learners. Thus, the motivation to explain, share and reuse this know (knowledge) is central to the Computer Environment for Human Learning.

In this context, ontologies, which are conceptual systems that allow concepts to be shared and reused through computational semantics, have a key role to play as intelligence amplifiers for knowledge sharing and reuse.

In this work we want to improve algorithmic learning by proposing a system based on the use of ontologies in human learning environments. More specifically, we are attempting through this research to make changes in the teaching method of this module.

Algorithms is a discipline that has long been used naively, as [1] pointed out, without any particular formalism. The algorithm allows the programmer's ideas to be organized and represented with a formalism that can be easily translated into a language that can be understood by the computer. This discipline is often a source of problem for the teacher as well as for the student; the teacher because he must find the appropriate methods to assimilate rather abstract concepts to students who are only in their initiation phase. [2] confirms that the failure or dropout rate for undergraduate introductory programming courses varies between 25 and 80% worldwide.

It is well known that many students find learning algorithms and programming difficult to master [3]. Our university does not give better results, according to the study by [4] which compared the success rate of algorithmic students with other modules taught during the same year. The result obtained showed that a failure rate of 75% in Algorithmic learning was observed over two consecutive years.

Since we assume that a misunderstanding of a basic algorithmic notion or a misinterpretation of it necessarily leads to the realization or design of an erroneous algorithm, trying to mitigate the difficulties encountered by any student in learning the algorithm is our main objective.

We note that all the algorithmic courses, in our university, given in the first year of the L1 MIAS degree are classroom-based. However, in traditional teaching based on lectures in which students must be present and in which the time in class is mainly devoted to the lecture given by the instructor and a short question and answer period, students are required to do the work requested outside the classroom, which, due to poor time management, makes the task difficult to accomplish.

It is for this reason that we have focused on the concept of "Flipped Classroom" as a teaching technique by proposing a flipped model based on Bloom's taxonomy. This Flipped approach integrates a dynamic and engaging face-to-face learning environment and a set of asynchronous online tools that prepare and improve student learning.

The rest of this paper is organized as follows: in section 2, we present a state of the art on related works on the difficulties in algorithmic learning, flipped algorithmic teaching and bloom's taxonomy in flipped classroom. Section 3 is devoted to the presentation of the design and implementation of flipped algorithmic class platform learning. We expose in section 4 the methodology of an experiment. Next, in section 5, we present the results of an experiment. Finally, we conclude with section 6, which contains the conclusion and the future work.

2. Review of literature

This section we give a review on the difficulties in algorithmic learning, also we presents the flipped classes approach and the importance of using Flipped Classroom for algorithm learning based on Bloom's revised taxonomy.

2.1. Difficulties in Algorithmic learning:

Algorithmic is the science whose object of study is the algorithm. This discipline, at the borderline between mathematics and computer science, is interested in the creation, description and analysis of algorithms.

Knuth (1985) sees algorithmic as the whole computer science.: "For many years Ihave been convinced that computer science is primarily the study of algorithms. My colleagues don't all agree with me, but it turns out that the source of our disagreement is simply that my definition of algorithms is much broader than theirs : I tend to think of algorithms as encompassing the whole range of concepts dealing with well-defined processes, including the structure of data that is being acted upon as well as the structure of the sequence of operations being performed [...] However, if I had a chance to vote for the name of my own discipline, I would choose to call it Algorithmics." [5]

Learning this discipline is considered as an immense challenge for the majority of undergraduate learners. This difficulty has been studied in many research papers , such as [6], [7], and they showed high dropout rate of first year computer science learners.

Algorithmic thinking is a special problem solving competence, which consists of several abilities, see [8]:

- Analyze given problems
- Specify problems precisely
- Find the basic actions that are adequate to given problems
- Construct correct algorithms to given problems using the basic actions
- Think about all possible special and normal cases of a problem
- Evaluate algorithms (correctness, efficiency, termination)
- Improve the efficiency of algorithms

Futschek and Moschitz have been working on activities where learners can play algorithms, either virtually or by themselves [9] or with

tangible objects [10] Their work focuses on the fact that the concepts of algorithmic thinking must be reduced to natural thinking for beginners. Moreover, that especially for beginners the complexity should be reduced to that level where the concepts of algorithmic thinking can be learned in a natural way [11].

This problem of algorithmic failure is not only a problem for our institution. Several studies on algorithmic learning conducted by different institutions in other countries [12], [13] have converged towards the same conclusion that algorithmic learning is still a source of difficulty not only for students but also for teachers.

These results and our own experience as a student at this university have led us to focus on "how to improve the quality of learners' understanding of algorithmic in our university?" and "What learning strategies should we use to facilitate the understanding of basic concepts and how?"

2.2. Flipped classroom teaching:

In the Flipped Learning model, teachers transfer direct learning from the large group learning space to the individual learning space, using one or more technologies. Teachers record and narrate screencasts of the work they do on their computers, create videos of themselves teaching, or select video lessons from websites such as TED-Ed and Khan Academy. Many educators are beginning to improve their classrooms using this readily available material. Students can access the videos or screencasts whenever and wherever they want (at home, in study hall, on the bus, even in the hospital), as many times as they want, allowing them to come to class better prepared [14].

The "flipped classroom" is a pedagogical approach that reverses the nature of learning activities in the classroom and at home, resulting in a shift in traditional learning roles, a strategic direction that helps higher education meet the expectations of today's students while optimizing instruction and classroom resources. [15]

Lebrun and Lecoq in [16] described the flipped classroom as:

- ✓ A means of increasing personalized interaction and contact between students and teacher.
- ✓ An environment in which the actors change roles: students take responsibility for their own learning under the guidance of the instructor who is no longer the master on the stage "wise on the stage" but the attentive guide on the side.
- ✓ A fertile mix of direct "I teach" transmission with a constructivist or socio-constructivist approach to learning (it is the learners who learn).
- ✓ A class in which students who are absent due to illness or extracurricular activities are not left "behind".
- ✓ A classroom where the content being worked on (the "subject matter") is permanently accessible for review, testing, remediation.
- ✓ A place where students can receive personalized support.

In the vast majority of this research, regardless of discipline and academic or school cycle, a positive impact on academic performance is reported in terms of higher average scores on assessments when the flipped classroom is used ([17]; [18]; [19]; [20]; [21]; [22]; [23]; [24]; [25]; [26]; [27]; [28]; [28]; [30]; [31]; [32]. [33];). It seemed appropriate to point out that in several other articles as recorded ([17]; [18]; [23]; [27]), no statistically significant positive impact on outcomes was recorded. Nevertheless, none of these articles showed a negative impact on academic performance following the implementation of the flipped classroom.

2.3. Flipped Classroom for algorithm learning based on Bloom's revised taxonomy:

In a flipped classroom, what the learner receives at the beginning of the "lesson" is a mass of information organized in the form of a video capsule most commonly used, but it may be other media or an explanation of a notion related to understanding the lesson.

Thus, the complex is approached first in order to analyze it, understand it and then bring production tasks during peer-to-peer classroom activities with a teacher who becomes a guide and accompanist.

By integrating the revised bloom taxonomy into reverse classroom learning, learners will achieve the lower levels of cognitive work (remembering and understanding) outside the classroom to focus on the higher stages of cognitive work (application, analysis, evaluation and creation) during classroom sessions, where there is an atmosphere of competition between their peers and encouragement from their instructor [34].

Table 1: Description of the Bloom's taxonomy steps

Step	Description
Remembering	In this stage, the learners try to recognize and recall the information they receive; they also try to understand the basic

	concepts and principles of the content they have learned.
Understanding	The learners try to demonstrate their understanding, interpret the information and summarize what they have learned.
Applying	The learners practice what they have learned or apply knowledge to the actual situation.
Analyzing	The learners use their critical thinking in solving the problem, debate with friends, compare the answer with peers, and produce a summary. The learners obtain new knowledge and ideas after implementing critical thinking or debate in-group activities. In this level of learning, the learners also produce creative thinking.
Evaluating	Assessment or established peer-review knowledge, judge in relational terms; in this stage, learners are evaluating the whole learning concepts and they could evaluate or make judgment on how far they succeed in learning.
Creating	The learners are able to design, construct and produce something new from what they have learned.

Bloom's Taxonomy classifies diverse domains of learning, from the basic recalling of facts to applying knowledge which generates something new. [35] Every domain has different levels, below is the revised version of Bloom's taxonomy for cognitive learning [36].

2.4. Algorithmic domain Model

Nowadays, there are many suggestions for ontology-based e-learning, or ontology-based instructional design. Here are some examples [37] [38]. From a pedagogical point of view, when a learner understands new concepts, it is important to integrate them as knowledge. Ontologies can make a significant contribution in this respect [39].

Many solutions and researches focus on the use of ontology in modeling personalization and automation of the e-learning environment, including: modeling the learner's profile, assessing behavior, describing knowledge about learning styles, and other issues arising in the context of personalizing e-learning [40].

The domain ontology expresses domain-specific conceptualizations and is intended for several applications in the domain. It provides concepts and relations to cover the vocabularies, activities and theories of these domains.

Today, ontologies are widely used in the field of artificial intelligence, because the use of ontologies offers several advantages: interoperability between systems, data sharing, reuse of domain knowledge, etc. It is this type of ontology that will be useful for defining the targeted objectives of our project.

3. Flipped algorithmic class learning platform

Our hypothesis is that "*the flipped classroom is an effective way to teach algorithmic*", compared to the traditional model. Given the nature of the module, that requires the acquisition of knowledge and skills, the materials covered in the algorithm courses are dense and for many learners difficult to understand at the rate at which teachers present them. Therefore, from time to time, the learner must stop and think for himself to catch up, but on a traditional conference, such a break is impossible because his need varies from one individual to another. In addition, the content is sequential and closely linked to each other, so if the learner's attention is lost for a while, he or she may not understand most of the course content and waste time attending the conference. Also requires a lot of practice, the latter, it is not well taken care of in traditional teaching as already explained.

The first two problems are solved by video conferences, which are assigned to learners in the reverse class model. The learner can watch the video at a speed that suits him/her, pause it when he/she needs to think about a concept or rewind it if he/she has missed anything.

The solution to the third problem lies in the "in-class" part of the reverse class model, where the learner finds himself in a situation of practice with the teacher and other learners in order to solve a given learning situation (exercise, case study, PBL...).

The present study aims to extend our collective understanding of flipped classroom in three ways:

- First, we tested the possibility to integrate ontology in the representation of algorithmic domain model.
- Second, we tested the feasibility of using an instructional design theory- theory of Bloom's revised taxonomy- to implement flipped classroom.
- Third, we designed and offered flipped classroom for underperforming learners and high ability learners based on learner's learning style and learner's skill level.

- Finally, we compared the effectiveness and learner perceptions in flipped classroom and traditional class.

3.1. Algorithmic Domain Model

Domain module is represented with domain ontology and resource ontology, domain ontology of algorithmic designed in [41] it consists of a set of concepts and relationship between these representative the field of algorithmic concepts, these hierarchies have been represented as follows:

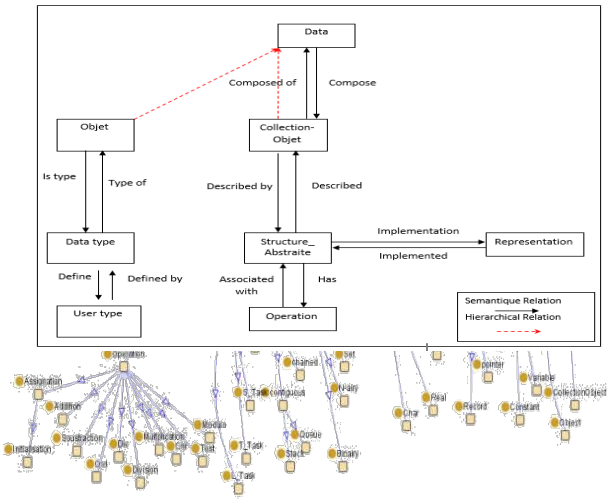

Fig. 1. Binaire relation diagramme of domaine ontology

The codification of our ontology was done using the Protégé 2000 ontology editor of Stamford University.

Fig. 2. Domain ontology

When the teacher integrates the lesson on the system, he must define tags for it, it is the last ones are externalized from the domain ontology. from these tags the system will present a semantic menu to the learner according to the relationships existing in the ontology, this menu will help the learner to see the relationship of the lesson read at this time with the other lessons already read or planned in the next sessions.

3.2. Bloom's taxonomy in flipped classroom of algorithmic:

In 1948, Bloom led a group of educators who set out to classify educational objectives; with the goal of implementing a method of classifying the thinking behaviors necessary for the learning process. This later became a taxonomy that covered three domains: the cognitive domain, the affective domain and the psychomotor domain. In 1956, a manual commonly called "Bloom's Taxonomy" was published.

In 1990, Lorin Anderson, a former student of Bloom's, again convened an assembly to update the taxonomy to make it more relevant to 21st century learners and teachers. The work was difficult, taking six years to finalize, and it was not until 2001 that a new version was published that included minor but important changes. The changes were in three main categories: terminology, structure and orientation. The terminology changes between the two versions appear to be the most visible and confusing differences. [42]

In an effort to improve algorithmic learning, we focused on the concept of the "flipped classroom" as a teaching technique by proposing a flipped model based on Bloom's taxonomy that is deployed in two stages:

- The first stage, called "Out class", provides students with a set of relevant instructional content on algorithms in the first two phases of the taxonomy, which are information retrieval and understanding. This content is in the form of video tapes that review the main points that will be covered in the second stage.

- The second stage called "In Class" consists of applying, analyzing, evaluating and creating an algorithm. In other words, students come to class with what they have learned in the first stage to discuss their learning with their teachers and peers, and to complete the planned activities individually or in groups.

Figure 3 below illustrates the levels of Bloom's revised taxonomy based on the flipped classroom approach.

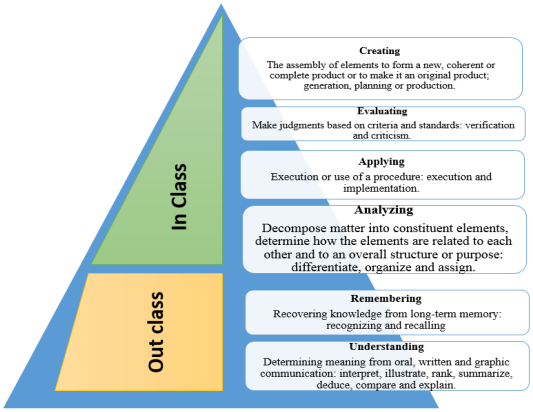

Fig.3. The levels Bloom's revised taxonomy according to the flipped classroom approach.

4. Experimentation

According to our hypothesis that the reverse class will be of great help in learning the algorithmic and will improve the quality of learning and its results, and always based on the fact that the basic concepts are the most important in this module.

We tested this learning approach on students to see the impact of integrating such a method into our academic environment compared to the traditional method.

4.1. Instruments

There were three instruments used in this study presented in the following table.

Table 2. Instruments used in the study

Instrument	Roles of teacher	Analyse
Pre-test and Post-test	- Create a 10-question test to be used as a pre-test and post-test assessment. (The tests included eight multiple choice and two open-ended questions from the content of their lessons.) Mappe each question with lesson objectives to ensure assessment consistency. (The same 10 questions were also used for the post-test implemented at the end of the experiment.)	The reliability analysis showed that the pre-test/post-test created and used in this study was found reliable (10 items; from α = .71 to α = .82). Even though no long term validity test applied to this instrument due to the time constraint, internal consistency scores showed positive results (10 items; from α = .69 to α = .79)
Creating Lesson Videos	- Create their lesson plans. Create content videos with different approaches depending on the lesson content.	
learner Survey	- Prepare an 8-questions survey to collect data regarding the experiences of the learners. The survey was prepared only for the group of learners that were taught in the flipped model. Create online survey using the Survey Monkey online survey service.	- The reliability analysis showed that the learner survey created and used in this study was found reliable (8 items; α = .74).

4.2. Progress of the experiment

we conducted an 8-day study on a population of 50 first-year undergraduate students, for the algorithmics course, the experimental group of 26 students took a flipped classroom course and the other control group of 24 students took a traditional course.

Both groups took a pre-test before starting the experiment to find out their initial level and a post-test at the end to assess their level of mastery of the new material.

We also used an online form to collect the opinions of the learners in the flipped classroom. Each of these steps will be described in detail in the following paragraphs.

5. Results

5.1. Pre-test

Firstly, all learners were divided into two groups according to their scores of prior knowledge assessment. Before one-way ANOVA, the homogeneity of variance assumption (F=0.516, p=0.476> 0.05) was tested. The result indicated that the homogeneity assumption was not violated. The results of the one-way ANOVA are presented in Table 3.

Table 3. Basic statistics for the two groups in pre-test

	Control			**Experimental**			**P-value/F-test**
	N	M	SD	N	M	SD	
Pre est	24	52.19	14.7	26	48.61	19.91	0.476/0.516

5.2. Post-test

Table 4 shows that the experimental group has significant impact on the post-test scores of the assessment (F=8.562, p=0.005> 0.05), meaning that in the experimental group, learner level of prior knowledge has a significant impact on their learning effectiveness. Furthermore, the

experimental groups have significantly better learning effectiveness than control groups.

Table 4. Basic statistics for the two groups in post-test

	Control			**Experimental**			**P-value/F-test**
	N	M	SD	N	M	SD	
Post-test	24	58,9	17	26	73,56	18,46	0.005/8.562

5.3.Survey to learners and Evaluation

In this section, we will present the survey in which learners specifically evaluate the flipped classroom approach. Table 5 shows the questionnaire results of this study. Overall, most of the learners (87.5%) found that flipped classroom was more engaging than traditional classroom, and preferred learning at their own pace. In addition, many learners (70.8%) liked watching instructional videos, and recognized that flipped classroom provided more chances for peer communication. The follow table present the 10 questions of the form:

Table 5: 10 questions of the experimental group Suestionaire

Nbr	**Statements**
1	The flipped classroom is more engaging than traditional classroom instruction
2	I like watching the lessons on video
3	I prefer a video-recording of the lesson to a traditional teacher-led lesson
4	I like to self-pace myself through the course
5	I like taking my quizzes online by using online learning platform
6	The flipped classroom gives me more chances to communicate with other learners.
7	I am more motivated to learn in the Flipped Classroom
8	The flipped classroom has improved my learning of algorithmic
9	I liked the navigation between tags in the lesson
10	The tags helped me to understand the relationship between the notions of the course

This figure show the results of learner evaluations of the flipped classroom experience

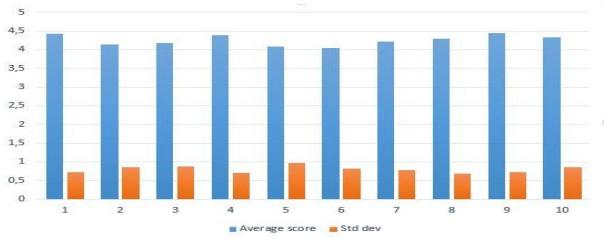

Fig. 4. Results of learner evaluations of the flipped classroom experience

Learners' answers to the open-ended questions of the questionnaire and interviews were analyzed by theme and organite into several categories.

Firstly, learners mentioned the benefits of the flipped classroom, such as the ability to learn at their own pace and autonomy in learning: "*Learners are free to choosewhether or not they want to watch the videos for review*" (learner 10), "*We can decide on our own learning progress*" (learner 9). In the same way, learners' perceptions of theflipped classroom were mostly positive. Some learners even asked the teacher to provide them with more examples and exercises, as well as to extend the duration of the lessons: "*It would be better to give more examples and advanced applicationproblems*" (learner 15), "*We can stay even after 6pm (end of lesson)*" (learner 20).

Secondly, the majority of learners reported that the classroom discussion made it easier for them to learn. They also enjoyed communicating with their peers in their learning. For example, "*learners mainly discussed the solution in class, whichfacilitated our communication and learning*" (learner 18).

Thirdly, although many learners liked the fact that they could receive more help from the teacher during school hours, a number of them indicated that they could not get immediate help for their out-of-class learning. Some learners asked for a place to ask the teacher questions: "*We cannot get instant feedback when we have problems athome*" (learner 17); "*You can provide a place where learners can ask questions during the out-of-class session*" (learner 12).

Finally, a lot of learners have shown that navigation by semantic tags has helped them to better understand the relationship between several notions, which before could not assimilate them. "*I didn't know that the notions of the course were related to each other and that even if we learned them in separate lessons*" (Learner 6); "the tags helped me to link the lessons I was reading with the one I had already acquired and animated my curiosity to wait for the one I didn't know yet" (Lerner 1).

6. Conclusion and future works

Our work focuses on the teaching of algorithms which, since its inception, has been a difficult subject for the teacher to teach and complex for the learner to assimilate. This is due to the intrinsic characteristics of the subject and the way in which teachers (the majority) understand its foundations. These difficulties make it very difficult to design a serious game for the algorithmic.

The development of a Computer environments for human learning based on the modeling domain model using ontologies to ensure functionalities related to competency management, pedagogical resource management and training quality management using the reverse class approach.

It incorporates multimedia pedagogical processes and monitors learners' activities. The aim is to allow the learner to consult the pedagogical contents online, carry out exercises, transmit assignments to his teacher and also allow communication between the learner and the teacher can be individual or in a group.

The difference compared to traditional teaching comes from the fact that knowledge is not transmitted by a teacher but is individually appropriate by the students.

It also changes the roles of teachers. They advise and support students and support learning processes. They ensure that students do not leave a topic with misconceptions. They ask open-ended questions rather than passing on knowledge.

All the more so since the integration of learning situations by class allows the development of desirable skills and attributes in learners.

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An HMM_Model-Checker for complex systems

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Informations

Keywords:

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ABSTRACT

Nowadays, probabilisticverification for embeddedsystems continues to attract more and more actors in the researchcommunity. Given a formula of the logic POCTL describing the specifications of a system, an HMM model, and a miningalgorithm to check if itissatisfied or not. This workpresentssome contributions in the verificationarea: the HMM as a new model, an implementation in the NetBeans 6.5 environment of a toolcalled "HMM_Model-Checker". Safetyproperties are checked on a case study of a real embedded system Hubble SpaceTelescope, results are encouraging.

1. Introduction

The proliferation of complexsystems in all aspects of ourlives places an increasing importance on the need for them to functioncorrectly. The presence of suchsystems in safety-critical applications, coupledwiththeireverincreasingcomplexity, meansthat the conventionalmethod of checkingthat a system behaves as intended, testingit on a representative set of scenarios, isofteninadequate.

A branch of computer science whichaims to resolvethisproblemisformalverification. A prime example of thisisprobabilistic model checking [1].

Our approachdiffersfromothers in the three basic entities: model, temporal logic and probabilisticalgorithm exploration.

This paperpresentsourtoolHMM_Model-Checkerfollowed by a case study of an embedded system whichis the Hubble SpaceTelescope to consolidateourwords.

2. Background material

2.1. *Probabilistic model checking*

Probabilistic model checkingis an automaticformalverification technique for the analysis of systemswhichexhibitstochasticbehavior [2]. The technique issimilar to model checking. The major differenceisthat a probabilistic model containsadditional information on likelihood or timing of transitions between states, or to be more specific, itcan model stochasticbehaviour.

Probabilistic model checkingrefers to a range of techniques for calculating the probability of the occurrence of certain eventsduring the execution of the system, and canbeuseful to establishpropertiessuch as “shutdownoccurswithprobabilityatmost 0.01” and “the video frame willbedeliveredwithin 5ms withprobabilityat least 0.97” [3].

2.2. *Existing model checkers*

There are a limitednumber of toolsavailable for probabilistic model checking. Wereference six tools of academic major. They are free and freely accessible via Internet: APMC, PRISM [2], ETMCC [4], MRMC, YMER, and VESTA.

3. Our approach

3.1 *Hidden Markov Model (HMM)*

An HMM [5] is a doublyembeddedstochasticprocesswith an underlyingstochasticprocess over some state space, whichishidden. The occupied state canonlybeobservedthroughanother set of stochasticprocessesthatproduce a sequence of observations. Given the sequence of

observations, we do not exactly know the occupied state, but we do know the probabilitydistribution over the set of states. This information iscaptured by a so-calledbelief state [6].

3.2 *The logic POCTL*

For agiven HMM, one isofteninterested in the properties of the underlyingstochasticprocess. In addition, one isalsointerested to reason about properties over the other set of stochasticprocesseswhichproduce the observations. POCTL [6] allows us to specifyproperties of interests over HMMs.

The basic syntax for expressing a property (prop) is as follows:

(prop) ::=true | false | (expr) | **(croyanceprop)|**

! (prop) |
(prop) & (prop) |
(prop) | (prop) |
(prop) => (prop) |

(cryanceprop) ::= $P_{(op)(p)}$ [(pathprop)]|
! (cryanceprop) |
(cryanceprop) & (cryanceprop) |

(pathprop) ::= $X_{(o)}$(prop) |(prop) U (prop) |
(prop) $U_{(time)}$ (prop) |

(time) ::=>=(t) | <=(t) |

Where:

- (expr) is an expression which evaluates to a boolean;
- (op) is a relational operator (one of <, <=, >= or >);
- (p) is an expression evaluating to a double in the range [0, 1];
- (t) is an expression evaluating to a non-negative double or integer;
- (O) is an observation.

3.3*Model checkingalgorithm*

The algorithm to check whether an HMM satisfies a propertycanbeadaptedfrom the one presented by Hansson&Jonsson [7].

The algorithmisbased on a recursiveprocedureSat(Φ) thatcomputes all states thatsatisfy the formula Φ [6].

3.4*Structure of HMM_Model-Checker*

Our toolcalledHMM_Model-Checkeris a probabilistic model checker, a tool for the modelling and analysis of systemswhichexhibitprobabilisticbehaviour.

A simplified version of the overall structure of the toolisshown in Figure 1.

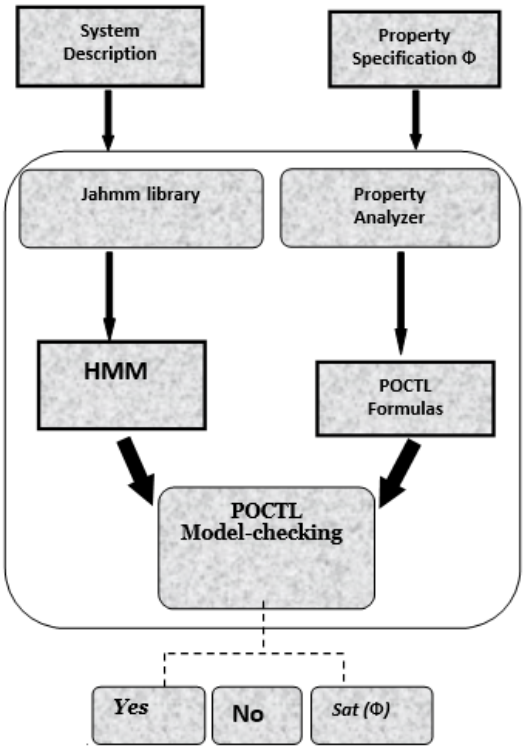


Fig. 1 : The structure of HMM_Model-Checker.

HMM_Model-Checkerwasimplemented in the environmentNetbeans and uses the Jahmmlibrary to create the model and analyzer. Here are some key featuresimplemented:

- Load an HMM H from a file;
- create an HMM H;
- The possibility of learning the parameters of an HMM model H using a model given and assumed to comments made by this model, weseek the transition probabilities and emissionmaximizing the likelihood of observations;
- Save an HMM H in a file;
- Load a sequence of observations from a file;

- Generatea sequence of observations;
- The assessment of the likelihoodthat the sequence of observations has been issued by a model. When multiple modelsexist, thisevaluationallows the selection of the mostlikelymodel;
- Save a sequence of observations in a file;
- The search for thesequence of states of a model thatproduced the sequence of observations, i.e. the search for the hiddensequence of probabilities and thatbetterexplainsthese observations;
- The input screen of a formula of logicPOCTL;
- Helping the user to enter the formula POCTL correctly and quickly, it displays information about the syntax of the formula and giving buttons to automatically display certain logicoperatorsconstituting the formula as:Until, Next, And so on ....;
- The ability to display error messages if the input formula does not meet the basic syntax of the propertyPOCTL;
- The ability to capture the screen to comment on the property to check;
- The calculation of SAT (Φ), all states thatsatisfy the formula;
- Verification of H |= Φ.

4. Experiment

4.1*Hubble SpaceTelescope (HST)*

This example (an adaptation from [4]) models the failurebehaviour of the Hubble spacetelescop. Westart by describing the real system, whichconsists of parts thatcanpossiblyfail. Once the system isunderstood, wewill model itsfailurebehaviour, sothatwemaypredictitsbehaviour.

The system has asteering unit with six gyroscopes, which are used to aim the telescope. Redundancyis an important issue whendesigningsystemssuch as the spacetelescope, sinceitisobviousthatperformingrepairsis not trivial. This iswhy the telescopeisdesigned in such a waythatitwillstillfunctionwith full accuracywhenonlythree of its six gyroscopes are operational. Withlessthanthree gyroscopes the telescopeturnsintosleep mode, meaningrepairs are necessary. If none of the gyroscopes are operational the telescopewill crash. No repair mission willbeundertaken, as long as there are more thantwo gyroscopes operational [8].

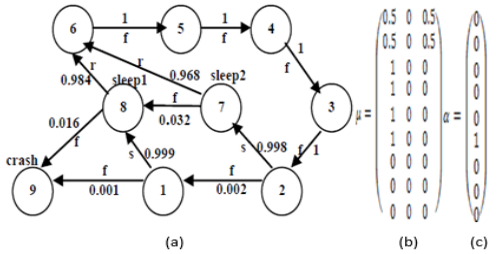
4.2*The model HMM*

The model HMM of the system that has just been describedisdepicted in Figure 2. The model has a total of nine states. Each state has a number and label (shownrespectivelyinside and outsideside the state symbol).

States 1 through 6 are not labelledexplicitly;their labels equaltheir state number, whichrepresents the number of operational gyroscopes. States 7, 8, and 9 are labelled sleep2, sleep1 and crash.

State 6 isconsidered the initial state where all gyroscopes are operational;thisisalso the state of the telescopeafter a successfulrepair mission. The state with label crash is a terminating state.

The model HMM have threeobservations: f represent a failureevent of a gyroscope, r means a repair mission has been undertakensuccessfully and s means the telescopeisgoing to sleep.



(a) The transition system with the set of observations

(b) Observation probability matrix

(c) The initial distribution

Fig. 2 : The HMM of the HST.

4.3*Someproperties to bechecked*

4.3.1 Description

Among the propertiessatisfiedduringtesting by ourtool, wewill mention three :

- The probabilitythat the next observation is f and then the model don't go to state 6 meets the bound ≤ 1;
- The probabilitythat the telescopewill not crash meets the bound ≤ 1;
- The probabilitythat the telescopewill crash isequal to 0.

4.3.2Specification In POCTL

The formulas POCTL are respectively as follows:

- P≤ 1 [X F !(six)];
- P≤ 1 [X F !(crash)];
- P>=0 [X E (crash)].

5. Results And Comparisons

Wecompared the resultsobtained by HMM_Model-Checker to double compared to the same system HST: the first withthoseobtainedmanually and the second to thoseobtained by the tool ETMCC [4]. The resultsobtained are summarized in Table 1 and are all identical.

Table-1. Comparative results.

Property	Manual approach	ETMCC	HMM_Model -Checker
1	verified	Verified	verified
2	verified	Verified	verified
3	verified	Verified	verified

6. Conclusion

In this paper, we focused on one aspect of automaticverificationbased on probabilistic model, a technique more general and realistic, which continues to attract more followers in the audit universe. Wedesigned and implemented a tool called HMM_Model-Checker. It allowsverifyingpropertiesdefined by logical POCTL over an HMM model with a veryfriendly interface. It wastested on a case study of an embedded system whichis the HST and the results are encouraging.

In the future, wehope to develop new features, on the one hand extend PRISM models to ourtoolsuchas DTMC, CTMC to ourtool and on the oher and addotherproperties to experiment on new real applications.

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Object multi-detection and multi-tracking via machine learning and deep learning

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Information

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Abstract

Objects detection and tracking in video frames constitute a vital field of research that provide appropriate information about objectsand their trajectories. An interesting technique to achieve these goals is using digital image/video processing methods with machine learning and deep learning methods. This paper presents an object multi-detection and multi-tracking approach based on a combination of machine learning methods,using KMeans clustering and silhouette coefficient measure that are used for objectmulti-detection with a deeper convolutional neural network method which represents a ConvNet architecture used for objectsclassification, and a proposed algorithm using a mathematical concept for object multi-tracking. This work demonstrates that the mission of object multi-detection and multi-tracking can be achieved via standard image/video processing and machine learning (consequently deep learning) methods. Therefore, and for both detection and tracking goals, we will show that optical flow analysis, data analysis and ConvNets architectures are well suited towards these goals.

1. Introduction

Image/video processing is the field of handling and analyzing images. There are several hidden information in an image that we unconsciously process. The goal of image/video processing is to use the different properties of an image/frame such as color, correlations between different pixels, pixels motion, object number and their placements.

Convolutional Neural Network (also called ConvNet) is one kind of feed-forward neural networks. It is an efficient recognition process which is widely used in pattern recognition and image processing. It has many features such as simple structure, less training parameters and adaptability. The pre-trained VGG19 **[1]**ConvNetused in this paperfor image identification is a deeper convolutional neural network that is trained on the ImageNet database **[2].**

Several works, using image/video processing and deep learning methods for object identification, are mentioned these last years, especially in recent deep ConvNets (CNNs) architectures that got an important improvements, these last allow them to outperform traditional computer vision techniques in image detection and classification tasks across benchmark datasets **[3].**

A recent ConvNet model that is called R-CNNs (for Regional Convolutional Neural Networks) combine these two tasks; candidate object locations are determined and automatically classified**[4].** However, in its original form, R-CNNs are computationally expensive to train and evaluate. An important idea is used to fix this challenge that consists on the introduction of sharing convolutions across proposals in Fast R-CNN and SPPnet **[5].** In **[6]** Ren et al. propose the addition of a Region Proposal Network (RPN), which shares convolutional features with the detection network leading to Faster-RCNN. Furthermore, Region-based Fully Convolutional Networks (R-FCNs) **[7].**

In **[8]**anapproach was proposed for foreground (i.e. object) extraction with minimal user interaction. Initially user draws a rectangle around the object region. Then GrabCut algorithm segments it iteratively to get the best result. The main difficulty in this approach is that, in some cases the segmentation won't be fine, like, it may havemarked some foreground region as background and vice versa. In that case, user needs to do fine touchups with whitestrokes (denoting foreground) and black strokes (denoting background).

In **[9]** the principal goal is to detect and locate Friesian cattle in images obtained from a top-down or aerial standpoint. The deep network used to address this problem is the R-CNN adaptation of the VGG CNN M 1024 network published as part of several other network architecture proposals **[10].** In another approach called YOLO described in **[11]** the authors frame object detection as a regression problem to spatially separated objects (i.e. Bounding boxes) and associated class probabilities, this model imposes strong spatial constraints on bounding box predictions since each grid cell only predicts two boxes and can only have one class. This spatial constraint limits the number of nearby objects that the model can predict. YOLO based algorithm with Gaussian Mixture Model by using the concepts of deep learning has given good accuracy for feature extraction and classification **[12].**

In **[13]** an approach based on SSD **[14]** and MobileNets **[15]** algorithms for object detection and tracking. With a help of RoIs (region of interest) the object is detected from given class of image. Different methods are used: Frame differencing, Optical flow, Background subtraction, this last is constrained by using a static camera.

Comparing the model proposed in this paper to other detection systems like **[9] [11-13]** we can highlight the main difference adopted by our approach that consists on the use of the VGG19 **[1]** model power and KMeans clustering method with the math rigorous concepts to allow specific objects selection ensuring a best object multi-detection and multi-tracking. However our approach gives alternate and weaker results in some cases that disappear in other detection systems**[9][12,13]** : In the case of small object detections (i.e. VGG19**[1]** model used for identification deals with large-scale images) and in the case of several objects within nearby frames that have mixed positions.

2. Tools and methods

2.1. *Tools*

2.1.1. *Python OpenCV*

OpenCV is a C++ library with modules that cover many areas of computer vision (image and video processing). Besides C++ (and C) there is growing support for Python as a simpler scripting language through a Python interface on top of the C++ code base **[16]**.This gives us two advantages: first, the code is as fast as original C/C++ code (since it is the C++ code working in background) and second, it is very easy to code in Python. So OpenCV-Python is an appropriate tool for fast prototyping of computer vision problems **[17].**

2.1.2. *Opticalflow*

Optical flow (sometimes called optic flow) is the image motion of objects as the objects, scene or camera moves between two consecutive images. It is a 2D vector field of within-image translation. It is a classic and well-studied field in computer vision with many successful applications in for example video compression, motion estimation, object tracking and image segmentation **[16].**

Consider a pixel $I(x, y, t)$in first frame (Check a new dimension, time, is added here). It moves by distance (dx, dy)in next frame taken after dt time. So since those pixelsare the same and intensity does not change, we can say**[17]:**

$$I(x, y, t) = I(x + dx,\ y + dy,\ t + dt) \quad (1)$$

OpenCV contains several optical flow implementations, we then use $calcOpticalFlow - Farneback$ method based on **[18].** That is considered one of the best methods for obtaining dense flow fields**[16].**

2.1.3. *Slicing operation*

Slicing is a Numpy (i.e. Numeric python library) operation that allows us to extract a sub-object from an object**[19].**

An image $I = [\{1, \dots, n_1\} * \{1, \dots, n_2\} \rightarrow W \subseteq \mathbb{R}]$ can be represented by a 2d-array of size $n_1 \times n_2$. Often, W is the set $\{0, \dots, 255\}$ representing a 08 bits channel (gray scale), then a color image can be represented by a 3d-array of size $n_1 \times n_2 \times 3$ (i.e.$width \times height \times channels$) assuming three color channels (e.g. RGB) **[20].** In these cases a slicing operation can have –within Numpy library- one of two following forms:

- *Sub-image = image[a:b, c:d] in gray scale*
- *Sub-image = image[a:b, c:d, :] in color image*

Where $a \geq 0,\ b \leq n_1,\ c \geq 0$ *and* $d \leq n_2$.

2.1.4. *Videoprocessing and object tracking*

Videos are a sequence of images and hence dealing with videos is similar to how we deal with images with a few exceptions of course,tracking objects in a video is a field of video processing**[21]**, given the initial set of points (region of interest), atracker tries to calculate the motion of these points by looking at the direction of change in the next frame (e.g. the KCF **[22]** tracker).

2.1.5.*Machine learning anddeep learning*

Modern artificial intelligence systems and machine learning algorithms have revolut-ionized approaches to scientific and technol-ogical challenges in a variety of fields. We can observe remarkable improvements in the quality of state-of-the-art computer vision, natural

language processing, speech recognition and other techniques **[23].**Deep learning (DL) is a particular subset of Machine Learning methodologies using artificial neural networks (ANN) slightly inspired by the structure of neurons located in the human brain. Informally, the word deep refers to the presence of many layers in the artificial neural network **[24].**

Convolutional neural network (CNN) is a technique of deep learning that is consists on different types of layers (principal components of a CNN), based on these layers complex architectures are used for classification tasks which are built by stacking multiples-layers**[22]**, each layer learns to identify the features that are necessary to do the final classification **[25].**

2.1.6.*Scikit-learn and Keras libraries*

Since its release in 2007, scikit-learn has become one of the most popular open source machine learning libraries for Python. It provides algorithms for machine learning tasks including classification, regression, dimensionality reduction, and clustering. Scikit-learn is built on the popular Python libraries NumPy and matplotlib. NumPy extends Python to support efficient operations on large arrays and multidimensional matrices. matplotlib provides visualization tools**[26].**

Keras (i.e. tf.keras) is actually the TensorFlow's**[27]** high-level API for building and training deep learning models. It performs modular-building models by stacking layers and connecting computational graphs. Keras is useful for fast prototyping (i.e. Ignoring the details of implementing different algorithms or writing optimization procedures) that supports convolution and recurrent layers and combination of both, it runs seamlessly on CPUs and GPUs with almost any architecture can be designed using this library**[28].** The VGG19 **[1]** model used in this paper is one of the Keraspretrained models.

2.1.7.*KMeans clustering and silhouette coefficient measure*

Clustering, or cluster analysis, is the task of grouping observations such that members of the same group, or cluster, are more similar to each other by a given metric than they are to the members of the other clusters**[26].**The K-Means algorithm is a clustering method that is popular because of its speed and scalability. The titular ***k*** is a hyperparameter that specifies the number of clusters that should be created. K-Means automatically assigns observations to clusters but cannot determine the appropriate number of clusters (i.e. ***k***) **[26].**

For this we will use a performance measure for clustering called the silhouette coefficient. The silhouette coefficient is a measure of the compactness and separation of the clusters. It increases as the quality of the clusters increase, it is large for compact clusters that are far from each other and small for large, overlapping clusters. **[26].**

2.1.8.*Barycenter*

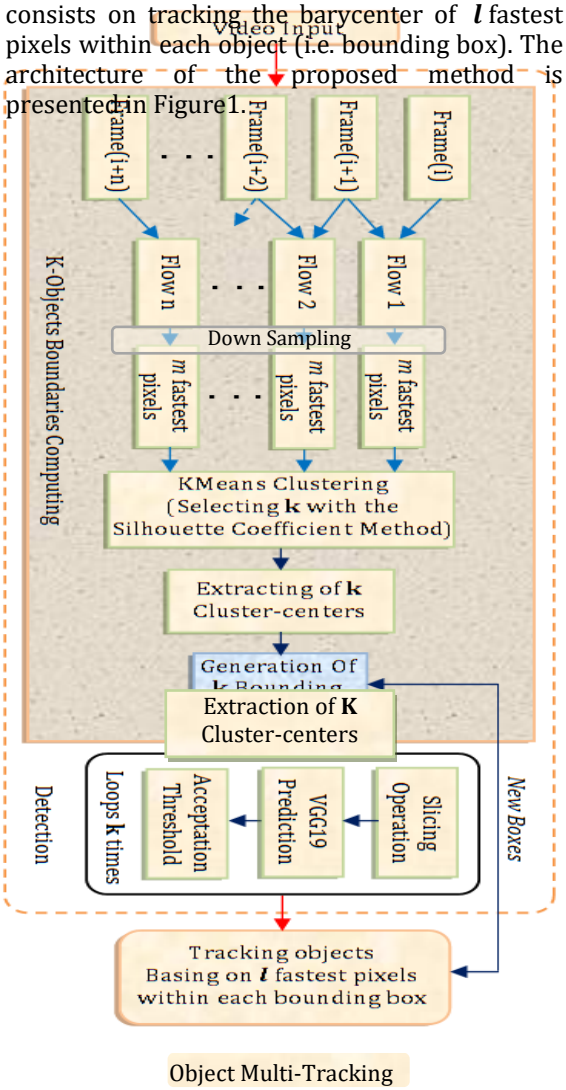
Giving a set of points $A_1, A_2, \dots, A_n \in E$ and some real numbers $\lambda_1, \lambda_2, \dots, \lambda_n$of not null sum, it exists a single point $G \in E$ verifying **[29]:**

$$G = \sum_{i=1}^{n} \lambda_i A_i \quad (2)$$

Where $\sum_i^n \lambda_i = 1$.
This point is called Barycenter of $A_1, A_2, \dots, A_n$ points affected by $\lambda_1, \lambda_2, \dots, \lambda_n$ coefficients.

2.2. *Methods*

The methodology proposed in this paper uses a combination of a proposed approach-basing on optical flow handling and Kmeans clustering- for "object multi-detection and multi-tracking" with a "pretrained ConvNet" for objects classification. The pre-trained VGG19 **[1]**ConvNet is used to classify each detected object then we pass its classification back to use as object label. A tracking algorithm takes place and waits for all objectsthat have the classification confidences surpass an acceptation threshold for starting object multi-tracking, the main idea in this last consists on tracking the barycenter of ***l*** fastest pixels within each object (i.e. bounding box). The architecture of the proposed method is presented in Figure1.



Object Multi-Tracking

Fig. 1: The architecture of the technique

Based on Figure 1, the technique includes the following steps: Optical flow handling, KMeans clustering, bounding boxes generating, sub-images extracting using slicing, VGG19**[1]** classifications and finally object multi-tracking.

2.2.1.*Optical flow handling and KMeans clustering*

After reading ofeachframe in its original size (1st level) it is down sampled twice (2nd and 3rd levels)using the OpenCVfunction *pyrDown()* which if nonew size is given, creates a new image half the size of the original (in 3rdlevel a pixel represents 4x4 pixels in 1st level), we use downsampling for increasing detection process efficiency and speed(i.e., increasing opportunity for slow objects to be captured), then we use the *calcOpticalFlowFarneback* method based on **[18]**for computing optical flow generated between frames (see **Fig. 2**), this method is used to detect objects which are in motion across frames using a camera or video records, for that we take $(\boldsymbol{n}+\mathbf{1})$ framesand compute the optical flow between each doublet of frames, then we extract $\boldsymbol{m}$ fastest pixelsthat have the fastest motions(represented by either dx in X-axis or dy in Y-axis) for each generated flow of $\boldsymbol{n}$ flows. Thus we obtain $\boldsymbol{n}\times\boldsymbol{m}$fastest pixels.

We then pass these$\boldsymbol{n}\times\boldsymbol{m}$points (i.e. pixels) as first parameter to the *centroids*() function described in Figure 3, and within this function we call the KMeans method for each value of a test vector = [2, 3, 4, 5, 8] (possible values of $\boldsymbol{k}$) and we calculate the associated silhouette coefficients, then we extract the maximum coefficient (that explains the right value of $\boldsymbol{k}$) with the associated clustering scheme (i.e. number of clusters, the pixels' membership and their centers).

```
def coordinates(n,m,w,h):
 pixels=[];coord=[];pyrdown=4
 _,im = cap.read()
 imh2=cv2.pyrDown(im);imh4=cv2.pyrDown(imh2)
 old_gray = cv2.cvtColor(imh4,cv2.COLOR_BGR2GRAY)
 for l in range(n):
  _,im = cap.read()
  imh2=cv2.pyrDown(im);imh4=cv2.pyrDown(imh2)
  gray = cv2.cvtColor(imh4,cv2.COLOR_BGR2GRAY)
  # compute flow
  flow = cv2.calcOpticalFlowFarneback(old_gray,gray,\
                                      None,0.5,3,15,3,5,1.2,0)
  print('w x h =',w,'x',h,'Total :',w*h//pyrdown**2)
  old_gray = gray
  for q in range(m):
   fastestmotion=max(abs(flow.ravel()))
   for i in range(w//pyrdown):
    for j in range(h//pyrdown):
     if (abs(flow[j,i,0]) == fastestmotion or abs(flow\
                                      [j,i,1])==fastestmotion ):
      print('x:',i*pyrdown,'y:',j*pyrdown,'dxdy:',flow[j,i])
      pixels.append((i*pyrdown,j*pyrdown))
      flow[j,i,0]=0;flow[j,i,1]=0
 maxslh,_tuple=centroids(pixels,[2,3,4,5,8],n)
 print('***Silhouette1 :',maxslh,_tuple);print(_tuple[2])
 coord=compute(_tuple)
 print('$$$$Coord ',coord)
 return coord,im
```

Fig. 2: Code for optical flowcomputing and fastest pixelsextracting.

In this step we fix detection at four objects, this is explained by the fact that the VGG19**[1]**model deals with large-scale images and not small ones, then for all values of $\boldsymbol{k}$ that surpass this barrier the detection process will be repeated but this time with the clusters' centers themselves.

```
def centroids(points,tests,n):
 silhouette=dict()
 for t in tests:
  kmeans_model = KMeans(n_clusters=t).fit(points)
  silhouette[metrics.silhouette_score(points,kmeans_\
  model.labels_, metric='euclidean')]=(t,kmeans_model.\
                labels_,kmeans_model.cluster_centers_)
 return max(silhouette), silhouette[max(silhouette)]
```

Fig. 3: Code for *centroids* function

2.2.2. *Bounding boxesgenerating andimages slicing*

In this step we pass the $\boldsymbol{k}$ clusters' centers returned par the *KMeans*() method to the *compute*() function (see **Fig. 4**) responsible for the bounding boxes definition, for that and for each cluster's center this function callsanother function called *boundary*(), using afixed offset, this last computes the associated bounding box like illustrated in Figure 5.

```
def compute(_tuple):
 computed=[];centers=[]
 k=_tuple[0];boolean=False
 for j in range(k):
  clustcenter=_tuple[2][j]
  if k<=4:
   computed.append(boundary(clustcenter,offset=180))
   print('computed:',computed)
  else:
   centers.append(clustcenter)
   boolean=True
 if boolean:
  maxslh,_tuple=centroids(centers,[2,3,4],0)
  print('***Silhouette2 :',maxslh,_tuple)
  return compute(_tuple)
 return computed
```

Fig. 4: Code for bounding boxes computing

Figure 5 shows detection process basing on clusters' centers and offset value, note that the top of each bounding box is weighted against other sidesthis is because (by intuition and for the most of objects) the bottom side moves more than other sides, in this case the cluster's center becomes the bounding box' pseudo-center, we keep this idea unchanged during tracking.The values of x_1, y_1, x_2, y_2 are computed by the $boundary()$ function illustrated in Figure 6.

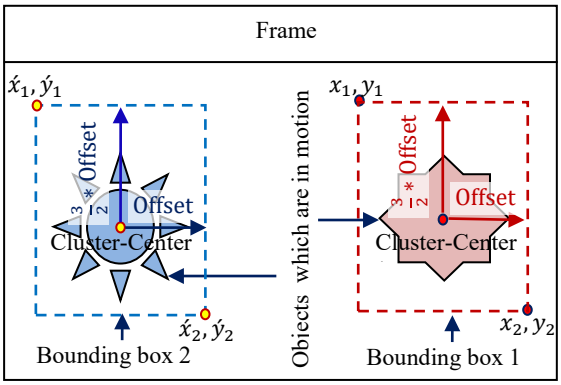


Fig. 5: Clusters' centers and associated bounding boxes

```
def boundary(clustercenter,offset):
 x1=int(clustercenter[0]-offset)
 y1=int(clustercenter[1]-offset*3/2)
 x2=int(clustercenter[0]+offset)
 y2=int(clustercenter[1]+offset)
 if x1<0:x1=0
 if y1<0:y1=0
 if x2>w:x2=w-1
 if y2>h:y2=h-1
 return x1,y1,x2,y2,clustercenter
```

Fig. 6: Code for *boundary* function.

For determining the sub_images (i.e detected objects) basing on these bounding boxeswe use slicing operation explained above.

In our case we use3d-array images (i.e. video color frames) then a slicing operation through these images we gives a 3d-array sub-images(see **Fig. 7**).

```
while True:
 k=0;detect=[];_,im = cap.read();old_im=im
 coordvec,im=coordinates(n,m,w,h)
 for i in range(len(coordvec)):
  x1,y1,x2,y2,cent=coordvec[i][0],coordvec[i][1],coordvec[i][2]\
                                  ,coordvec[i][3],coordvec[i][4]
  box=old_im[y1:y2,x1:x2,:]
  cv2.imwrite('img'+str(k)+'.png',box)
  pr=vgg19('img'+str(k)+'.png')
  if pr[0] > threshold :
   detect.append((pr[0],pr[1],(x1+50,y1+50,x2-50,y2-50,cent)))
  k+=1
 print('Detected Objects',detect)
 if len(detect)!=0:
  tracker(detect,im,n,w,h);Break=True
  break
```

Fig. 7: Code for sub_images extractionusing slicing

2.2.3. *The Vgg19 function*

We define the vgg19 function (see **Fig. 8**) within a python module called $vgg.py$ in the python site-packages directory, this functionuses the pretrained VGG19 **[1]**model for predicting sub_images (i.e. detected objects).

This function returns the prediction that has the maximum probability among probabilities returned by the pretrained VGG19 **[1]** ConvNet, these probabilities explain the membership percentage of the detected objects at each class in the output layer of the VGG19 **[1]** model.

```
from tensorflow.keras.applications.vgg19\
          import  VGG19,decode_predictions
.....
from numpy import *
def vgg19(detectedobject)        :
 model = VGG19()
....
 y_pred = model.predict(image)
 labels = decode_predictions(y_pred)
 predictions=dict()
 for i in range(5):
  predictions[labels[0][i][2]]=(labels[0]\
                    [i][1],labels[0][i][0])
 idd=max(predictions.keys())
 return round(idd,3),predictions[idd][0]
```

Fig. 8: Code for *vgg19* function

2.2.4. *Objectmulti-tracking*

In the tracking process our model tracks objects by capturing $\boldsymbol{l}$ fastest pixels (represented by `tracking_pixels` variable, see **Fig. 9**) in each associated bounding box (i.e.the object container) and computing their barycenter using equation**(2)** with theirmotions as coefficients(i.e. $\lambda_i = fastestmotion_i/coefficients$ where $coefficients = \sum_{i=1}^{n} fastestmotion_i$).The computed barycenter is used for the next bounding box definition.The system starts trackingby calling the $tracker()$function which has five parameters (see **Fig. 7**):list of detected objects (with their classifications and bounding boxes), actual frame, optical flows' number, frame width and height.

In the tracking process and for increasing model performance, especially in the case of objects interference during tracking, we reduce the tracking area to a part of each detected object.In this case the bounding boxes' sizesarecomp-uted according to the pixels fastest motion within each bonding box.

```
fast=[];tracking_pixels=4
for l in range(tracking_pixels):
 fastestpixel=max(abs(fl.ravel()))
 for i in range(detect_[k][2][0],detect_[k][2][2]):
  for j in range(detect_[k][2][1],detect_[k][2][3]):
   if (abs(flow[j,i,0]) == fastestpixel or abs(flow[j,i,1])==\
                                          fastestpixel):
    print('x=',i,'y=',j,'dxdy=',flow[j,i]);flow[j,i]=0
    fast.append((i,j,fastestpixel))
bary_,fastmotion=bary(fast);print('Motion:',fastmotion)
```

Fig. 9: Code for fastest pixels extraction

3. Results and discussion

For illustrating the utility of our model we usetwoscenarios*detection* and *tracking*, in the first scenario we execute the model with help of videos records (dynamic camera) and with a

notebook camera (static camera),based on fastest pixels'number $\boldsymbol{m}$, and the optical flows'number $\boldsymbol{n}$ .The acceptation threshold is fixed at 0.2 (i.e. 20% of confidence). In the second scenario we ignore the acceptation threshold and we concentrate on tracking operation.

For the firstscenario we plot, with help of matplotlib Python library, the clusters' forms returned by the *KMeans* methodwith the associated silhouette coefficients for each value of the test vector (possible values of$\boldsymbol{k}$).

3.1. *Scenario1:Detection*

3.1.1. *Using video records (dynamic camera)*

Figure 10 shows detection of a single object basing on 100 fastest pixels and one flow, note that the camera speed should be lower than object speed, in casethe camera has a nearby speed with the object we must increase the fastest pixels number and flows number.

In the KMeans algorithm the minimum number of clusters $\boldsymbol{k}$ should be upper or equal to two clusters, then in case of single object detection the object will be detected twice, this last is solved by the system itselfduring tracking process by integrating detections that have the same classification, like illustrated in Figure 11.

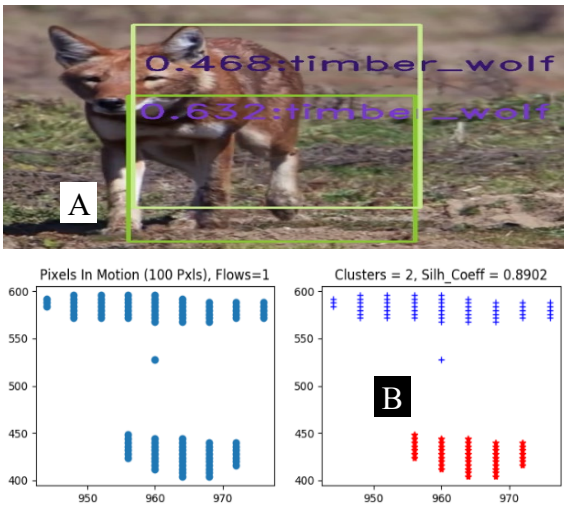


Fig. 10:A: Detection of timber_wolf (63.2% and 46.8%), B: the associated KMeans clustering with the maximum silhouette coefficient.

Fig. 11: One object detection with labels unification.

In this last step the system compares the detections and chooses the detection that has the great percentage of confidence.

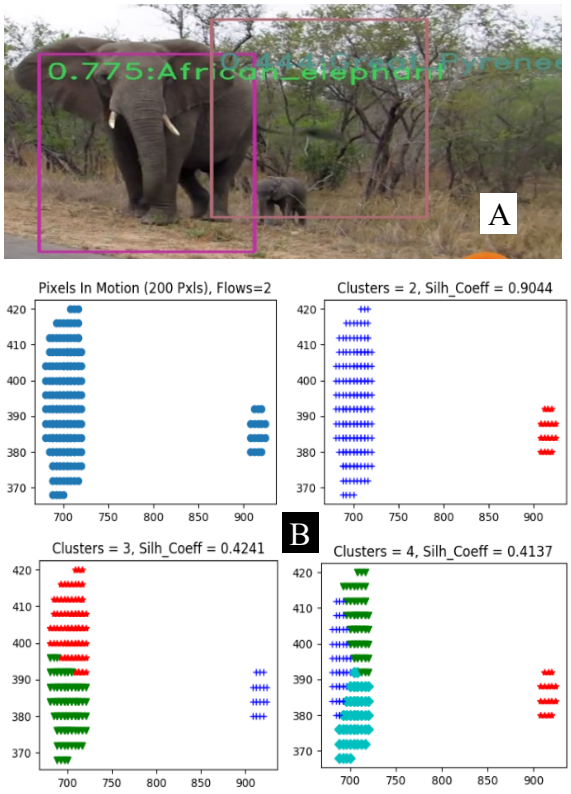


Fig. 12: A: Detection of African_elephant (77.5%) and Great_Pyrness (44.4%), B: The associated KMeans clustering with the silhouette coefficients until 04 clusters.

As we can see in Figure 12, the system detects two clusters representing the elephant (successful identification) and its tail (mismatch identification) basing on 200pixels (100 pixels per flow).

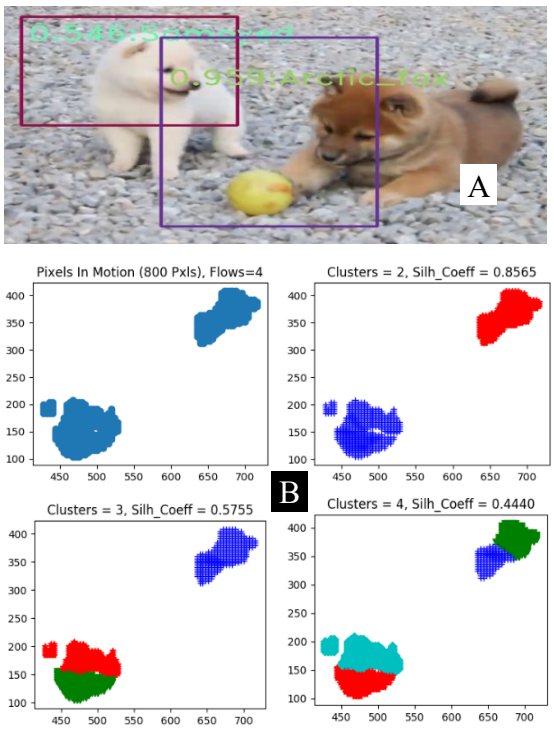


Fig. 13: A: Detection of Arctic_fox (95.9%) and Samoyed (54.6%), B: The associated KMeans clustering with the silhouette coefficients until 04 clusters.

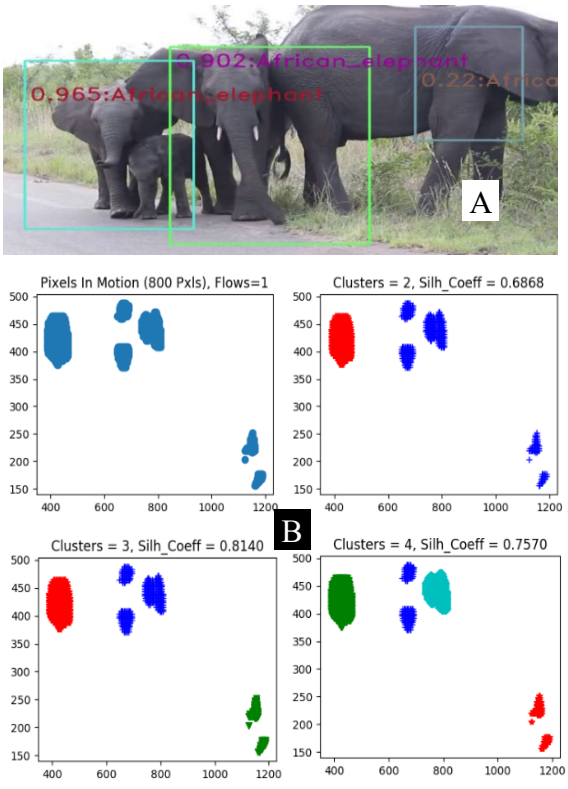


Fig. 14: A: Detection of three African_elephants(96.5%, 90.2% and 22%), B: The associated KMeans clustering with the silhouette coefficients until 04 clusters.

3.1.2. *Using notebook camera*

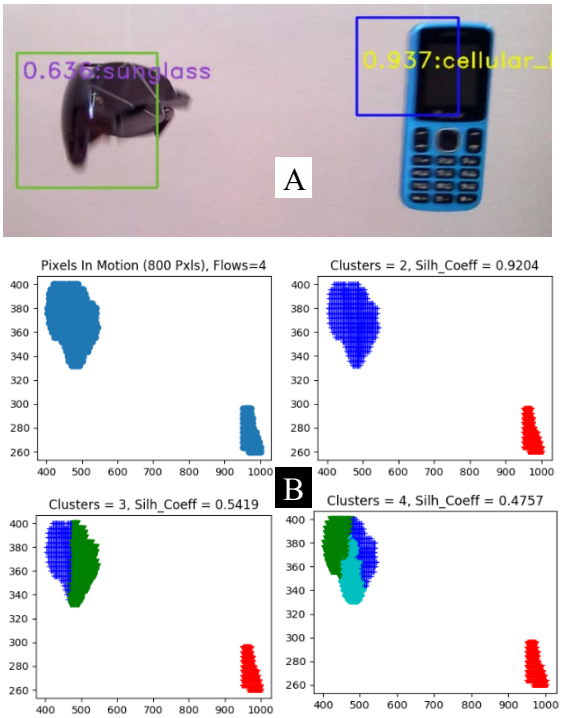


Fig. 15: A: Detection of Sunglass (63.6%) and Cellulartelephone (93.7%), B: The associated KMeans clustering with the silhouette coefficients until 04 clusters.

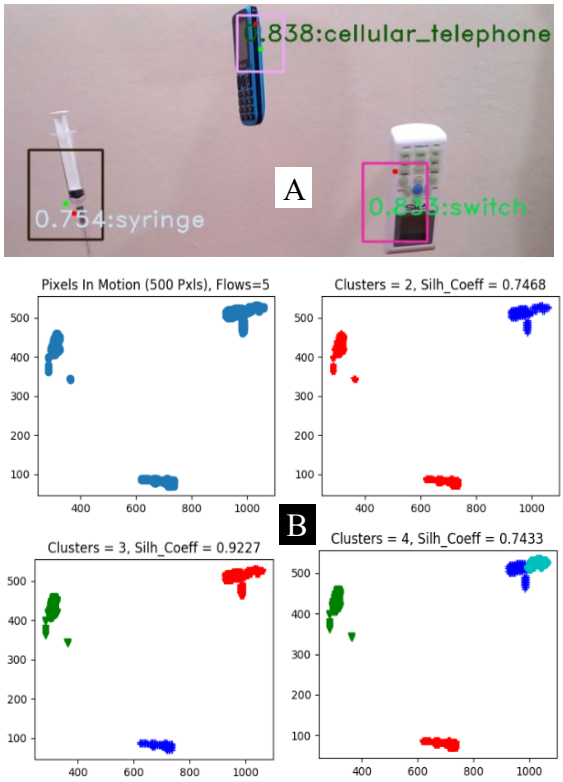
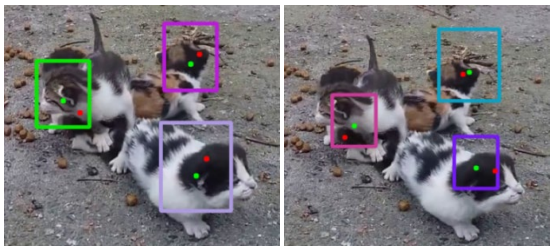


Fig. 16: A: Detection of Switch (83.3%), Cellulartelephone (83.8%) and Syringe (75.4%), B: The associated KMeans clustering with the silhouette coefficients until 04 clusters.

During detectionand for both dynamic camera and static camera the technique has given well results.

3.2. *Scenario 2: Tracking*

In this scenario we ignore object identification and we highlight the tracking process.The object multi-tracking process is achieved by computing the barycenter (note that this technique retards the bounding boxes union)of ***l***fastest pixels in each bounding box (during tracking we also reduce the bounding boxes' sizes for avoiding their interference thus their union). Figure17 illustrates this process.



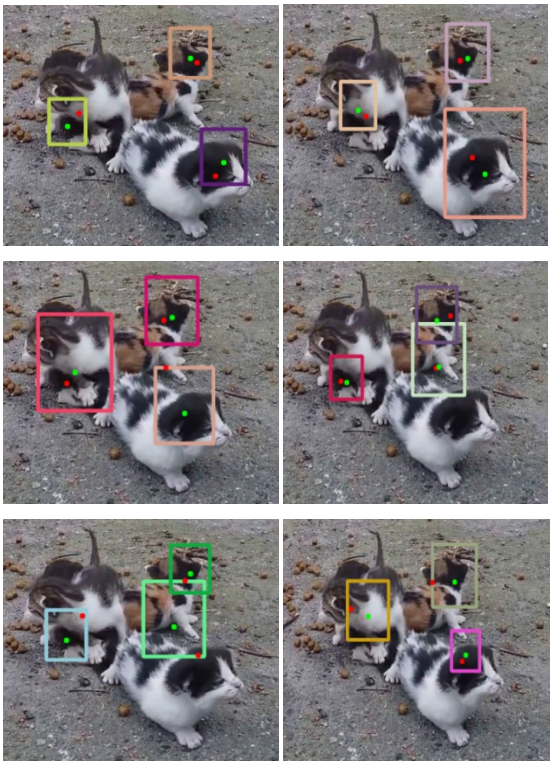


Fig. 17: Object multi-tracking.

The system tracks a part -represented by the colored rectangle- of each object, the green points represent the actual boxes' pseudo-centers (see **Fig.5**) and the red ones represent the ***l*** fastest pixels' barycenter within each actual bounding box (i.e. the next bounding boxes' pseudo-centers).

The object multi-tracking process gives acceptable results except in the case of forte object interference where the bounding boxes that contain the same ***l***fastest pixels will be integrated.

4. Conclusion

In this paper an approach for object multi-detection and multi-tracking has been proposed, an implementation of the proposed approach has been performed using python programming language basing on machine learning and deep learning libraries.

Object detection and tracking are basic data for security and inspection process which includes surveillance tasks.However, processing within limited and real time video frames is challenging task for prevention, surveillanceand scientific purposes, likewise the real time analysis of the technique can yield great results by enabling security in all supervision domains.

In the future and continuing improvement of the work we will concentrate on the amelioration of the system interactionin the case of an interference's high level basing on image-video processing algorithms.

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Personalized recommender system for e-Learning environment based on student's preferences and evaluation of teachers peer

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Abstract

At the present time, new technologies and the rapid development of the Internet have made access to information easier for all class of people, but create new challenges for education when they use the Internet as a tool, which has created a need for new techniques to help users find their interest; these techniques are called Recommendation Systems (RSs). These systems will adapt the learning experience according to the goals of the individual learner. In this paper, we present a recommender e-learning approach which utilizes one of recommendation techniques to identifying preferences of learners and employing particle swarm optimization algorithm to find optimal scenario proposed by their teachers during the formation and the scenario which has high weight is recommended to another teacher during the conception of his scenario, taking into account the measure of similarity between these teachers.

Introduction

Technology Enhanced learning is the application of information and communication technologies for teaching and learning [1]. Recommendation Systems (RSs) are software tools based on machine learning and information retrieval techniques [2] in other words, it can be defined as programs which attempt to recommend the most suitable items to particular users by predicting a user's interest in an item based on related information about the items, the users and the interactions between items and users. Most of the modern e-Learning systems are still producing the same educational resources in the same way to learners with various profiles [3]. Recommendations represent an important role in an adaptive e-Learning system. This needs learner profile due to different preferences, learning activities between learners. Moreover, it is very challenging for a teacher to decide the best learning strategy for each learner and to apply it in a real classroom and also the current e-Learning systems are not providing a better facility to track the learner's progress. It leads learners to interact less with the e-Learning system or keep out from e-Learning. One way to address this problem is to use recommender system techniques which can help e-learning by automatically recommending the most suitable learning scenario to the learners according to their personalized preferences and profile.In this way we propose a recommendation system approach to recommend a pedagogical scenario dedicated to teachers in the phase of designing a pedagogical scenario for learners in the e-learning context which is adapted to the learner's profiles.In this work we propose a CF-PSO-KNN by employing collaborative filtering method and particle swarm optimization algorithm to find optimal individual pedagogical scenario. After finding suitable weights of scenario, we compute similarities between teachers by utilizing K-nearst

neighbors to recommend the scenario which is adapted to the learner's profiles.

Literature review

Dianping. Lakshmi and al. [4] propose a new method named by item-based collaborative filtering technique to generate a new recommender item list. They ask to find the relation between different items compared to a user-item rating matrix to see the similarities.

A novel hybrid-filtering recommender system proposed by M.R. Lee and al. [5]. They using machine learning and Facebook Fan Page data. This technique solves cold start and accuracy problems and increase customer satisfaction.

A new hybrid recommender system for learning materials was proposed by Salehi and al. [6] to improve the accuracy and quality of recommendations. This system is consisting of two modules. The first module considers weights of implicit attributes of learners' material as chromosomes in genetic algorithm and then these weights of learners are optimized according to historical rating after which recommendations are generated using Nearest Neighborhood Algorithm. The second module uses a Preference Matrix to model learner's interests based on explicit attributes of learning materials.

Ghazanfar and Prugel-Bennett [7] propose a hybrid recommender system using and combining all recommender system techniques. This technique has advantages of all techniques, this technique used to eliminate redundant records problems with the recommendation system.

In this paper [8] a new model named by iExpand was proposed by Liu and al. to makes recommendations by exploiting the information about user's latent interests.

In 2013 [9] a personalized recommendation model was proposed by to shows three social factors: personal interest, interpersonal interest similarity and interpersonal influence, these factors are combined with a unified personalized recommendation model based on probabilistic matrix factorization.

A social contextual recommendation model (contextMF) was proposed by Jiang and al. [10] to prove that individual preference is a major factor in social network to make recommendations.

Aher & Lobo [11] proposed recommendation system to recommend particular MOODLE courses for learners based on enrolled classes by a combination of machine learning approaches and they also combined algorithm (Clustering, Simple K-Means, and Apriori Association Rule Algorithm). They proposed a data mining recommendation process based on historical data.

Ogwoka et al [12] proposed hybrid method to evalute the student model based on data like attendance lesson tests, student enrolment status by using a J48 decision tree and Simple K-means based model.

logic recommender system was proposed by Almohammadi and al. [13] [14] to improves e-learning adaptability to the learner taking into account the detection of the level of student engagement through the Kinect 3D camera that identifies student engagement learner facing the direction and emotions without portable electronics. The fuzzy rules recommended pedagogical approach most appropriate as PowerPoint explanation, questions and answers, examples.

In this paper [15] a personalized e-learning recommender system, called PERS, was proposed to suggest adaptive classroom materials that meet the student's needs based on the group's preferences. The cold start problem is solved by using a static questionnaire for each new student base. This system is based on collaborative filtering recommendation

2. Background

Recommendation Systems

Recommendation systems can largely neutralize the effect of information overload by filtering out the vital information portion of a large amount of dynamically generated information. The recommendation system is smart enough to predict a user's preference for one item over another [16]. The recommendation system takes into consideration a set of multiple factors to provide good recommendations. It includes the type of data available for the system, the algorithm used for filtering, the model used, the technique used including Bayesian networks, genetic algorithms,

probabilistic approaches, the nearest neighbor strategy. The results of the recommendation system are also affected by the performance system, the dissemination of the database, the objective of the system and finally the quality of the results targeted by the system [11].According to Venkatesan and al. [16] Recommender system can be considered as a decision support tool for obtaining optimal recommendations for the use of resources or services based on the personalization or preferences of the user concerned. The idea behind (RSs) is to collect information about user preferences for a set of articles according to their activities and their social belongenace (movies, songs, books, jokes, gadgets, applications, websites and e-learning platform). The RSs mainly use three filtering methods to provide personalized recommendations to users; the most popular ones are collaborative filtering (CF), content-based filtering and hybrid filtering. Collaborative filtering approaches employ community data such as comments, ratings, or clicks from other users to build recommendations. Content-based approaches make recommendations using content features to identify similar items or determine the similarity between items and the user's profile. Hybrid approach combines several of these methods to profit from their advantages and refrains from their limitations.

Collaborative filtering

The recent widespread increase in information available on the Internet, further accelerated by social media, has raised the need for systems that can help users find valuable information. In this context, filtering information based on CF can help users in their searches. It is widely based on human psychology of a person who asks his friends and family for suggestions on something they own, so it helps the person to make a decision. This technique is one of the most dominant techniques that have ever been confirmed, and works with collecting data from a large amount of users, it plays an important role in the recommendation process. Collaborative filtering operates by collecting and analyzing a large amount of information about user behaviors, activities, preferences, and exploiting the evaluation similarities between users to determine how to recommend an item [15].CF uses the opinions of users similar to the active user. It is the phenomenon that users with similar tastes and choices in the past tend to agree in the future with unrated items. The CF system represents users with their notes on a set of articles. The CF system selects a set of similar users based on a measure of similarity or correlation. Then, it generates rating forecasts for items not rated by the target user. Finally, the system recommends the items with the highest expected ratings [17].Three major steps are needed to accomplish the recommendation task in CF.

• Collection of data for creation of a user profile

• Neighborhood set generation

• Predictions and recommendations

As an example, consider that there are two users: user1 and user2 if user1 likes element {A, B, C}, and user2 element {A, B, C, D}, then according to the similar choices of {A, B, C} between two users. The D element is recommended to User1 because both User1 and User2 have the maximum similarity of the {A, B, C} element. Both users, therefore, see themselves as users of similar taste. Collaborative filtering is considered the most popular and prevalent method in RS. Although Collaborative filtering is frequently used along with other filtering techniques like content-based.

Particle swarm optimization

Particle swarm optimization (PSO) is a population based evolutionary technique like genetic algorithms. It differs in that each particle or solution contains a position, velocity and acceleration. The velocity and acceleration change the position of the particle to explore the space of all possible solutions, instead of using crossover and mutation to generate new offspring. As particles move around the space, they sample onto different locations. Each location has a fitness value according to how good it is at satisfying the objective. Because of the rules governing the swarming process, particles will eventually swarm around the area in the space where fittest solutions are. Every particle possesses its respective velocity and position and initial population of particle initialized randomly. The velocity and particle position is updated by following the two best values in the problem space. The first best value is the best solution (fitness) of the particle achieved so far which is called particle best denoted by “pbest”. The other best value is the best value obtained so far by any particle. This best value is called global best denoted by “gbest”.[18]

The steps of the PSO algorithm are:

Procedure PSO ()

Initialize parameters;

Initialize swarm;

Evaluate the Performance of particles;

Do

{

Find the personal best;

Find the global best;

Update the velocity;

Update the position;

Evaluate the Performance of particles;

}

While (Termination criterion not satisfied);

K nearst neighbors

K-Nearest Neighbors (KNN) is one of the most basic yet essential classification algorithms in Machine Learning. KNN is a simple algorithm that stores all the available cases and classifies the new data or case base d on a similarity measure. The idea of the KNN algorithm is: if the majority of the k most similar neighbors of model in the feature space belongs to a certain group, so the model is considered to belong to this group [19].

Our proposition

Today, social networks have become essential tools in the lives of students. The different interactions generate immeasurable information on the profiles of the learners, their choices, their habits, their preferences...

One of the difficulties encountered by educational designers is the design of a pedagogical scenario which is adapted to the learner's profiles.

The aim of our proposition is to recommend a pedagogical scenario dedicated to teachers in the phase of designing a pedagogical scenario for learners in the e-learning context.

The approach described in this paper is based around a collaborative filtering approach, building up profiles of users that contains rating of pedagogical scenarios proposed by teachers, demographic data(age, gender, and preferences), and implicit data about user behavior, then employing particle swarm optimization algorithm to find optimal pedagogical scenario which is evaluate by learns and teachers peer and the scenario which has high weight is recommended to another teacher during the conception of his scenario, taking into account the measure of similarity by employing K-nearest neighbors between these teachers we also based on the principle of:

Social influence: two friends can have the same interests

Co-citation regularity: if they have some similarities in common, they will be more likely to have the same interests.

The proposed approach relies on three types of data:

Profile data that describe learners

Rating data that describe the evaluations of learners and teachers peer

Social data that describe links between users

The peer teacher evaluation covers:

- Learner satisfaction. This allows knowing the perception concerning the quality of organization.
- The level of acquisition of the learners
- The teaching methods used in training
- Clear objectives, realistic and achievable
- Short sequences
- Varied teaching methods
- The adequacy between the teaching methods used and the objectives of the activity

Conclusion and future work

Recommendation system (RS) is a type of information filtering system that gives advice on products' information, or services that a user may be interested in. RSs were used, among the many solutions available to mitigate the information problems and cognitive overload by providing users with related and relevant elements. Existing RSs mainly use feedback from users and their similarities to offer them adequate resources for their needs. In this paper, we present a recommender e-learning approach which utilizes one of recommendation techniques to identifying preferences of learners and employing particle swarm optimization algorithm to find optimal individual scenario proposed by their teachers during the formation and the scenario which has high weight is recommended to another teacher during the conception of his scenario, taking into account the measure of similarity between these teachers.

Our future work is to experiment our approach in real E-learning context on a large amount of learners and teachers to test the effectiveness of our proposed approach.

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Bio-inspired techniques for robots autonomous navigation: A Survey

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Planning algorithm collision

Avoidance approach dynamic,

Environnements intelligent control

Mobile robot.

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Abstract

This paper presents the current robot automatic navigation methods based on bio-inspired techniques. An autonomous robot has to be able to acquire the information it needs to reason and to provide it with a locomotion capacity adapted to its environment. However, it is necessary to understand the basic functions that are required for robots to think and work like humans, it involves complex systems in the realization, on the one hand, technological where this mechanical system capable of navigating anywhere using sensor-actuator control techniques.

And on the other hand scientific is how to transform this normal mobility into intelligent navigation the basis of the functions of planning, action, monitoring, perception, and reasoning. These functions help the robot to develop its skills, which can control a mobile robot autonomously in a static and/or dynamic environment and avoid obstacles based on information about its position and the environment in which it is operating.

1. Introduction:

Nowadays, mobile robots are widely used in many fields. The artificial intelligence brings to those machines the ability to think in an analytical way to accomplish different tedious tasks efficiently and without any human intervention.

Autonomous robot navigation is one of the most difficult problems encountered in robot realization. Navigation is the set of methods, knowing the position of mobile in relation to a reference system or a fixed point, allow the calculating or the measuring of the path to follow to reach another well-known coordinate point [1].

In literature, a great number of automatic robot navigation approaches are proposed. The aim of most of them is to improve the performance of time calculation and/or the quality of the proposed solution. Only the researches based on bio-inspired approaches published since 2011 are discussed in this paper.

In the continuation of this paper, section 2 explains different bio-inspired techniques used for automatic robot navigation. Section 3, compares the studied navigation approaches. Finally, Section 4 gives a summary of this literature review.

2. Bio-inspired Navigation Strategies

The navigation strategies allowing a mobile robot to trace a trajectory and automatically reach an objective using its abilities to

- build a representation of its static or dynamic environment
- analyze collected information and,
- give a decision about the direction it has to take to near its objective or to avoid obstacles.

Several bio-inspired approaches are used in this field. We will discuss the most famous methods based on Neuroscience, evolutionary algorithms and swarm intelligence. Figure 1 flows the most used bio-inspired techniques applied to robot navigation approaches.

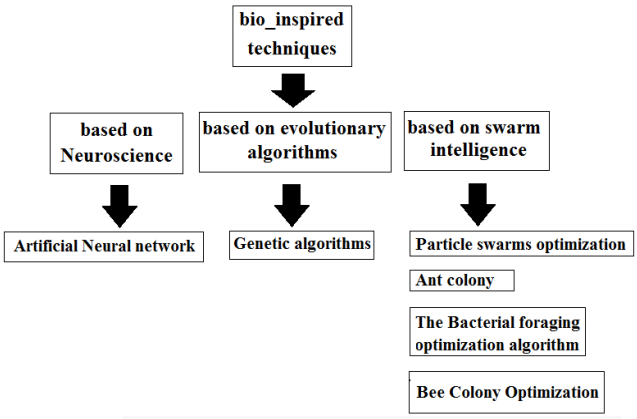

Figure 1: Bio-inspired techniques applied to robot navigation approaches.

2.1. Genetic Algorithms (GA)

Genetic algorithms belong to an Evolutionary Algorithm [2]. These algorithms are stochastic optimization techniques inspired by Darwin's Theorem of evolution, whose goal is to obtain an approximate solution at an acceptable time.

Genetic algorithms are the result of the research of John Holland and his colleagues and students at the University of Michigan who, as early as 1960 [3], worked on this subject. Genetic Algorithms use techniques inspired by genetics and natural evolution: crosses, mutations, selections, etc.The novelty introduced by taking into account the crossover operator in addition to mutations is that this operator makes it possible to approach the optimum of a function by combining the genes contained in the different individuals in the population.

Genetic algorithms are based on the notion of natural selection and apply it to a population of solutions to a given problem. They represent a stochastic optimization method of "0" order, which means that neither continuity nor differentiability is necessary for the method to work properly, only the knowledge of the value where the proximity of the function to be optimized is sufficient. Thus, the efficiency of a genetic algorithm depends on a good knowledge of the problem to be treated.
The steps in the execution of a genetic algorithm are:

1. Initial population:
2. Ability function:
3. Selection:
4. Crossing and mutation:
5. Mutation
6. Stop Test: If this criterion is not met, go to step (2).

In [4] the authors proposed a new mutation operator for a genetic algorithm (GA) and applied it to mobile robotic navigation in a dynamic plane. In conventional GA, the random mutation can generate infeasible pathways, and this new node modified by the mutation can present an obstacle and therefore produce an infeasible pathway. In [4] technique, random points are chosen from the free points close to the mutation gene. The selection of these points is guided by the direction forward determined by a comparison of the coordinates of the starting point and the target. If this direction is impossible, a random selection of points is repeated until the process finds a possible direction or the set of points is finished. Besides, the authors tested their approach in various simulation environments and compared it to conventional genetic algorithms. They found that their proposed GA is more efficient than the traditional GA.

In [5] the authors combined crossing in genetic algorithms with dynamic chromosome coding to propose a multi-objective method. The proposed method objective is to find a feasible and achievable routing between two points through the whole distance to the arrival point and of course, avoiding obstacles. The proposed method respects distance, security and computation time, and it optimizes certain criteria such as distance (length), safety (the trajectory must be as far as possible from obstacles).The authors applied modifications so that the chromosomes are coded on a variable length and also avoid premature convergence and avoid the state of ergodicity.

Table 1. Genetic algorithm approaches for mobile robot navigation

Approach	Used methods	Contributions
[4]. 2017	GAs	*Propose a new mutation* operator
[5]. 2018	MGAs	*Combine crossing in genetic* algorithms with dynamic chromosome coding

2.2. Artificial Neural Network (ANN)

The neural network approach is a method of modeling intelligence. These networks are capable of solving problems in different areas. Their strength lies in their ability to learn, and in this framework.
Artificial neurons are a formal abstraction of the behaviorof the biological neuron [6]. They are an ideal solution for certain problems that require reasoning or are highly complex. This is due to their learning capacity.
A neuron is a non-linear, parameterized function with a limited value (figure 2). A neuron contains two main elements:
- The weights associated with the connections of the neurons.
- An activation function.
Learning can be understood as a change in an organism's capacity or behavior caused by experience. The learning algorithm will formulate explicit rules that will allow it to be generalized [7].
The formulation of the rules is done by changing the synaptic weights that lead to the change in the behavior of the network; the change is made by a set of iterations

that make these networks capable of reacting with new situations based on experience.

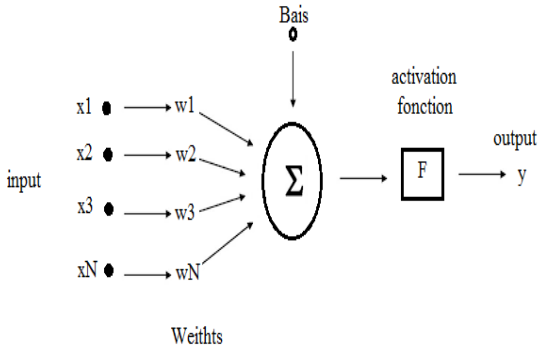

Figure 2: Artificial Neuron.

In [8] the authors conceded that current neural network approaches to navigation are limited to one type of robot platform and distance sensor, and are not scalable to other types of robots and distance sensors. Therefore, to add another type of sensor it is necessary to modify the network structure. They proposed a general method for interpreting data from various types of two-dimensional distance sensors and a neural network algorithm to perform the navigation task. Their approach can produce a global navigation algorithm that can be applied to various types of distance sensors and robot platforms. Also, this method contributed to reducing the time required for network formation and, designed a direct-powered multi-layer neural network, which controls the steering angle of the robot autonomously in static and dynamic environments. The different obstacle distances are the inputs to the four-layer neural network, and the steering angle is the result. However, real-time collision-free path planning becomes more difficult when the robot moves in a dynamic and unstructured environment.

In [9] Offer an autonomous navigation system provided by a fuzzy logic controller, a neural network and an adaptive neuro-fuzzy inference system (ANFIS) with a safety limit algorithm. In this search, the method targets obstacle avoidance and at every moment improve the robot's performance. The inputs of the controller are the signals of the sensors fixed on the front, left and right panel. The controller output signal adapts the angular velocity of the two front driving wheels of the robot. The shortest path is designated using fuzzy logic, neural networks and the adaptive neuro-fuzzy inference system with an integrated safety limit algorithm. The authors prove that the adaptive neuro-fuzzy inference system with a safety limit algorithm gives better navigation performance in case the obstacles are curved and/or irregular.

In [10],the authors describe a new method of mobile robot navigation in a dynamic environment containing static and moving obstacles. They use an artificial neural network (multilayer perceptron) to select a collision-free segment from a set of segments.This network monitors the speed for each movement and calculates the time required to reach its local destination at each collision-free segment and uses the time taken by critical obstacles. The authors say that the results of this simulation show that the neural network gives an optimal trajectory with shorter computation time. The main idea of their work is to use this approach in an automatic car driving.

Table 2:Artificial Neural Networkapproaches for mobile robot navigation

Approach	Used methods	Contributions
[8]. 2011	MLP	***Robot and distance sensor*** platform expandable without changing the neural network structure
[9]. 2017	ANNs, Fuzzy logic, ANFIS, safe boundary algorithm.	***Designate the shorte path***
[10]. 2018	MPL	***Divide the trajectory into several segments***

2.3. Swarm intelligence

Because of humanity's attachment to the natural environment in which it evolves, human tends to want to inspire, by adopting an analogical process to solving the problems that arise in his daily life.
like of what ethology proposes (i.e. the study of animal behavior in its natural environment), and to formalize utilitarian approaches to adapt to solve an optimization problem consisting of seeking a solution of sufficient quality among a set of solutions with regard to one or more criteria and objectives to be achieved.

a. Ant Colony (ACO)

The algorithms of the ant colonies (ACO) aim at optimizing a path for mobile robots. They are used for a task that requires the collaborative work of several mobile robots. The objective is to solve a concrete navigation problem.
The ants move using complex combinations of information, as a vector of integration and visual cues [11].

Ant colonies' navigation approaches are developed first on a simulator, then it is implemented for a real robot. As a first step, a simulator was realized to evaluate navigation strategies directly inspired by the behavior of ants. Figure 3 gives a simulation example. Then, the simulation ant's navigation concepts are adopted for a set of robots.

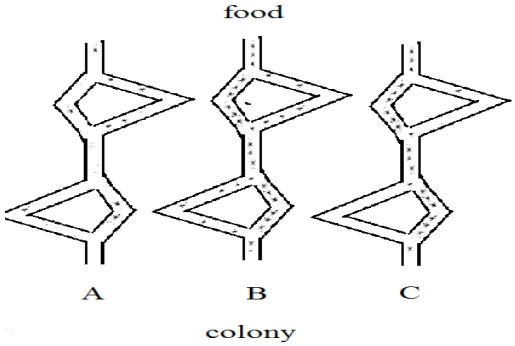

Figure 3: Ant colony

[12] Proposed and improved a method based on ant colonies for planning trajectories for mobile robots in complicated environments. This method uses the characteristics of the A* algorithm and the MAX-MIN Ant system. The first method step builds the grid model environment. It introduces an evaluation function of A* and the bending suppression operator to enhance the heuristic information that accelerates the speed of convergence and increase the global smoothness of the path. The second method step introduces a retraction mechanism to solve the deadlock problem. It transforms the MAX-MIN ant system into a local diffusion pheromone and adds the best solution of the iteration tests to update the pheromones. The pheromones help to drag forces and to avoid premature convergence.

In [13] the authors proposed an ant colony algorithm improved by the genetic operator and merged it with the traditional ant colony algorithm.They wide the search space of the solution and introduced a function of aptitude for respecting the safety distance. Then, they introduced the optimization operator to eliminate redundant nodes and improve fluidity.

Table 3:Ant Colonyapproaches for mobile robot navigation

Approach	Used methods	Contributions
[13]. 2019	MAX-MIN Ant System, ACO, A* algorithm	***Introduce an evaluation*** function of A* and the bending suppression operator to enhance the heuristic information that accelerates the speed of convergence and increase the global smoothness of the path ***Transform the MAX-MIN ant system a local diffusion pheromone***
[12]. 2019	ACO	***Ant colony algorithm improved by the genetic operator to widen the search space of the solution The used function of aptitude respect the safety distance Used optimization operators to elimi redundant nodes and improve fluidit***

b. Particle Swarms Optimization(PSO)

PSO algorithm aims at maximizing or minimizing a set of fitness functions while respecting constraints related to the problem being addressed. It is one of the methods inspired by animal behavior and considered a good technique to find a good solution much faster and more efficient for multidimensional research spaces.The PSO process is schematized in figure 4. A PSO solution characterizes are:

- The number of particles in the swarm.
- The maximum velocity of a particle.
- The topology and size of the neighbors.
- The inertia of a particle.
- Confidence coefficients.

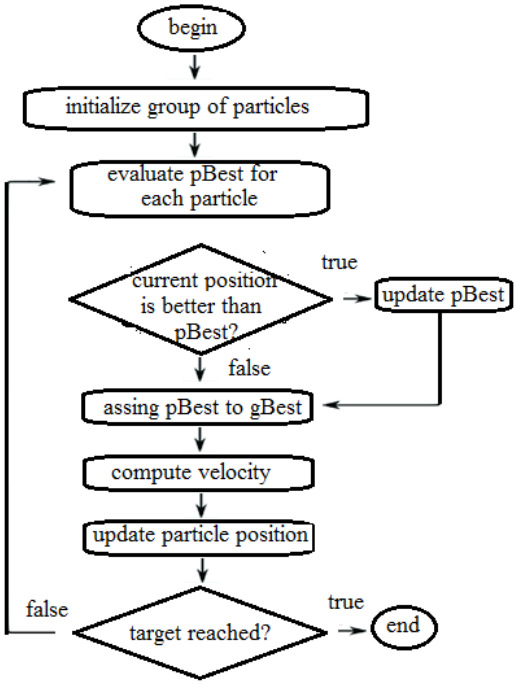

Figure 4: Particle swarmsoptimization process.

Autonomous navigation for mobile robots consists of searching for an optimal or quasi-optimal trajectory with several types of constraints in different complex environments.

In [14], the authors proposed a self-adaptive learning PSO with different learning strategies. They transformed the trajectory-planning problem into a multi-objective minimization optimization problem and they formulated a fitness function that respects three objectives: distance, the degree of collision risk and regularity. They developed a new self-adaptive learning mechanism to select the most appropriate search strategies at different stages of the optimization process that improved the capability of PSO. They applied a new violation processing schemes to restrict the speed and position of each particle to improve the feasibility of the generated paths.

In [15], the authors improved the performance of the classical potential field algorithm to a new method based on the combination of a modified potential field algorithm with fuzzy logic. This algorithm is designed to overcome classical potential field problems (local minima) and improves navigation in dynamic environments. The fuzzy logic controller is used for motion control with membership functions that are optimized by the PSO algorithm. This method of trajectory planning and motion control reacts much faster in static and dynamic environments and effectively avoids obstacles according to the authors.

Table 4:Particle swarms optimization approaches for mobile robot navigation

Approach	Used methods	Contributions
[15]. 2017	PSO, Potential Field, Fuzzy Logic	***Uses fuzzy logic to improve AFP performance Use of fuzzy logic to avoid the proble of local minimums Optimizing fuzzy logic membership functions with the PSO algorithm***
[14]. 2018	PSO	***Fitness function respects three objectives: distance, degree of risk of collision and regularity. Self-adaptive Learning Improve the feasibility of the trajectories generated with the application of violations to restrict the speed and position of each particle***

c. The Bacterial foraging optimization algorithm (BFO)

This approach is inspired by the mechanisms of real bacteria, which undergoes chemotaxis, where it propagates towards a gradient of nutrients and avoids harmful environments. In general, the bacteria move over a greater distancein an ergonomic environment.

This technique of biomimetics for bacterial research strategy has been considered in the development of a mobile robot navigation strategy. Bacterial research approacheshave been proposed to plan the path of a robot. This last mimics the behavior of bacteria to determine the optimal path without collision between the starting point and the target point in a dynamic environment.

Hossainand Ferdousand [16] applied Bacterial Search Optimization (BFO) for navigation of mobile robots to find the optimal path in minimum time from the start position to the end position between moving obstacles, using particles that are randomly distributed on a circle around a robot. The criterion on which it selects the best particle is the distance between their position and the goal and also the Gaussian cost function of this particle.A high-level decision strategy is used for the selection and proceeds to the result. It works on the local environment using a simple robot sensor. Thus, no additional map is needed, which adds costs. Moreover, it can be implemented without the need to adjust the algorithm and make complex calculations.

Liang et al [17] have developed a bacterial food search algorithm to develop a biologically inspired navigation strategy for a robot. In the proposed model, the behaviour of bacteria is applied to search for an optimal collision-free path from the start node to the target node in an environment with obstacles.

Table 5:Bacterial foraging optimization approaches for mobile robot navigation

Approach	Used methods	Contributions
[16]. 2015	BFO	***Finding an optimal path in the short possible time between the start and finish position between moving obstacles. Distributing random particles on a circle around a robot. le robot sensor is used***
[17]. 2018		***the authors simply use this biologica inspired technique for a mobile robot to find an optimal collision-free path in an environmen with obstacles.***

d. Bee Colony Optimization (ABCO)

The artificial bee colony optimization algorithm is an intelligent swarm-based approach inspired by the activities of honeybees in search of food and proposed by Kharaboga [18]. The ABCO algorithm is a population-based technique that consists of a population of inherent solutions (food source). It is simple to use, quick to process and based on a stochastic population-based approach in the field of swarming algorithms.

The food search cycle of the Artificial Bee Colony Optimization Algorithm consists of three rules:

- Send the employed bees to a food source and evaluate the quality of the nectar.
- The viewers choose the food sources after obtaining information from the employed bees and calculating the nectar quality.
- Identify the scout bees and send them to possible food sources.

Contreras-Cruz et al [19] present the application of the artificial ABCO to the navigation of the mobile robot in a static environment. This approach uses ABCO for a local search and an evolutionary algorithm to find the optimal path. Saffari et al [20], and Bhattacharjee et al. [21] develop another approach in a static environment in a simulation environment. The problem designed here attempts to determine the path of mobile robots from known initial positions to fixed target positions on a map, with the ultimate goal of minimizing the path length of all robots. In these approaches, the authors supposed that each channel consists of several straight segments passing through specific points. The selection of these points leads to paths with different distances. They used ABCO to find these points and to select the shortest possible path.

Table 6: Bee Colony Optimizationapproaches for mobile robot navigation

Approach	Used methods	Contributions
[21]. 2011 [19]. 2015 [20]. 2019	ABCO	**The difference in these methods lies in the way that defining the environment, and modeling the robot and obstacles.**

3. Comparison of the different Techniques

Recent bio-inspired approaches for autonomous robot navigation studied in this paper are summarised in table 7. These approaches aim to determine the optimal trajectory from a start point to a target point in a static or dynamic environment.

GA, ANN, ACO, PSO, BFO, and ABCO are the bio-inspired technique used by the researchers to solve the optimal path research with avoided obstacles.

From table 7 we can see that no bioinspired technique is preferred from the others. All works assume and proved that bioinspired techniques appropriate for robot navigation. Most of these works used simulation strategies before application on a real robot.

Table 8 gives the advantages and disadvantages of each studied approach

Table 7:Summary of some bio-inspired methods for mobile robots autonomous navigation.

Ref	GA	ANN	Swarmintelligence			
			ACO	PSO	BFO	ABCO
Tuncer A and Yildirim M, [4]	*M.*					
Lamini C et al, [5]	*M.*					
Singh M and Parhi D, [8]		*D.*				
Rao A.M et al, [9]		*.*				
Singh N.H and Thongam K, [10]		*Q.*				
Yang L et al, [12]			*.*			
Xiaolin D et al, [13]			*			

Guangsheng L andWusheng C, [14]						
Turki Y et al, [15]						
Hossain M.A and Ferdousand I, [16]						
Anish P and Abhishek K.K, [17]						
Contreras-Cruz M.A et al, [19]						
Patle B.K et al, [20]						
Bhattacharjee, P et al, [21]						

Table 8 gives the advantages and disadvantages of each studied approach

Techniques	High Points	Low Points
Based on Evolutionary Algorithms	- The evolutionary algorithms use the coding of the parameters - evolutionary algorithms are working on the population of points - The use of probabilistic transition rules to avoid local optimizations - Synthesis of aerodynamic shapes and structures and composite materials - Better exploration of the research space	- Problems of timetables, industrial and network scheduling (steel, food processing, railway schedules, positioning, sewerage circuits, etc.). - Pattern recognition and learning (by reducing these problems to an optimization) - Pattern detection in bioinformatics, imaging, - Synthesis of electronic circuits
Based on Neuroscience	- Building a solution in a simple way - The ability to calculate an exact navigation path	- Deficits in finding a reliable representation knowledge.
Based on SWARM Intelligence	- They are very robust. - They are flexible - They are fast good solutions so the parallel work and the use of heuristic information, among other things. - Highly effective in the search for optimal solutions. - Overcomes the problem of the local optimum. - The use of several adjustable parameters. - Good solutions in a time much shorter. - works on the local environment using a simple robot - can be implemented without the need to adjust the algorithm and perform complex calculations	- A blocking state can arrive. - Execution time sometimes long. - Does not apply to all type of problems. -a mechanism for evolution and diversification - High values can trap the algorithm for several cycles and can eliminate a solution before the operation. - Sensitive to complex problems - converge prematurely - stochastic approaches have a problem of dependency, everything change in one of their parameters may have an effect on the operation of the algorithm as well as on the solution obtained - prematurely converge - a metaheuristic approach is sure we'll find the right solution

4. Conclusion

This paper presents an overview of different bioinspired approaches used for autonomous robot navigation. For each approach, we start by giving the principles of the bioinspired technique.Then we explain the navigation approach based on the bioinspired strategy. The advantages and disadvantages of eachstudied approach arecited.

The main challenge in this area of research is to build robot navigation systems capable of simulating the human system. Finding and evaluating such systems and adapting them to appropriate software processes remains the main challenge of autonomous navigation planning.

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IP Msan Management In Algeria

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Informations

Mots clés :

NGN
MSAN
Configuration Network

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Résumé

Because of the growing demand for multimedia services, several operators worldwide have begun to deploy NGN architectures. To respond to their customers' needs (offer both broadband and narrowband services in real-time very capricious that require a reliable and stable access infrastructure and low cost). Algeria Telecom and Mascara Provence deploy an MSAN M500T. It enables the transition between the PSTN and the NGN, intending to provide more services that are reliable to the end-user. In our work, we will present the management techniques of this MSAN M500T for the first time. We were able to configure and perform local and remote network operations in the Mascara province, such as Vlan creation, flow increase, and line testing.

1. Introduction

Traditional fixed telephony networks of incumbent operators rely on circuit switching (also known as TDM transmission) between subscriber lines and a hierarchical organization of switches based on different call zones. Furthermore, this telephony network coexists with one or more data transport networks (including the network used to provide DSL broadband services).

The migration of incumbent operators' core fixed networks to NGN (Next Generation Network) is primarily a cost-cutting measure, with the transition to a single IP-based infrastructure for the transport of all flow types, voice or data, and access technologies (DSL, FTTH, PSTN, Wi-Fi, etc.).

The primary impact of adopting an NGN architecture for switched telephone networks is separating the traditional switch into two distinct logical elements: the media gateway for transport and the soft switch for call control.

Theoretically, this evolution allows for gains in terms of performance and cost optimization. Next-generation optical system solutions combine existing optical networks such as DWDM and SDH optical networks. Traditional transport devices now include data and Ethernet functions [1].

New access technologies play a critical role in developing next-generation multimedia IP services to improve service quality. They are distinguished by their maturity level, switching architecture, and high throughput. [1-3].

2. NGN Overview

NGN is defined as a packet-based transport network that enables the convergence of Voice/Data and Fixed/Mobile networks.

These networks will allow the delivery of multimedia services accessible from various access networks.

To adapt to significant trends such as the search for flexibility in network evolution, the distribution of intelligence in the network, and the opening up of the network to third-party services, NGNs are

Based on a gradual evolution towards "all-IP" and are modeled in independent layers that communicate via open and standardized interfaces [3].

2.1 Layered NGN architecture

The transition to an NGN-type architecture is distinguished by the separation of physical switching and call control tasks. The NGN architecture employs a layered model that divides the functions and equipment in charge of traffic transport and control. An architectural model can be defined using four successive layers.

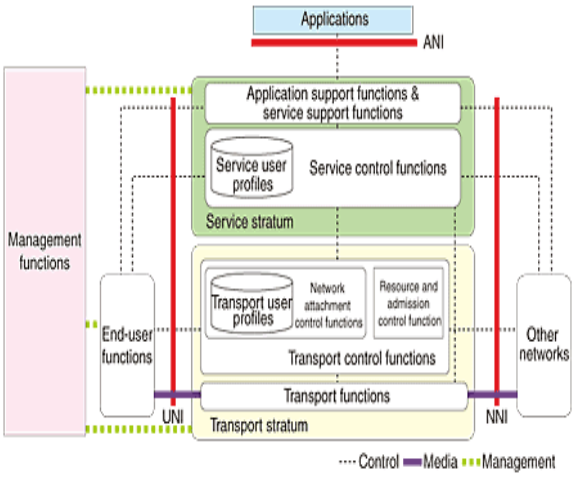

Fig.1 : General architecture of an NGN [3]

3. MSAN in NGN Rôle

There was a separation between voice and data flows before deploying the MSAN in fixed networks; the MSAN is a powerful solution that replaces a DSLAM for data services and an AXE for voice services. It includes POTS, Ethernet, xDSL, and FTTx cards to provide converged technology over IP, with features such as encoding and packetizing media streams from the access network to the packet network and vice versa, i.e., traffic conversion, such as TDM/IP [2].

According to the Media Gateway Controller, Supports H.248, MGCnd SIP protocols also support real-time transport protocol RTP/RTCP and Ethernet and Supports PSTN, ISDN, FAX, V5 interface, xDSL, and GPON services.

4.NGN advantages

This new topology has the following benefits:

- The operator now has a multiservice network that can interface with any access thanks to NGN (local loop, PBX, telephone access switch, ADSL access, GSM or UMTS mobile access, IP telephone, etc.).
- The operator will only be required to run a single multiservice network.
- It uses IP or ATM transport, ignoring the limitations of TDM (Time Division Multiplexing) networks at 64 kbit/s. TDM loses efficiency when asymmetric, sporadic, or variable bit rate services are introduced.
- It is an open topology capable of transporting both telephone and multimedia services (video, real-time data).
- It separates the network's support and control components, allowing them to evolve independently and breaking the monolithic communication structure. The transport layer can be changed without affecting the control or application layers.

It uses open interfaces between all elements, allowing the operator to purchase the best products for each segment of his network [10].

5. MSAN Advantages

MSANs are a natural progression from DSLAMs. An MSAN is a piece of equipment that serves as a single point of access to the operators' access networks in most NGN architectures.

The access layer groups together the functions and equipment used to manage user equipment's network access, depending on the access technology (switched telephony, DSL, cable). This layer contains, for example, DSLAM equipment that provides DSL access. (6–7)

The transport layer, which, depending on the protocol, is in charge of routing voice or data traffic in the core network. At this level of an NGN architecture, the Media Gateway (MGW) is responsible for adapting transport protocols to the various types of physical networks available (PSTN, IP, ATM) [8].

The control layer oversees all service control functions in general and calls control in particular for voice services. At this level of an NGN architecture, an essential piece of equipment is the call server, also known as a "sofswitch", which provides the equivalent of an NGN's switching function in voice services. The software switch functionalities and interfaces are standardized in the IMS standard defined by 3GPP, and the equipment is referred to as CSCF (Call Session Control Function) [3].

The layer's equipment consists of two types: application servers and enablers, which are functionalities, such as the management of user presence information, that multiple applications can use. Because SIP (Session Initiation Protocol) is used in an NGN architecture to manage multimedia sessions in general and voice over IP services in particular, this layer typically includes SIP application servers.
These layers are self-contained and communicate with one another via open interfaces. This layered structure is intended to increase flexibility and efficiency in the implementation of new services. The use of available interfaces not only facilitates the integration of new services developed on an operator network, but it is also necessary to ensure the interconnection of an NGN network with other networks, whether NGN or traditional.

The most significant impact on traditional switched telephone networks is separating the standard switch into two distinct logical elements: the media gateway for transport and the soft switch for call control [4]. Once the telephone communications are "packaged" by the media gateway, the services are no longer dependent on the physical characteristics of the network. For operators, a single packet network core shared by

multiple access networks is an appealing prospect. In many cases, a shared IP/MPLS core at the NGN's transport layer is chosen to provide sufficient QoS mechanisms to ensure adequate service delivery [5].

The MSAN provides the operator with a multiservice network that allows it to interface with any access. The operator will only be required to run one multiservice network. It employs transport methods such as IP or ATM while ignoring the limitations of TDM networks. It serves as a single point of contact for all network-related inquiries and offers a bandwidth solution as well as managed access. Basic PSTN services are being migrated to an IP platform.

The customer will have, on his simple fixed-line, telephone, ADSL, and possibly Television, Tele purchase, etc., at his convenience and request, without burdening him with equipment (ex: modem, interface, etc.) [8].

It provides subscribers with more personalized and higher-quality services. It provides companies with innovative services and intelligent networks, whose security and storage capabilities will allow for better networking and information system integration.

It is capable of delivering secure, high-performance, and widely accessible voice and data services. Billing systems will be simplified and will account for all services provided to subscribers. For the same price as his previous network, the subscriber now has four times the bandwidth. MSAN provides the following services:

MSAN supports two types of services: broadband services such as Triple Play, IPTV, and xDSL, and narrowband services below 4 kHz such as POTS, ISDN, and FAX [7].

5.1. Triple Play service

Triple Play service enables the simultaneous integration of three services: Internet access, IPTV, and Voice over IP in a single channel to increase broadband throughput.

5.2. xDSL service

xDSL is the evolution of a group of technologies that enable broadband transmission over twisted telephone pairs. It has a bandwidth of 1 Mhz and uses more carrier frequencies for data. Among the most widely used xDSL technologies is (ADSL, SHDSL, VDSL).

5.3. IPTV service

IPTV is a new service that allows for delivering real-time programs such as broadcasting and video on demand. This service ensures high quality across a wide range of frequencies. This service is built on the multicast mechanism, which allows multiple target machines on the network to receive the same frame (point-to-multipoint transmission) [3, 6].

6. The functional entities of the NGN core network

6.1 The Media Gateway (MG)

The Media Gateway is located at the level of media flow transport between the PSTN network and packet networks or between the NGN core network and access networks. Its function is to:

- Encoding and packetizing the PSTN media stream and vice versa (TDM/IP traffic conversion).
- The transmission of media flows is received from both sides by the instructions of the Media Gateway Controller.

6.2 Signalling Gateway (SG)

The Signalling Gateway's role is to convert the signaling exchanged between the NGN and the interconnected external network into a format understandable by the equipment in charge of processing it, but without interpreting it (this role being assigned to the Media Gateway Controller). It adapts the signaling to the transport protocol particularly (e.g., TDM/IP adaptation) [3].

6.3 The call server or Media Gateway Controller (MGC) or soft switch

The MGC is the "intelligence" in an NGN network. It is in charge of the exchange of signaling messages sent from one side to the other via signaling gateways and the interpretation of this signaling. Call processing entails interacting with H.323, SIP, or MGCP terminals and communicating with application servers to provide services. [2].

7. Functional architecture of the MSAN MA5600T

7.1. Services interface module

This module contains all of the Access interfaces ports for the various voice and data services, including ADSL2+ Access Interface; Access interface for SHDSL; Access interface for VDSL2; P2P FE optical access interface; Access interface for GPON; Access interface for POTS (VOIP); Module for Ethernet switching.

The collection and switching of Ethernet packets are possible with this switching module; This entity is associated with the SCU control card.

7.1.1. Control module for services

This service control unit is made up of the SCU control card and other sub-cards, and it performs the following tasks:

- Maintain control over broadband services
- Maintain serial and network ports to facilitate system maintenance using a terminal or a network management station.

7.1.2. Voice packet-processing module (VOIP)

A VoIP packet routing and management module.

7.1.3. NIM stands for Network Interface Module

This module contains all of the network layer interface ports of the MA5600T equipment FE optical port (electrical) GE optical port (electrical) E1 ports [7].

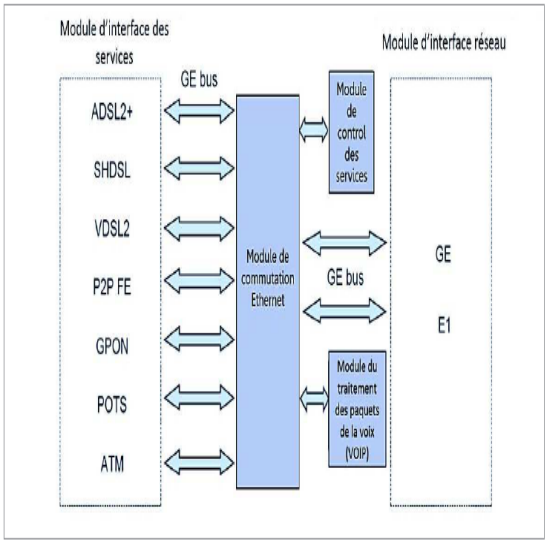

Fig. 2 : Functional architecture of the MSAN MA5600 [6]

8. Configuration and test operations

We were able to perform some configuration operations on the 'Froha' and 'Ghellal Zine Abidine' sites at the Mascara city.

8.1. Configuration 'Froha' Site

We were able to create two types of vlans using this script: smart for data connection and standard for management operations. Each vlan is assigned a board number ranging from 1 to 18.

UA5000:

```
port vlan 10 0/2 1
port vlan 510 0/2 1
port vlan 810 0/2 1
```

600K:

```
sysname M_29_FROHA_600K
display board 0
vlan 510 smart
vlan 810 smart
vlan 10 standard
port vlan 510 0/9 0
port vlan 810 0/9 0
port vlan 10 0/9 0
inter vlanif 10 : ip address 172.18.29.246 24
ip route-static 0.0.0.0 0.0.0.0 172.18.29.1
ip route-static 172.20.50.8 255.255.255.248 172.21.29.1 description To-U2000-standby
ip route-static 192.168.116.0 255.255.255.248 172.21.29.1 description To-U2000-Active
SNMP (management - BMS)
snmp-agent community read public
snmp-agent community write private
snmp-agent trap enable standard
snmp-agent target-host trap-hostname BMS-ORAN address 192.168.131.2 trap-paramsname BMS
snmp-agent target-host trap-hostname BMS-ALGER address 192.168.116.2 trap-paramsname BMS
snmp-agent target-host trap-hostname BMS-ALGER2 address 192.168.116.3 trap-paramsname BMS
snmp-agent target-host trap-hostname BMS-MASCARA address 192.168.129.2 trap-paramsname BMS
snmp-agent trap source vlanif 10
==========
DELETE VLAN 101: 1- undo service-port all 2- undo port vlan 101 0/9 0 3- undo vlan 101
///// inter vlan 10 / 1060
```

8.2. Flow increase of Ghellal Zine Abidine site

The flow increases from 2 to 20 Mbit/s, or we associate the appropriate profile to the port; in this script, we activated port 34 to increase the flow.

```
Integrated Access Software (MA5600T).
------------------------------------------------------------------------------
User last login information:
------------------------------------------------------------------------------
Access Type : Telnet
IP-Address : 192.168.116.4
Login Time : 2021-03-25 10:02:48+01:00
Logout Time : 2021-03-25 10:15:34+01:00
------------------------------------------------------------------------------
29_M_Ghellal_Zine_Abidine_1000_I_B> Warning: Using the default user password is not recommended. Please change the password.
29_M_Ghellal_Zine_Abidine_1000_I_B>enable
29_M_Ghellal_Zine_Abidine_1000_I_B#config
29_M_Ghellal_Zine_Abidine_1000_I_B(config)#display mgpstnuser 0 34
{ <cr>|span-area<U><1,10000> }:
Command:
    display mgpstnuser 0 34
------------------------------------------------------------------------------
F /S /P MGID TelNo Priority PotsLineType TerminalID
------------------------------------------------------------------------------
0 /1 /34 0 - Cat3 DEL A34
------------------------------------------------------------------------------
29_M_Ghellal_Zine_Abidine_1000_I_B(config)#interface adsl 0/1
29_M_Ghellal_Zine_Abidine_1000_I_B(config-if-adsl-0/1)#display port state 34
------------------------------------------------------------------------------
Port Status Line_Profile Alm_Profile Ext_Profile
------------------------------------------------------------------------------
34 Activating 2 1 --
------------------------------------------------------------------------------
29_M_Ghellal_Zine_Abidine_1000_I_B(config-if-adsl-0/1)#Deactivate 34
29_M_Ghellal_Zine_Abidine_1000_I_B(config-if-adsl-0/1)#Deactivate port 34 successfully
29_M_Ghellal_Zine_Abidine_1000_I_B(config-if-adsl-0/1)#Activate 34 profile-index 1002
29_M_Ghellal_Zine_Abidine_1000_I_B(config-if-adsl-0/1)#Send the command to activate port 34 successfully
29_M_Ghellal_Zine_Abidine_1000_I_B(config-if-adsl-0/1)#Display port state 34
------------------------------------------------------------------------------
Port Status Line_Profile Alm_Profile Ext_Profile
------------------------------------------------------------------------------
34 Activating 1002 1 --
------------------------------------------------------------------------------
29_M_Ghellal_Zine_Abidine_1000_I_B(config-if-adsl-0/1)#
```

8.2.1. Vlan

This script is a network management supervisory between the equipment and the server. U2000

displays the types of vlans 111 standard for voice management and valn 10 for data and smart, which are assigned for data connection.

```
29_M_Ghellal_Zine_Abidine_1000_I_B(config)#

Huawei Integrated Access Software (MA5600T).
 ------------------------------------------------------------------------
 User last login information:
 ------------------------------------------------------------------------
 Access Type : Telnet
 IP-Address  : 192.168.116.4
 ------------------------------------------------------------------------
29_M_Ghellal_Zine_Abidine_1000_I_B>
 Warning: Using the default user password is not recommended. Please change the password.
29_M_Ghellal_Zine_Abidine_1000_I_B>enable
29_M_Ghellal_Zine_Abidine_1000_I_B#config
29_M_Ghellal_Zine_Abidine_1000_I_B(config)#display vlan all
{ <cr>|vlanattr<K>|vlantype<E><mux,standard,smart,super> }:
 Command:
      display vlan all
 ------------------------------------------------------------------------
VLAN  Type     Attribute  STND-Port NUM  SERV-Port NUM  VLAN-Con NUM
 ------------------------------------------------------------------------
   1  smart    common          4             0             -
  10  standard common          1             0             -
 111  standard common          1             0             -
1022  smart    common          1             1             -
1065  smart    common          1             1             -
3142  smart    stacking        1           780             -
3180  smart    common          1             1             -
 ------------------------------------------------------------------------
 Total: 7
 Note : STND-Port--standard port, SERV-Port--service virtual port,
      VLAN-Con--vlan-connect
29_M_Ghellal_Zine_Abidine_1000_I_B(config)#vlan ?
---------------------------------------------
 Command of config Mode:
---------------------------------------------
attrib            VLAN attribute
bind              Bind
forwarding        Set VLAN forwarding mode
loop              VLAN loop
name              VLAN name
packet-policy     Set VLAN packet forwarding policy
priority          VLAN priority
reserve           The reserved VLAN ID
service-profile   VLAN service profile
vlan-list<S><Length 1-255>
                  VLAN list(2,5-8,10)
vlanid<U><2,4093>    VLAN ID
---------------------------------------------
 Command of privilege Mode:
---------------------------------------------
desc              Description Operation
```

8.3. Ping of remote site 'Ghriss'

This operation consists in determining whether or not a remote site is operational, that is, whether or not the consulted connectivity by integrating its address IP reveals that 5 packet(s) were transmitted, 5 packet(s) were received, and 0.00 percent were packet lost.

```
Huawei Integrated Access Software (MA5600T).
------------------------------------------------------------------------
 User last login information:
------------------------------------------------------------------------
 Access Type : Telnet
 IP-Address  : 192.168.116.4
 Login  Time : 2021-04-07 10:21:54+01:00
 Logout Time : 2021-04-07 10:31:14+01:00
 ------------------------------------------------------------------------
29_M_110_Logts_Ghriss_1000_I_B>
 Warning: Using the default user password is not recommended. Please change the password.
---------------------------------------------
<cr>              Please press ENTER to execute command

29_M_110_Logts_Ghriss_1000_I_B(config)#ping 172 ?
---------------------------------------------
 Command of privilege Mode:
---------------------------------------------
<cr>              Please press ENTER to execute command

29_M_110_Logts_Ghriss_1000_I_B(config)#ping 172.18.29.9
 PING 172.18.29.9: 56  data bytes, press CTRL_C to break
   Reply from 172.18.29.9: bytes=56 Sequence=1 ttl=254 time=17 ms
   Reply from 172.18.29.9: bytes=56 Sequence=2 ttl=254 time=6 ms
   Reply from 172.18.29.9: bytes=56 Sequence=3 ttl=254 time=6 ms
   Reply from 172.18.29.9: bytes=56 Sequence=4 ttl=254 time=6 ms
   Reply from 172.18.29.9: bytes=56 Sequence=5 ttl=254 time=6 ms
 --- 172.18.29.9 ping statistics ---
   5 packet(s) transmitted
   5 packet(s) received
   0.00% packet loss
   round-trip min/avg/max = 6/8/17 ms
29_M_110_Logts_Ghriss_1000_I_B(config)
```

9.Conclusion

Several operators worldwide have begun to deploy NGN architectures that allow them to meet their customers' needs (offering highly capricious real-time broadband and narrowband services that require a reliable, stable, and low-cost access infrastructure) [11].

The research conducted during this project enabled us to demonstrate the importance of implementing the Multi-Service Access Node MSAN by presenting the HUAWEI MA5600 solutions and the services they provide to meet the demand of subscribers for a higher quality of connection. As an extension of this work, we proposed securing the connection server under Linux with a Fortinet firewall to protect it from various attacks.

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Semantic Big Data integration: A survey

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Abstract

The emergence of Big Data has increased the amount of daily produced data. These data are in various formats namely: email, audio, video and structured/unstructured text data, etc. In fact, traditional databases and software techniques cannot handle such huge and heterogeneous information. Therefore, new data management systems should be adopted to integrate this distributed data and to abstract this heterogeneity. In this context Semantic Web (SW) technology, especially ontologies were widely used in the data integration system to eliminate semantic data heterogeneity. Mining the state of the art, two main techniques exist, physical and virtual data integration. In this context, several research works around the aforementioned methods were proposed. In this paper, we studied the most relevant research works in the semantic Big Data integration area. In fact, we performed a comparative study and its discussion of the different approaches proposed to achieve both physical and virtual techniques.

1. Introduction

Nowadays, a huge amount of data comes from several sources. Indeed, these data can be disparate, on different formats, from various sources and without uniformity; it means they can be structured or unstructured. It is generally characterized by the 3V's: a large volume of data to be processed, a wide variety of information from several sources and velocity, which is the frequency, or speed of creating, collecting and sharing this information. Thus, Big Data requires a specific infrastructure for their storage, processing and analysis. Companies are struggling on how to integrate, query and analyze such data.

Data integration is one of the oldest research areas in the field of databases. This area deals with the problem of providing a unified view about heterogeneous and distributed data to the user by combining data residing in different sources **[1]**. Besides, applications that need to query multiple data sources face the challenge of integrating heterogeneous and autonomous data. Therefore, data integration is an important phase in large enterprises having a multitude of data sources **[2]**. Thus, offering uniform access to a set of autonomous and heterogeneous data sources is the goal of data integration systems **[3]**.

Big data integration differs from the traditional data integration in terms of (1) the number of data sources, (2) dynamicity of data sources, (3) extreme heterogeneity of data sources and (4) the wide difference in quality between data sources, with significant differences in the coverage, accuracy and timeliness of the provided data **[4]**. In fact, the task of data integration has become more difficult and more complex and the semantics of the data can be lost if it arrives with huge volume and high velocity. In this context, ontologies were widely used in semantic data integration systems **[5][6]**. According to **[7],** an ontology is a formal, explicit specification of a shared conceptualization for a domain. They have been developed in Artificial Intelligence to facilitate knowledge sharing and reuse **[8]**. They were employed in data integration systems to solve syntactic and semantic heterogeneity problems by providing a semantic model of data sets to be integrated.

In the literature, several works and approaches addressed the issue of semantic Big Data integration. Those approaches can be classified into physical (or materialized) integration, where the data is physically copied to dedicated storage (such as Data Warehouse), and virtual integration in which data remains in the original sources and is accessible during the execution of the query on an intermediate interface.

In this paper, we summarizedifferent semantic data integration approaches. Then, we compare the aforementioned approaches and discuss the comparative study. This manuscript is organized as follows: The first section regroups a state of

the art of semantic data integration approaches. The second sectioncontains a comparative study of works presented. The comparative studies are discussed in the third section. We end the work with a conclusion in the fourth section.

2. State of the art

In physical data integration, data is extracted from different sources and loaded into common storage after performing a set of transformation and cleaning operations to make them uniform.

The data warehouse, which is the main approach of physical data integration defined by Inmon, W.H in 1992 as a "subject-oriented, integrated, time-varying, non-volatile method of data collection, is used primarily in organizational decision making". Also known as data warehouse population, data warehousing is done through the ETL (Extract, Transform, and Load) process. The ETL process is composed of 3 phases. The first phase consists in extracting data from different sources. The second step is the transformation phase involving the conversion of data into the target schemas **[9]** by applying a series of cleaning operations including eliminating duplicates, filling empty fields, converting data types, etc. The final phase (loading) is to store the transformed data in the data warehouse.

In this data integration type, the response time to the user's requests is short because the query will look for a result from a single data source represented by the common storage (DW). Therefore, the physical data integration approaches suffer from the freshness of data as enough fresh data cannot be found only after the updating phase.

Virtual integration (also known as mediator **[10]**) is defined as an approach applied to provide an intermediate tool between users or applications, on one hand, and a set of autonomous, heterogeneous, distributed and scalable information sources, on the other hand. This tool offers a transparent access service to sources through a unique interface and a single query language"**[11]**.In the virtual integration, data remains in the sources and the query is executed at the intermediary interface. The query executed in the intermediate is converted into the formats of the local data sources. Then, results of sub-query retrieved data need to be combined to answer the query.

In the virtual integration, the query is slow because it will be divided into sub-requests and sent to the wrappers of the individual sources to be executed on local models. Then, the intermediate interface receives the responses of the wrappers, combines them into one answer and sends it to the user. This process is time-consuming. However, in the virtual integration approaches, data is always fresh and updated because it is extracted from the sources directly.

We presented in the next section several works for Big Data integration approach, in particularly semantics ones.

- In **[12]**, authors have proposed a data integration framework where the target schema was represented as a semantic web ontology and the sources corresponded to NoSQL databases. Currently, they are implementing their data integration solution on two popular NoSQL databases: MongoDB, as a document database, and Cassandra as a column family store. Their contributions are: (1) Analyzing a set of schema-less NoSQL databases to generate local ontologies; (2) Generating a global ontology based on the discovery of correspondences between the local ontologies; and finally (3) proposing a query translation solution from SPARQL to query languages of the sources.
- In **[13]**, the authors proposed a semantic ETL framework that uses semantic technologies to integrate and publish data from multiple sources. Those technologies were also applied to connect, link and load data into a data warehouse. The proposed framework includes: (1) creating semantic data model via ontologies to provide a basis for integration and understanding knowledge from multiple sources; (2) forming integrated semantic data using Resource Description Framework (RDF) as the graph data model and (3) extracting useful knowledge and information from the combined web of data using SPARQL as the semantic query language. This approach uses ontologies to provide a common vocabulary for the integrated data and generated semantic data as part of the transformation phase of ETL.
- Handling the semantic heterogeneity for Big Data application in industrial automation using Semantic Web technologies is the main topic of **[14]**. Authors, in this study, dealt with structural heterogeneity (or syntactic heterogeneity) by taking into consideration various data sources to ensure quick and valuable decisions as well as semantic heterogeneity by creating a shared ontology, which guaranteed the transformation of the data sources into the same "language". The developed approach includes the following steps: (1) Construction of upper ontology describing all data sources, (2) Transformation of data according to this ontology and (3) Analysis of data with the help of Big Data paradigm.
- In **[15]**, researchers described a (Python-based) programmable Semantic ETL framework (SETL) to process and integrate data semantically. This approach uses the Semantic Web (SW) standards and tools to produce a

semantic data warehouse based on RDF triples. SETL involves traditional relational data, semantically annotated data (RDF data) in the analytical process, and provides a method to produce semantic data (in RDF triples format) from the source data. The main phases are the following: The first step consists in defining an ontology that describes the relevant data and the target data warehouse applying the Ontology Definition module. After mapping between data sources and the target ontology using the Define Mapping module, the Extraction module extracts data from multiple heterogeneous data sources. The third phase is to transform the source data. In this step, the Traditional Transformation module cleanses and formats the extracted data and the Semantic Transformation module converts the data into RDF triples according to the target ontology. The final phase consists of loading the data into a triple store and/or publishing the data on the Web as Linked Data.

- Authors of **[16]**have presented a semantic mediation architecture based on ontology for reducing the semantic problems, and on the summary for reducing the quantity of data with minimum execution time. A domain ontology on alimentation risks field is built to use as well as a global schema of the mediator. Their architecture is split into three separate layers: Mediator layer, Wrapper layer and data source layer. (1) The mediator layer represents the unified interface for querying heterogeneous data sources by using the global ontology. (2) A wrapper layer is a middle layer between the mediator layer and data source layer. The initial query is written by SPARQL language of this ontology and the wrapper will translate this query to sources query language and extraction of answers. (3) The source layer contains external data sources. These local sources are voluminous and it associated by its own ontology represented the knowledge in an independent with other local ontologies.
- Paper **[17]** introduce SemLinker, an ontology-based data integration system. SemLinker is part of a metadata management framework for personal data lake (PDL). It adopts an automatic approach that only operates on the schema metadata level without involving the physical transformation of data during integration. Thus, it preserves the data in their native formats and structures while, at the same time, allowing the data to be easily analyzed and queried by casual users. The SemLinker architecture consists of three layers: (1) a global schema layer G, which is modelled as a global ontology and is described using web ontology language (OWL). (2) a local schemata layer which is described using the resource description framework (RDF) and is stored in the schema's repository S., and (3) the relationships between these layers were SemLinker is responsible for automatically mapping the local schema Si of the data source i to a semantically corresponding concept in the global ontology G.
- In **[18]**, an ontology-based Big Data integration approach, exploiting a NoSQL database (namely MongoDB), was depicted. It is based on three main steps: (1) by wrapping data sources to MongoDB databases, the content of each data source was converted into a MongoDB database; (2) mapping MongoDB databases into ontology modules where each MongoDB database was mapped into an OWL ontology module by means of transformation rules; and (3) Creating a global ontology module by merging the modules obtained in the previous step. They employed two tools: M2Onto (MongoDB To Ontology), implementing transformation rules from MongoDB to ontology modules, and MOOM(Modular Owl Ontology Merging) allowing to merge the ontology modules resulting from the previous step to get a global one.

3. Comparative study

We analyzed the above approaches using the four following criteria: (1) Approach type to identify the type of data integration approach (physical or virtual), (2) Data sources (depicting the formats of the data sources), (3) Target schema was taken into account to describe the output of the process and (4) Ontology construction automaticity degree grouped the approaches to build ontology as Manual (M), semi-manual (SM) or automatic (A).

Work	Approach type	Data sources	Target schema	Ontology construction automaticity		
				M	SM	A
[12]	Virtual	NoSql DB (MongoDB and Cassandra)	Ontology		+	
[13]	Physical	Big data	DW	+		
[14]	Physical	Big data	RDF shared storage		+	
[15]	Physical	Big data	DW		+	
[16]	Virtual	External data sources	Ontology		+	
[17]	Physical	Big data	key-value tuple store			+
[18]	Virtual	Databases wrapped to MongoDB	Ontology			+

Tab.1.Comparative study

4. Discussion

From the exhaustive study of both physical and virtual integration approaches, we mentioned that the main challenge faced is the data heterogeneity. Indeed, heterogeneous data requires more effective solutions to perform the integration process. To overcome this problem, Semantic Web (SW) technologies were used. In this context, ontologies were widely utilized in data integration system, especially in the transformation stage in physicals approaches, to create a semantic data model and generate semantic linked data to be stored in the common storage, also as a querying model in virtual approaches.

One of the challenges of **[13]** is the engineering of ontology, which requires the intervention of a human expert and it is often a time-consuming process. Otherwise, there are systems that need real-time data processing. The manual ontology construction in **[14]** is a complicated and time-consuming process.

Work in **[12]** does not support NoSQL stores corresponding to a graph model, is dedicated only for both the MongoDB and Cassandra NOSQL databases. In addition, **[14, 18]** cannot support all NoSQL system.

These works tried to solve the problem of semantic heterogeneity without taking into account the volume and velocity of the data. The semantics of the data can be lost if it arrives with huge volume and high velocity.

As perspectives, there is a need to consider the solving of automaticity problem to limit manual intervention. It is also necessary to incorporate another category of NOSQL stores: graph databases.

5. Conclusion

In this paper, we analyzed a set of works that dealt with big data integration. These works were divided into 2 types according to their integration process. The first type includes physical approaches where data from different sources are copied to common storage after a set of transformation operations to make them uniform. In the other hand, in virtual integration type, data remain in the origin's sources. To interrogate them, the user's query will be executed in an intermediate interface.To solve semantic problem in data integration system ontologies were widely utilized, especially in the transformation stage in physicals approaches, to create a semantic data model and generate semantic linked data to be stored in the common storage, also as a querying model in virtual approaches.

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A new approach to switching from natural language to a SPARQL query

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Informations

Mots clés :

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Linked data, NLP, http,
URI

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Résumé

With the growing amount of semantic data available on the web, there is a strong need for systems that allow common web users to access this body of knowledge. Question answering systems have received particular attention, as they allow users to express arbitrarily complex information needs in a simple and intuitive manner. The main challenge is to translate users' information needs into a form that can be assessed using standard Semantic Web query processing and inference techniques. Over the past few years, a series of approaches have been developed to address this challenge, showing significant advances towards answering natural language questions in relation to large, heterogeneous sets of structured data. However, only a few systems still deal with the fact that the structured data available today is spread across a large collection of interconnected data sets and that answers to questions can often only be provided if information from multiple sources is combined. . In addition, a lot of information is still only available in textual form, both on the web and in the form of labels and summaries in linked data sources **[1]**

1. Introduction

A difficult task in answering natural language questions (Q / A for short) on the RDF knowledge graph is how to bridge the gap between unstructured natural language questions (NLQ) and structured RDF data in graph (G). One of the effective tools is the "template," which is often used in many existing RDF Q / A systems. However, few of them study how to automatically generate models. To our knowledge, we are the first to offer a join approach for model generation. Given a workload D of SPARQL queries and a set N of natural language questions, the goal is to find pairs q, n, for q ∈ D ∧ n ∈ N, where the SPARQL query q is the best match for question n in natural language n. These pairs provide promising advice for automatic model generation. With the ambiguity of natural languages, we model above problems as an uncertain graph join task. We offer several structural and probabilistic pruning techniques to speed up assembly. Extensive experiments on real-world RDF Q / A benchmarks confirm both the effectiveness and efficiency of our approach. **[2]** Recently, knowledge graphs have gained a lot of attention both in academia and in industry. Since the Resource Description Framework (RDF) is the de facto standard for a knowledge graph, we focus on the RDF repository in this article. A key issue is how to access knowledge graphs and quickly get the information you want. Although SPARQL is a structural query language on RDF charts, it is not practical for non-professional users to query RDF charts using SPARQL, due to the complexity of the SPARQL syntax and schema. RDF. We illustrate a sample SPARQL query on DBpedia as follows.

SELECT ?person

WHERE { ?person rdf : type Artist .

?person graduatedFrom Harvard University.}

2. Natural Language Processing

Natural language processing (NLP) is one of the most important techniques that change the computer into the human brain. The NLP comes under the field of artificial Intelligence where NLP is used to train the computer to understand the human language [3]. The computer is trained as a human brain for its activities of language processing.

The NLP is majorly aimed for the reading of language, decipher, understanding the language and after this all making sense like the human brain and reacts as per human brain reactions [4]. So doing all these tasks makes the NLP the most important technique for building a system that can reply according to the human brain. This method of language processing is used in many applications.

One of the applications of NLP is seen in the question answering system where the answering for the questions asked by the user is done [5]. This task of answering the question builds the QA system. The NLP helps in this system as it reads the question and tries to answer like a human brain. Whereas the NLP uses machine learning for the evaluation of the proper meaning of the question and then the answering is done.

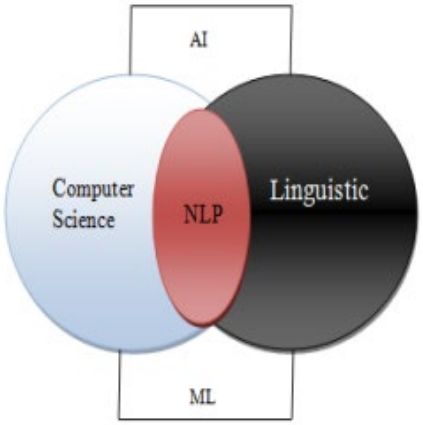


Figure 1 : Natural Language processing

3. Methodology

To reduce the complexity of the SPARQL syntax, RDF question and answer (Q / A) systems provide an easy to use interface for users, which has attracted great attention in both NLP and DB communities (database). A difficult task is to translate natural language questions (NLQ) into structural queries, such as SOARQL, on a large knowledge graph G. one of the effective tools is the model, which is used in many existing RDF Q / A systems. A typical system is EVI (http://www.evi.com/, officially True Knowledge), which registered over one million users within four months of its launch in January 2012. EVI was acquired by Amazon in October 2012 and is now part of the Amazon group of companies. EVI aims to directly answer questions posed in plain text in English on the knowledge base. It uses a model-based approach to answering natural language questions, where a model describes how to transform a class of natural language questions into correct structural queries. However, EVI must manually define the translation models. It is clear that the quality of the models determines the quality of the response. The challenge is how to automatically generate a large number of high quality models. Few of the previous works explore this question, but all have to manually define the models Obviously, it is expensive to manually define these models, especially for open domain Q / A systems on large-scale RDF knowledge graphs. . In this document, we study how to automatically generate models. [1]

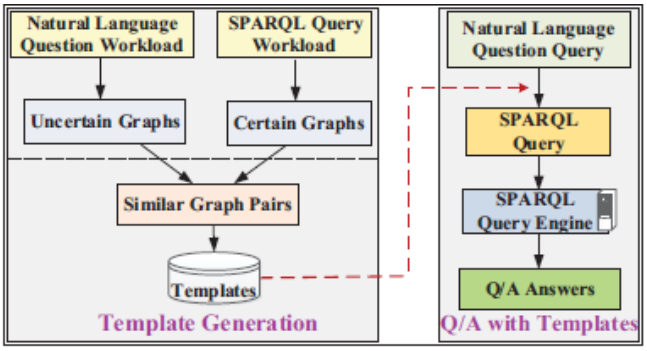


Figure 2:Framework for Model Based RDF Q/A

In figure 2 shows the RDF Q / A framework using templates. It consists of two tasks: how to generate models and how to use these models in RDF Q / A. To solve the first problem (subject of this article), we propose a workload-based approach of queries for automatic generation. of models. Specifically, the inputs for the model building task are two query workloads; one is a D set of SPARQL queries on the RDF repository (such as DBpedia workload1). The other is an N set of natural language questions, which can be collected from some community-based question-and-answer (Q&A) sites (such as Yahoo Answers) or the query engine workload. Search (such as WebQuestions2). **The whole process takes place in three stages as follows.**

Step 1: Uncertain graph generation. According to the method, natural language questions can be interpreted in semantic query graphs. Due to the ambiguity of interpretation, we model the semantic query graph as an uncertain graph, i.e. each vertex / edge has multiple possible labels with different probabilities. Here, the labels are uncertain due to semantic ambiguity. For example, consider the question "which American actor is married to New York City-born Michael Jordan" in Figure 3.

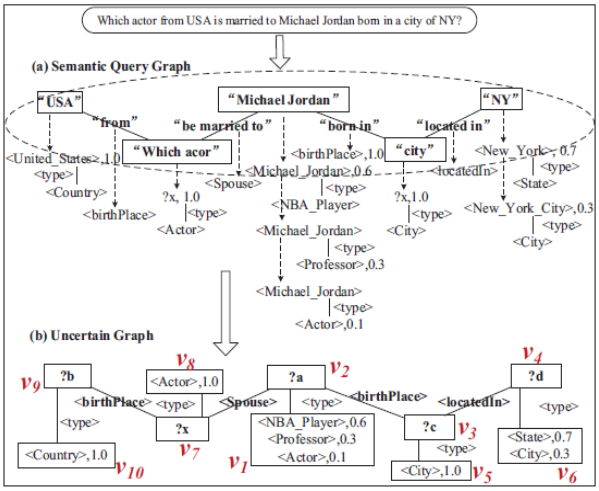


Figure 3: Uncertain graph generation

There are three people named "Michael Jordan" in the DBpedia RDF chart, that is, an NBA star, a professor and an actor, each associated with a probability. "NY" also has two possible connections, namely state and city. Therefore, we can get an uncertain graph containing nodes with multiple labels, each associated with a probability.

Step 2: Find pairs of similar charts. The goal is to find some pairs q, g, for q ∈ D ∧ g ∈ U, where D corresponds to the SPARQL queries and U are the uncertain graphs derived from the questions in natural language3. Here we use the graph edit distance, which is widely used to measure the similarity of graphs, to calculate the similarity between q and g.

Step 3: Generation of models with pairs of similar charts. Given a returned pair q, g, based on the mapping between q and g (the mapping is found when calculating the graph edit distance in step 2), we can build the models. In order to generate models, the key problem is how to find the pairs of similar graphs efficiently (ie step 2). This is the subject of this article. We propose a new approach, namely, Similarity Join on uncertain charts, denoted SimJ. More exactly, we offer a series of effective terminals to improve performance. Given the models generated, a natural language question is translated into a SPARQL query using the models generated during the first task. Then, the SPARQL query is searched on the knowledge graphs. Existing systems, such as **Jena, RDF-3x, Virtuoso4, and gstore** , can be used to complete the search.). **All the processing takes place in two stages as follows.**

Offline processing: To enable online semantic relation extraction processing, a dictionary of RDF relations and their paraphrases in natural language is automatically constructed in advance. For example, the relationship manager can be expressed as "directed by" or "a movie by". We follow a simple dependency analysis approach based on three points as described in [6]. For each subject-predicate-object triplet (s, p, o) in the data set, these sentences in the s and o confidence coding are retrieved. Then the sentences are analyzed by the dependency analyzer, and the shortest paths between s and o are selected as paraphrases of the relation p. Another challenge is the ambiguity of natural language. A single sentence in the question can often find more than one mapping in the RDF chart. To deal with this, we introduce RDF fragments, which are star-like RDF sub-graphs that discover the neighborhood of each relation, entity, or semantic class. Then we can roughly figure out how a certain semantic element is connected in the graph within a step length threshold. RDF fragments have good filtering and disambiguation power for these inappropriate mappings, while having acceptable space consumptions in many such entities, which share the same fragments. RDF fragments can be indexed by a reverse list.

Online processing: During the online step, the input question qNL is introduced into the following four-step pipeline: First, qNL is parsed in a tNL dependency tree. Second, sentences in qNL that mention any semantic relation are recognized in tNL with the help of the paraphrase dictionary. Sentences for entities and classes are those syntactic arguments in tNL associated with relation sentences. We also unify sentences that refer to the same element by co reference analysis. Third, these sentences are mapped to RDF fragments to find their semantic element matches in RDF graph G. Variables are introduced by question focus, unmatched entity sentences, and RDF fragments of semantic classes that are type constrained variables. Finally, the RDF fragments are attached to the reasonable sub graphic computer of graph G, checking their compatibility against the tNL dependency tree. The results are ranked according to the similarity and semantic consistency score, leading to the target SPARQL.

4. Linked data

The Web data (linked data, in English) is an initiative of W3C (World Wide Web Consortium) to promote the publication of structured data on the Web, not as isolated data silos each other, but by linking them together to form a global information network.

It relies on web standards , such as HTTP and URI - but rather than using those standards just to make it easier for humans to navigate, the web of data extends them to share information evenly between machines. This allows data to be requires automatically, regardless of where it is stored, and without having to duplicate it.

Tim Berners-Lee , director of W3C , coined and defined the term Linked Data or data linked and synonymous Web of data in a book on the future of the semantic web. In France, the term Web of data is used more and more by the community of professionals in the field.

For libraries, it is necessary to participate in the web of data in order to gain visibility and to make this data usable in other contexts. The web of data thus makes it possible to decompartmentalize data in catalogs, so that they are more accessible to users and those in the future. Among other things, it allows data from archives, museums or biographies to be linked to texts in the catalog, thus providing researchers with more complete information.

Tim Berners-Lee has defined four pillars to support the “Web of Data ” initiative :

1. use unique URIs to identify things.
2. use HTTP URIs that exist on the Web (URLs, therefore). An HTTP 404 Error simply indicates that the URI used is not explicitly documented.
3. provide usable, human-readable and machine-readable information through the URI, using open formats such as RDF or SparQL . For example, by using the HTTP redirection mechanism (code 302) and the User-Agent variable contained in the headers of HTTP requests, a server can display an XML or RDF page for a machine or an HTML page for the browser. 'one person.
4. Using the initial URI by associating it with external URIs to improve the discovery of other information on the Web.

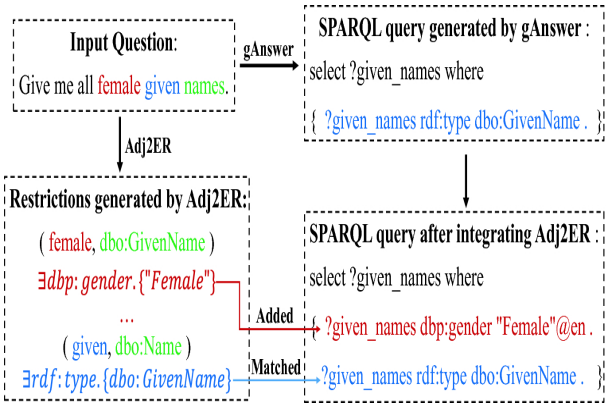
5.Algorithm for switching from natural language to a SPARQL query :

Algorithm 1. Integrating Adj2ER into existing QA systems

Input: A natural language question Q
Output: A SPARQL query for the input question Q

```
procedure GENERATESPARQL(Q)
    S := ExistingQASystem.GENERATESPARQL(Q);
    for all (adj, C) pair in Q do
        Restrictions := Adj2ER(adj, C);
        if S contains a restriction ∈ Restrictions then continue;
        S' := S;
        Remove all restrictions in S' which have semantic similarity ≥ 0.6 with adj;
        for all restriction ∈ Restrictions do
            S* := Resulting SPARQL for adding restriction to S';
            if S* is a non-empty query then S := S*; break;
    return S;
```

We have integrated our adjective mapping approach into two state-of-the-art quality assurance systems, namely gAnswer and WDAqua . Who placed first and second respectively in the QALD-9 challenge. The procedure for integration Adj2ER into them is presented in Algorithm 1. An example of integrating Adj2ER into existing quality assurance systems. [7]



	70 QALD questions			50 YA questions			Overall
	P	R	F1	P	R	F1	F1
gAnswer	30.49%	55.30%	29.75%	16.56%	36.26%	13.97%	23.18%
gAnswer + Adj2ER	**44.03%**	**62.25%**	**43.02%**	37.32%	**56.59%**	38.59%	**41.18%**
WDAqua	21.10%	26.64%	17.79%	23.53%	28.10%	22.04%	19.56%
WDAqua + Adj2ER	33.28%	43.86%	32.05%	**42.70%**	44.88%	**40.99%**	35.77%

6. Conclusion

In this article, we provide a data-based graphics framework for answering natural language questions about RDF graphics. Different from existing work, we allow sentences and structure ambiguity in the phase of understanding questions. We push the disambiguation in the

evaluation of stage queries. Based on the results of the queries on the RDF charts, we can effectively resolve the ambiguity problem. In other words, we combine disambiguation and query evaluation into a uniform process. Therefore, the data-driven graphing framework not only improves the accuracy but also speeds all the performance of the RDF Q / A system.

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A blind frequency based scheme for audio sounds watermarking

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Informations

Mots clés :
Watermarking
Audio file
Telemedicine
Discrete Cosine Transform Least significant bit

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Abstract

In order to enhance the security of data exchanged in telemedicine, we propose in this work a blind watermarking scheme for audio sounds protection. A blind watermark method is proposed; the successful watermark integration will be typically done by combining three successive values parity; each variant will adequately represent a different combination. These approaches will be implemented in the frequency domain. The watermark bits will be substituted to the Discrete Cosine Transform coefficient's least significant bit. The obtained results sufficiently demonstrate that our proposed approach offers a good imperceptibility results. However, using small audio file for our experiments significantly reduces the capacity of our used methods in the frequency domain.

1. Introduction

Encryption technologies can be used to prevent unauthorized access to digital content. However, encryption has its limits in protecting intellectual property rights because once digital content is decrypted; nothing prevents an unauthorized user from illegally reproducing it [1]. Another modern technology is clearly needed to help both establish and merely prove ownership rights, adequately monitor the possible use of content [2], ensure authorized access, facilitate content authentication and typically prevent illegal replication, and especially with the considerable scope and great potential of specific information in the chosen field of digital imaging in many practical aspects of everyday and professional life [3], television, the Internet, audiovisual, medical or satellite imaging and remote monitoring. This specific need attracted the attention of the research community and industry leading to the creation of a new information concealment form, called Digital Watermarking [4], which remains the most convenient method to address the issue of privacy and copyright and ensure the authenticity of multimedia products [5]. The fundamental idea of digital watermarking is to typically create metadata properly containing accurate information about the digital content to be adequately protected [6], and then to carefully hide the metadata in that content [6]. Information stored as metadata can utilize various formats, such as a character string or binary image or even a digital image. An effective watermarking system must guarantee the imperceptibility of the hidden data [7]. The inserted mark must not affect the visual quality of the cover. A watermarking system is also evaluated for its robustness; this criterion represents the resistance after sudden changes by

attacks [8]. Capacity is also a significant measure to evaluate the effectiveness of a watermark. It represents the amount of information that can be inserted into the medium; however, the larger the brand size is the greater the degradation is important [9]. In order to enhance the security of data exchanged in telemedicine, we propose in this work a blind watermarking scheme for audio sounds protection. The watermark consists of the patient information and the acquisition data. Thus during the extraction process, a comparison between the patient information and the watermark will indicate whether the data has been altered. This will ensure that the sample corresponds to the patient indicated in the record. In this work, we will propose a watermarking scheme for audio files; our goal is to find a compromise between capacity and imperceptibility in order to hide as much data as possible while minimizing file degradation. The distortion measurements will be calculated (between the original and watermarked files) in order to have a more objective idea of the distortions that have occurred in the container. This will also make it possible to determine the imperceptibility rate.

2. Materials and methods

In the proposed approach for the frequency domain, a DCT is carefully applied to the audio frames, after the thresholding and quantification step the watermark is carefully inserted into the complex DCT coefficients to get the watermarked file.

2.1 The Discreet Cosine Transform (DCT)

DCT is an audio transformation technique [10] that transforms data from the spatial domain into a transformation domain. This linear transformation transfers a matrix of n elements into another matrix of n coefficients as a cumulative sum of cosine functions of different frequencies. The matrix is thus divided into three frequency bands: low frequency (LF), medium frequency (MF) and high frequency (HF). The largest quantity of energy is concentrated in the LF band, while the smallest quantity of energy is concentrated in the HF band [11]. Embedding the watermark in the HF band may affect the audibility of the signal, while embedding the watermark in the HF band may affect the quality of the watermarked bits. Therefore, in our approach the watermark is integrated into the MF band because it is the least sensitive to noise. After the calculation of a DCT by formula 1, a thresholding is performed to increase the compression efficiency. If the absolute values of the (non-zero) coefficients of the DCT matrix obtained are below a certain threshold, these coefficients will be eliminated (set to zero).

$$F_{u,v} = \frac{1}{\sqrt{2N}} C_u \sum_{x=1}^{N} f(x) \ .\cos[\frac{(2x+1)u\pi}{2N}] \qquad (1)$$

$$Where\ \mathrm{C_u} = \begin{cases} \frac{1}{\sqrt{2N}} & if\ u = 0 \\ 1 & if\ u > 0 \end{cases}$$

2.2 Quantification process

A quantification of the obtained DCT coefficients is performed. The quantification of each block groups together the sets of similar values. This minimizes the data required to represent the audio file. A single quantum value will thus represent a range of values [12]. In order to calculate the quantization matrix, the value of the quantization Q, (Q represents the number of bits required to code each element of the DCT matrix) is selected. The two MAX and MIN values of the DCT matrix (DCTmax, DCTmin) are determined. Then, the DCTQ matrix is calculated by the following formula:

$$DCTQ(i,j) = \frac{(-1+2^{Q})(\mathrm{DCT(i,j)}-\mathrm{DCTmin})}{\mathrm{DCTmax}-\mathrm{DCTmin}} \qquad (2)$$

2.3 Integration process

In this scheme, the parity of three successive coefficients is exactly calculated and then compared to the possible bits to be carefully hidden. In specific case of used inequality, the parity of a determined constant is then modified to sufficiently satisfy equality according to the specific rules in Table 1. R1, R2 and R3 represents three successive coefficients and X, Y two possible bits of the private message to efficiently be hidden.

Table 1- Substitutions rules for the proposed insertion scheme

Condition	Action
X= (R1 – R2) % 2 Y= (R1 – R3) % 2	No change required
X≠ (R1 – R2) % 2 Y= (R1 – R3) % 2	Change R2 component
X= (R1 – R2) % 2 Y≠ (R1 – R3) % 2	Change R3 component
X≠ (R1 – R2) % 2 Y≠ (R1 – R3) % 2	Change R1 component

3. Experiments and results

In this section, the proposed watermarking techniques are tested on a large database of heartbeat sounds file [13]. The data were gathered from two sources: 176 patient files from the general public via the iStethoscope Pro iPhone app and 176 patient files from a clinic trial in local hospitals properly using the digital stethoscope DigiScope. To determine and verify the validity of the proposed methods, the signal-to-noise ratio can be measured. SNR [31] is a classical metric that accurately quantifies the amount of specific noise typically introduced into the audio signal during watermarking. A high SNR value is desirable and implies that the degree of distortion is low; SNR measurement is the most frequently used measuring method.In order to experiment our approaches in the frequency domain, a DCT was calculated for each file in our database (after block division), then a sequence of bits (representing the patient information and the acquisition data) was substituted for the least significant bits of the quantized DCT coefficients obtained for each file "Figure 1". The distortion measurements are calculated between the original files and watermarked file.

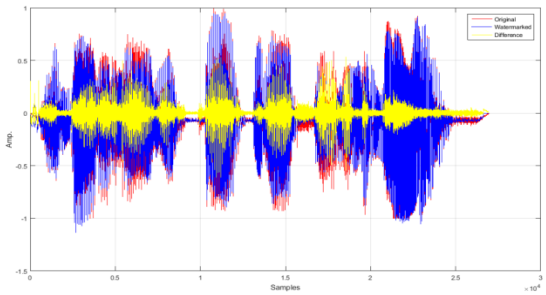

Figure 1 - Difference between the original and watermarked audio file

As we can see in Table 2, the number of values modified by a simple LSB substitution remains significantly higher than the number of values modified by our approaches. We logically obtain a higher SNR for our approaches. However, since we do not hide directly in the frame values and quantized DCT coefficients are manipulated, the dissimulation capacity of our approaches is much less than the dissimulation capacity offered by the LSB method.

Table 2 - Imperceptibility results

	2.000 bits	3.000 bits	4.000 bits	Average
Proposed	32,86	29,68	21,84	28,13
LSB	32,39	27,70	18,89	26,33

Table 3 shows that the SNR obtained by our proposed approach still satisfactory. The concealment process combines three information for a two-bit integration. Knowing that only one value can be changed. One of these three values is modifiable, which reduces the possibility of a possible shift, unlike some methods. This normally means a reduction of possible changes and therefore a distortion reduction of the source file, which correctly explains the good SNR rate achieved and therefore a good invisibility.

Table 3 – Imperceptibility results

Frequency domain	LSB1	Proposed
SNR	32,39	32,87

4. Conclusion

In this paper, we proposed a new method for heartbeat sound security; the remarkable fact of changing a minimum of data allowed us to efficiently reduce the foreseeable distortions. The proposed approach was used in the frequency domain, after calculating and quantifying the DCT; the LSB modification of the quantized coefficients was performed by comparing the parity between the consecutive elements, allowing the insertion of the watermark bits. The practical use of transforms typically makes the private message more robust to efficient compression, since it properly utilizes the similar space exploited for coding. In valuable addition, these elaborate

schemes can typically provide better robustness against filtering attacks, as the marked coefficients are equitably distributed throughout the audio file. The satisfactory results observed are satisfactory objectively compared to similar work where the SNR is greater than 33dB on average. However, based on very small audio files (with a reduced number of coefficients) and since our method uses only three complex elements to integrate two potential bits, the capacity of our techniques is considerably lower at the frequency level (about 4328 to 5770 bits per patient file).

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A comparative study of two meta-heuristic approaches for image registration of printed circuit boards

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Informations

Keywords :

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Printed Circuit Board
Sine cosine algorithm

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Abstract

Nowadays, printed circuit boards (PCBs) are so short and high density that diagnosing and detecting defects becomes an increasingly difficult task. In this paper, we suggest using two recent bio-inspired optimization methods called sine cosine algorithm (SCA) and Grey Wolf Optimizer (GWO) to find the optimal parameters for the rigid transformation of PCB images. The comparative performances of these methods have been studied and the best meta-heuristic optimization method is identified. Simulation results show that Grey Wolf Optimizer achieves extremely accurate and robust recording compared to SCA methods.

1. Introduction

Image registration is playing an increasingly important role in image processing and it has a variety of applications in the field of military automatic target recognition remote cartography, computer vision, image fusion, medical imaging **[1,2]**, and the printed circuit board (PCB) layout technology**[3]**. A printed circuit board (PCB) is the electrical connection provider of electronic components. The use of PCB can greatly reduce layout and assembly errors **[4]**. In the automatic PCB defect detection system, image registration of PCB plays an important role. The goal of PCB image registration refers to the process of overlaying two comparison images.

Image registration consists to compute a spatial transformation function between two images to be superimposed by maximizing their resemblance criteria. One of the two images is referred to as the reference image and the second image is referred to as the target input image **[5]**. Image registration techniques can be divided into intensity-based and feature-based. In the intensity-based methods, the intensity patterns in the two images are compared utilizing correlation metrics, while in the feature-based methods, the image features such as points, lines, and contours are used to find correspondence between them. The intensity-based method is more robust and easy to realize than feature-based methods. Meanwhile, the feature-based method is sensitive to the extracted features **[5]**.

Intensity-based image registration is based on the calculation of a spatial transformation function between two images to be superimposed on the optimum of their resemblance criteria. This can be described by three components: a transformation model, a similarity metric, and an optimization method **[4]**. The spatial transformation can be rigid, affine, perspective, and elastic. Similarity metrics can be based on intensity difference, cross-correlation and mutual information (MI). Mutual information is a robust measure used in image registration **[6]**. It evaluates the relative independence of two images and does not depend on the specific dynamic range or intensity scaling of the images. High values of mutual information indicate a high dependence between images **[5]**. Usually, optimization in image registration means to maximize similarity. Many meta-heuristic methods have been introduced and adopted for the registration process **[7]**, such as genetic algorithm **[7]**, differential evolution **[8]**, ant colony optimization **[9]**, simulated annealing **[7]**, Firefly algorithm **[10]**, particle swarm optimization (PSO) **[11,12]** , and Biogeography-Based Optimization Algorithm **[13,14]** have been applied to image registration.

In this paper, two recent bio-inspired optimization methods called sine cosine algorithm (SCA) **[15]** and Grey Wolf Optimizer

(GWO) **[16]** are used to compute the optimal geometric transformation that allows the target PCB image to overlay the reference PCB image. The sine cosine algorithm is a global optimization approach based on two trigonometric functions, the sine and the cosine functions. Grey Wolf Optimizer (GWO) is a new meta-heuristic algorithm proposed in 2014 **[16]**. This algorithm is inspired by the hunting process found in Grey Wolves.

The rest of this paper is organized as follows. In section 2, we will describe the proposed algorithm, including geometric transformation andsimilarity measure. The gray wolf and the sine cosine algorithms are discussed in section 3. Experimental results and comparative analysis are given in section 4. In section 5, some conclusions are presented.

2. Proposed algorithm to register PCB images

In this section, we describe the proposed algorithm to register PCB image pairs. The proposed image registration process can be described by three components: a transformation which relates the target and source images, a similarity measure which measures the similarity between target and source image, and an optimization algorithm which determines the optimal transformation parameters as a function of the similarity measure **[5]**. The flowchart of our method is given in Figure 1.

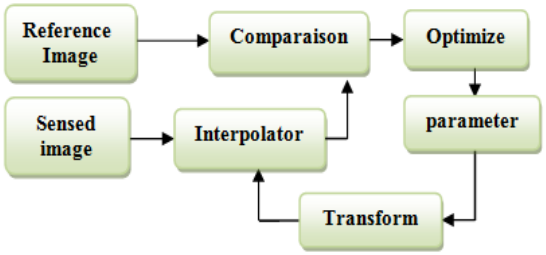


Fig.1: Block diagram of image registration process

2.1. *Transformation*

The transformation model determines which kind of geometrical transformation to be applied for the registration. In this paper, our study is limited to applying the rigid transformation, which contains a translation along x and $y$axes t_x, t_y, and rotation θ. This transformation is popular because in many common medical images the rigid body constraint leads to a good approximation. Furthermore, it has relatively few parameters to be determined and it can be defined as **[1]**:

$$M = \begin{bmatrix} \cos(\theta) & -\sin(\theta) & t_x \\ \sin(\theta) & \cos(\theta) & t_y \\ 0 & 0 & 1 \end{bmatrix} \quad (1)$$

2.2. *Similarity measure*

To evaluate the similarity between model image A and registered source image B, the normalized mutual information (NMI) is used [6] :

$$NMI(A,B) = \frac{H(A)+H(B)}{H(A,B)}. \quad (2)$$

where :

$$H(A) = -\sum_a P_A(a) log_2 P_A(a) \quad (3)$$

$$H(A,B) = -\sum_{a,b} P_{A,B}(a,b) log_2 P_{A,B}(a,b) \quad (4)$$

$P_A(a)$and$P_{A,B}(a,b)$ are the marginal probability distribution of A and the joint distribution of Aand B respectively.

2.3. *Objective function of image registration*

Image registration determines spatial transformation $\hat{T}$which maximizes the NMI of the reference I_r and floating I_f images. Previous description of image registration can be represented by the following equation **[2]**:

$$\hat{T} = \underset{T}{argmax}\, NMI[I_r(x,y), I_f(T(x,y))] \quad (5)$$

In this equation$(x,y)$is the coordinates of the image.

3. Optimization algorithms

3.1 *Sine Cosine algorithm*

The sine cosine algorithm proposed by Mirjalili**[15]**, is a population-based optimization technique. It begins by generating a set of random solution, and then, these solutions are updated based on the sine or cosine function as in equation (6).

$$X_i^{t+1} = \begin{cases} X_i^t + r_1 \; x \; sin\; (r_2) \; x \left| r_3 P_i^t - X_i^t \right|, & r_4 < 0.5 \\ X_i^t + r_1 \; x \; cos\; (r_2) \; x \left| r_3 P_i^t - X_i^t \right|, & r_4 \geq 0.5 \end{cases} \quad (6)$$

where$t$is the current iteration , $P_i^t$is the position of current solution at iteration t,$X_i^t$is the position of current solution , and r_2, $r_3$and$r_4$are random variables and are uniformly distributed between $0$and 2π, 0 and 2, and between 0 and 1 respectively. The variable$r_1$is updated as:

$$r_1 = a(1 - \frac{t}{T_{max}}) \quad (7)$$

where a is a constant, T_{max} and t respectively are the current and the maximum iterations. The sine cosine algorithm is summarized as follow **[15,17]**:

Algorithm 1: Sine Cosine Algorithm

1. ***Initialize*** *a set of random solutions* X.
2. ***Calculate*** *the objective function of each solution.*
3. ***Select*** *the best solution that optimizes the objective function.*
4. ***Initialize*** *the parameters* r_1, r_2, r_3 *and* r_4 .
5. ***Initialize*** *the generation count* $t = 0$.
6. ***While*** $t <$ maximum number of iteration T_{max}
7. ***For*** *each candidate solution*
8. ***Update*** *the solution using Eq. (6)*
9. ***Calculate*** *the objective function of updated solution.*
10. ***Update*** *the best solution.*
11. ***End for***
12. ***Update*** r_1, r_2, r_3 *and* r_4.
13. *t=t+1*
14. ***End while***
15. ***Return*** *the best solution obtained so far as the global optimum.*

3.2 *Grey wolf optimizer*

The gray wolf belongs to a Canadian family. This type of wolf is considered predatory so it is at the top of the food chain. Gray wolves prefer to live in groups of 5 to 15 on average. They follow a strict social dominant hierarchy. The gray wolves are divided into three groups α, β, δ, each with a specific role that is different. Alpha wolves represent the best solution inside the group of possible solutions. **[16,18]**.This process is represented from equations 8to 11.

$$\vec{X}(t+1) = \vec{X}_p(t) - \vec{A} \cdot \vec{D} \quad (8)$$

where $\vec{X}$ is the grey wolf position, t is the number of iteration, $\vec{X}_p$ is target position,and $\vec{D}$ isdistance vector calculated as :

$$\vec{D} = | \vec{C} \cdot \vec{X}_p - \vec{X}(t)| \quad (9)$$

where $\vec{A}$ and $\vec{C}$ are the coefficient vectors represented as Equations (10) and (11)respectively **[19]**.

$$\vec{A} = 2.k.\vec{p}_1 - k \quad (10)$$

$$\vec{C} = 2.\vec{p}_2 \quad (11)$$

where $k = 2 - t\left(\frac{t}{T_{max}}\right)$ is decreased from 2 to 0 linearly through the number of iterations, T_{max} is total number of iterations and $\vec{p}_1, \vec{p}_2$ are two random vectors between [0, 1]. The alpha is responsible for directed the fishing pattern of the wolves .Beta and Delta are also involved in fishing. Thus, the first three best solutions are chosen to be the hunting wolves, and their current positions can update all wolves' positions. The formulas in this regard are as follows:

$$\begin{cases} \vec{D}_\alpha = | \vec{C}_1 . \vec{X}_\alpha - \vec{X} | \\ \vec{D}_\beta = | \vec{C}_2 . \vec{X}_\beta - \vec{X} | \\ \vec{D}_\delta = | \vec{C}_3 . \vec{X}_\delta - \vec{X} | \end{cases} \quad (12)$$

where $\vec{X}_\alpha$, $\vec{X}_\beta$, $\vec{X}_\delta$ are the states of leaders alpha, beta and delta, respectively. $\vec{C}_1$, $\vec{C}_2$ and $\vec{C}_3$ are the random vector. After calculating the differencevectors $\vec{D}_\alpha$, $\vec{D}_\beta$, and $\vec{D}_\delta$ the updated states for (t + 1) the iteration can be calculated by:

$$\begin{cases} \vec{X}_1 = \vec{X}_\alpha - \vec{A}_1 \vec{D}_\alpha \\ \vec{X}_2 = \vec{X}_\beta - \vec{A}_2 \vec{D}_\beta \\ \vec{X}_3 = \vec{X}_\delta - \vec{A}_3 \vec{D}_\delta \end{cases} \quad (13)$$

$$\vec{X}(t+1) = \frac{\vec{X}_1 + \vec{X}_2 + \vec{X}_3}{3} \quad (14)$$

where $\vec{A}_1$, $\vec{A}_2$ and $\vec{A}_3$ are the random vectors.

The GWO algorithm is summarized as follow:

Algorithm 2: GWO algorithm

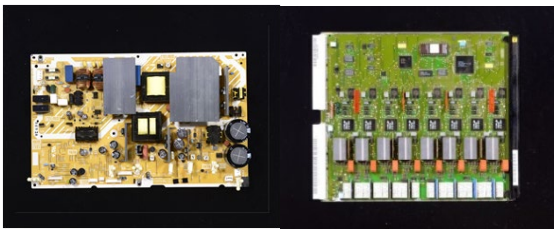
1. **Initialize** the randomly generated population of wolves
2. **Evaluate** the fitness of each wolf
3. **Select** the fittest wolf alpha and second and third best wolves beta and delta form the population of wolves
4. **Initialize** the algorithm parameters $\vec{A}$ and $\vec{C}$
5. **Initialize** the iteration count t=0
6. **While** t <T_{max}
7. **For** each wolf
8. **Update** the position using equations 8-11:
$\vec{X}(t+1) = \vec{X}_p(t) - \vec{A} \cdot \vec{D}$
$\vec{X}(t+1) = \frac{\vec{X}_1 + \vec{X}_2 + \vec{X}_3}{3}$
9. **End for**
10. **Evaluate** the fitness of wolves
11. **Update** the leaders alpha , beta and delta of the wolf pack
12. t=t+1
13. **End while**
14. **Return** the fittest wolf alpha

4. Simulation results

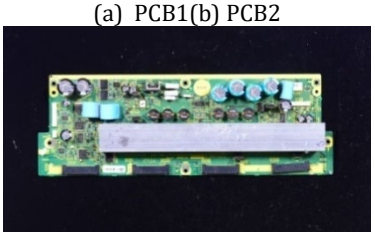
Several simulations were performed to compare the algorithm SCA and GWO, to show the most effective algorithm in optimization. The results were obtained using MATLAB 2019 on a computer with an Intel CORE i3 processor.

4.1. *Test Images*

The test images are obtained from the PCB DSLR dataset available in **[20]**.The dataset contains 748 images of PCBs from a recycling facility, captured under representative conditions using a professional DSLR camera. Figure 2 shows three samples from the used dataset.



(a) PCB1(b) PCB2



(c) PCB3

Fig.2 : Test images

4.2. *Evaluation criterion*

To assess the performance of the two methods GWO and SCA, the mean squared error (MSE), and structural similarity metric (SSIM) **[21]** are used as quantitative assessment metrics to compare various registration algorithms. They are defined as:

$$MSE = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}(I_g(i,j) - I_{s\_reg}(i,j))^2 \quad (15)$$

$I_g(i,j)$and$I_{s_reg}(i,j)$ are the pixel values of the ground truth image and the registered image, respectively. The image size is $M \times N$.

$$SSIM(I_g, I_{s\_reg}) = \frac{(2\mu_g\mu_{s\_reg} + (k_1L)^2)(2\sigma_{gs\_reg} + (k_2L)^2)}{(\mu_g^2 + \mu_{s\_reg}^2 + (k_1L)^2)(\sigma_g^2 + \sigma_{s\_reg}^2 + (k_2L)^2)} \quad (16)$$

Where $\mu_g, \mu_{s\_reg}, \sigma_g, \sigma_{s\_reg}$, are the local means, standard deviations, and cross-covariance for images I_g, I_{s_reg}. k_1 , $k_2$are parameters with small values and L is the maximum pixel value **[21]**. The higher SSIM value and the less MSE value indicate better registration results.

4.3. *Accuracy*

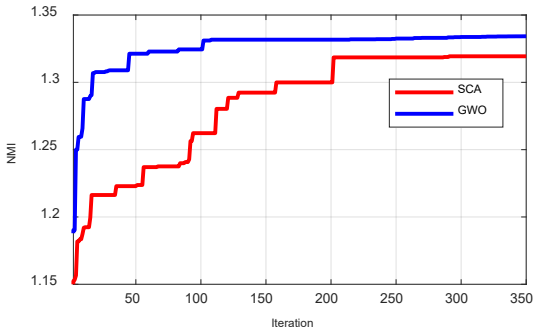
A test image and reference image will be converted into gray image first, and then the transformation matrix is calculated to transform the test image into the same orientation and position as the reference image. In the experiment, the floating (test) image is obtained by applying a translation$(t_x, t_y) = (-5, -5)$ and, a rotation of $\theta = 5°$to the ground truth image. Bio-inspired algorithms SCA and GWO have been used to register these three images with similar population size of 40. Both algorithms are sufficiently iterated to ensure the convergence. After some trials, the number of iterations was fixed to 350.

After applying the SCA and GWO algorithms, the results were recorded and compared to determine the best algorithm. From the results obtained after applying the two algorithms to the PCB images that appear in Table 1, we found that the GWA algorithm is more accurate compared to the SCA algorithm, we can show that the transformation parameters obtained by the GWO algorithm are more accurate than those obtained using the SCA. The SSIM and the NMI values for the GWO are higher. This proves that the two images are well aligned. Furthermore, the GWO algorithm is faster than the SC algorithm.

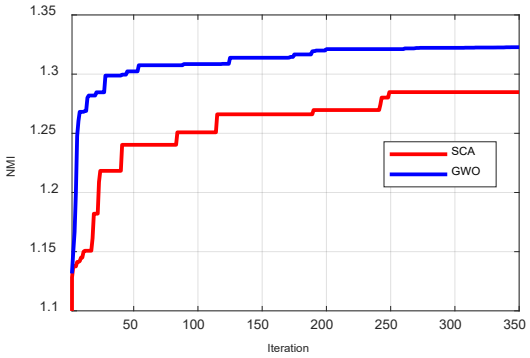
TABLE 1 : Registration results for SCA and GWO

	PCB 1		**PCB 2**		**PCB 3**	
	SCA	**GWO**	**SCA**	**GWO**	**SCA**	**GWO**
$-t_x$	5.771	**5.550**	**5.315**	5.506	**5.422**	5.549
$-t_y$	6.612	**6.626**	6.140	**6.620**	**6.726**	6.584
$-\theta$	5.048	**4.997**	5.091	**4.998**	5.054	**4.998**
SSIM	0.977	**0.980**	0.969	**0.970**	0.969	**0.973**
NMI	1.319	**1.334**	1.284	**1.322**	1.279	**1.292**
MSE x10^{-4}	72	**31**	**33**	40	91	**9**
Time	586.9	**540.6**	611.8	**587.4**	**596.**	597.9

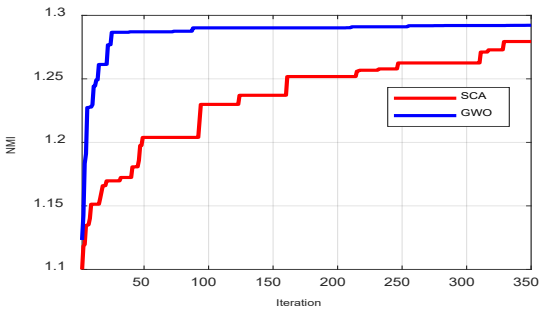
The convergence curves using the three images are shown in figure (3). As we can see, the GWO algorithm is faster and more accurate compared to the SCA algorithm.The Figures 4,5, and 6 show the visual results of the registration process using the SCA and the GWO algorithm. The absolute error image and the SSIM map justify the efficiency of the GWO algorithm.



(a) PCB 1

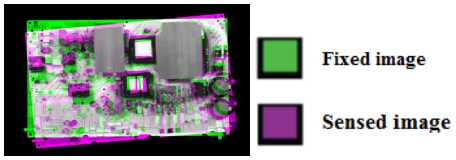


(b) PCB 2

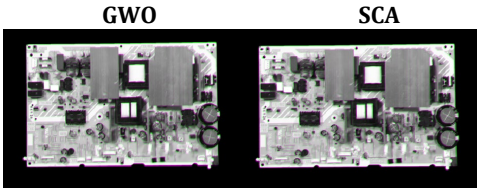


(c) PCB 3

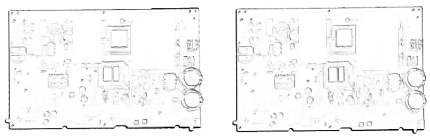
Fig.3 : Convergence curves for the SCA and GWO algorithms



Images before registration



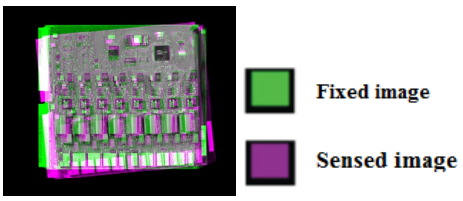
Registered image



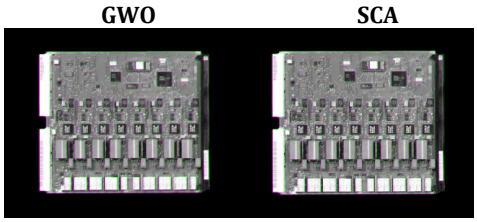
SSIM Map image

Absolute error

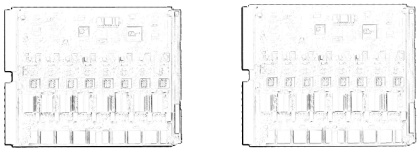
Fig.4 : Visual results for PCB1



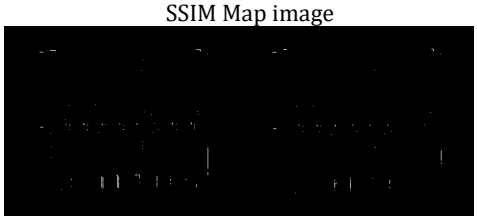
Images before registration



Registered image

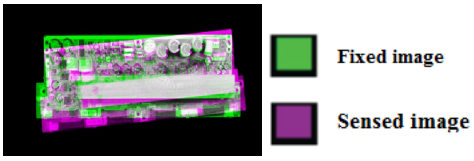


SSIM Map image

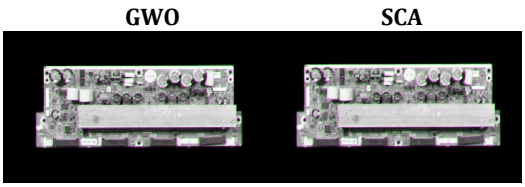


Absolute error

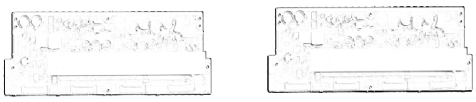
Fig.5 : Visual results for PCB 2



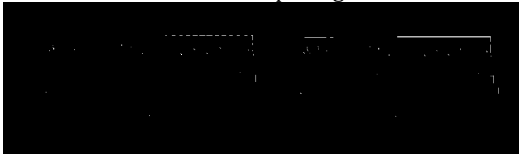
Images before registration



Registered image



SSIM Map image



Absolute error

Fig.6 : Visual results for PCB 3

5. Conclusion

Printed circuit board (PCB) is the fundamental carrier in electronic devices on which a great number of elements are placed. The quality of the PCB will directly impact the performance of electronic devices. So registration is indispensable in reference comparison based method. During the last decades, a large number of image registration methods have been described in the literature. Unfortunately, there is no one method that works very well for Printed circuit board images registration. To improve the performance of image registration, two new methods sine cosine and grey wolf optimizer algorithms based on normalized mutual information are proposed in this paper. From the obtained results we have found that the GWO algorithm is faster and more accurate compared to the SCA algorithm for PCB image registration.

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Multi-modal medical image fusion based in Multiscale Alternative approach to cross bilateral filter

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Informations

Keywords :

Image fusion, multi-scale image decomposition ・ ・ Visual saliency, cross bilateral filter, weight maps

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Abstract

Image fusion is a process of combining additional information from source images into a single image. We are interested in this paper in the medical field where image fusion is a great advance in medical imaging because it helps the doctor to make his diagnosis. The aim of this paper is to propose a multi-scale method based on the cross bilateral filter, visual salience detection, and weight map construction for image fusion. In the proposed image fusion approach, the cross bilateral filter is applied to one source image to obtain a base layer by considering another image for the guiding purpose. Whereas, the detail layers are computed by finding the difference between source image and the base layers and used for visual saliency extraction and weight maps construction . Later, base layers are averaged to get the final base layer. Finally, final base and detail layers are combined to obtain the fused image. The proposed method has been tested on a set of gray scale and color medical images. The results show that the proposed method can be competitive or even outperform the methods in comparison in terms of subjective and objective evaluations.

1. Introduction

Image fusion is an important branch of information science, [1]which has been widely used in many fields, such as bioinformatics, medical image processing, and military target visualization. Image fusion is the art of combining multiple images from different sensors to enhance the overall information content as compared to the limited data found in a single-sensor image[2]. The key problem of image fusion is how to extract salient features from the source images and how to combine them to generate the fused image.

In the field of medical imaging, [3]many imaging methods are used, among them, positron emission tomography (PET), single-photon emission tomography (SPECT), computer tomography (CT), and magnetic resonance imaging (MRI) are used to capture complementary information. The previously mentioned imaging methods differ according to the information they provide, for example, a CT scan provides information about the bone structure while an MRI provides information about soft tissues. Therefore, the combination of the two types of imaging methods provides more information regarding disease cases and increases the ability to diagnose.

Several Multiscale fusion algorithms have been proposed, included the Laplacian Pyramid[4], Wavelet transform[5], Curvelet transform [6], Contourlet Transform [7], Nonsubsampled Contourlet Transform[8]. Although these methods are widely used in integrating images in various applications, most of them fail to maintain a certain quality of the source images.

Bavirisetti et al. Proposed thecross bilateral filter (CBF) based algorithm that relies on analyzing, fusion, and then reconstructing images. This method is referred to as "Alternative approach to CBFF" or (ACBFF), more about this algorithm can be found in[2]. Despite the good results, it still needs to be developed in order to obtain a good fusion of images and to reduce the anomalies that hinder the diagnostic process in the medical field in particular.In this paper we present a new algorithm Multiscale Alternative approach to CBFF (MACBFF), In this algorithm the single-scale decomposition of user images in ACBFF has been replaced by multiscale image decomposition and an extension of this method is proposed for fusion of medical images in color.

This paper is structured as follows. In Section 2, we give a brief introduction to CGF for multi-scale decomposition. In Section 3, the proposed image fusion method is introduced in detail. The experimental results, visual and quantitative evaluation are presented in Section 4. Finally, Section 5 draws the conclusion.

2. Decomposition and reconstruction by the CBF

The multi-scale decomposition allows the representation of edge information at different resolutions. Simultaneous use of CBF can help transfer edge structures at different scales. The main requirement of a merge algorithm is to transfer information from one image to another. Therefore, multiscale CBF operating in structure transfer mode can support this at different resolutions, thus improving performance [9].

A. Cross bilateral filter

The cross bilateral filter (CBF) performs the smoothing by considering the statistical properties of the neighborhood of a pixel[10]. It calculates the output as a linear time invariant (LTI) filter. However, it uses another image for guidance purposes. This additional image can be the entry or its translated version. You can also choose a completely different image for this purpose. Like other edge-preserving filters, CBF can also preserve edge information during the decomposition process, which helps to avoid artifacts[10]. Besides the edge preservation property, CBF also has another property called structure transfer property. If the guide image is the same as the input, then an edge preserving smoothing will be performed, while the structural behavior remains the same. On the other hand, when the guide image differs from the input, the smoothing process is regulated by the guide image structures. So when we apply CBF on images, the edge structures can be transferred.

Suppose that A and B are two different images, $G_{\sigma s}(K-I)$ is the kernel space of A and $G_{\sigma_S}(B_K - B_I)$ is the kernel range calculated on the image B then the mathematical equation of the CBF is given by[9]:

$$A_{CBF}[B,A]_K = \frac{1}{W_K}\sum_{I\in S} G_{\sigma_S}(K-I)\,G_{\sigma_r}(B_K - B_I)\,A_I \qquad (1)$$

Where

$$W_K = \sum_{I\in S} G_{\sigma_S}(K-I)\,G_{\sigma_S}(B_K - B_I) \qquad (2)$$

$$G_\sigma(K-I) = \frac{1}{2\pi\sigma^2}\exp\left(\frac{K-I^2}{2\sigma^2}\right) \qquad (3)$$

G_{σ_S} is the Gaussian spatial kernel and G_{σ_r} is the Gaussian kernel of the scale. The parameters σ_s and σ_r are spatial and range parameters, which control the smoothing respectively.

The multiscale decomposition of theimage I can be performed using CBF. Suppose that b^{n-1}, G^{n-1} are the base layer and the guide images at level (n - 1), σ_s and σ_r are the spatial and range parameters and r is the filter window size, then the base layer b^n can be calculated by performing a CBF of the image b^{n-1} considering G^{n-1} as the guide image. The d^n detail images can be calculated by taking the difference between the previous base layer b^{n-1} and the current base layer b^n . These expressions are given by [*]:

$$b^n = CBF\left(b^{n-1}, G^{n-1}, \sigma_S, \sigma_r, r\right) \qquad (4)$$

$$d^n = b^{n-1} - b^n \qquad (5)$$

Where:

$$b^0 = I \qquad (6)$$

The input image I can be reconstructed from base layer b^n and detail layers détails d^k, $k = (1,\ldots,n)$ as follows [**]:

$$I = \sum_{k=1}^{n} d^k + b^n \qquad (7)$$

This multiscale decomposition and reconstruction process is illustrated by algorithm 1 and figure 1.

Algorithm 1: Decomposition and reconstruction of an image by the CBF.

Inputs: Image to filter I, guidance image G^0 , σ_s , σ_r , r and the number of levels n

Outputs: Reconstructed image I and base layers and details $(b^k,\ d^k)$

1. $b^0 = I$
2. For $k = 1, 2, 3, \ldots, n$ do

$$b^k = CBF\left(b^{k-1}, G^{k-1}, \sigma_s, \sigma_r, r\right)$$

$$d^k = b^{k-1} - b^k$$

End for

3. $I = \sum_{k=1}^{n} d^k + b^n$

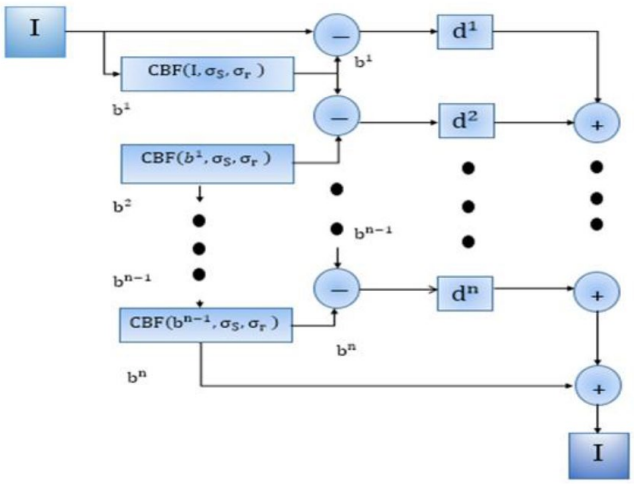


Fig. 1. Functional diagram of the multi-scale image decomposition and reconstruction of an I image by the CBF.

3. Proposed image fusion method

The proposed method MACBFF requires the following steps to perform the merge:

Multi-scale decomposition of source images using CBF.

- Generation of visual saliencies of each input image at different levels.

- Calculation of weight maps corresponding to detail layers.
- Combine detail layers using weight maps
- Generation of the final fused image.

B. Multi-scale image decomposition

Consider two source images I_1 and I_2 of the same size. These two images are decomposed by CBF to a base layer B containing large scale variations and detail layer D containing small scale variations as follows [3]:

$$B_1^k = \begin{cases} I_1 & si\ k = 0 \\ CBF\left(B_1^{k-1}, B_2^{k-1}, \sigma_S, \sigma_r, r\right) & si\ k = 1, \ldots, n \end{cases} \quad (8)$$

$$B_2^k = \begin{cases} I_2 & si\ k = 0 \\ CBF\left(B_2^{k-1}, B_1^{k-1}, \sigma_S, \sigma_r, r\right) & si\ k = 1, \ldots, n \end{cases} \quad (9)$$

Where B_1^k, B_2^k are base layers of two source images at k level which depend on their previous level base layers B_1^{k-1}, B_2^{k-1} respectively.The detail layers D_1^k, D_2^k are obtained by finding thedifference between the previous and current level base layers:

$$D_1^k = B_1^{k-1} - B_1^k,\ k = 1, \ldots, n \quad (10)$$

$$D_2^k = B_1^{k-1} - B_2^k, k = 1, \ldots, n \quad (11)$$

C. Generation of visual salience maps

Visually salience maps of source images are calculated by taking the absolute value of the detail layers D_1^k, D_2^k as follows:

$$S_1^k = \left|D_1^k\right| \quad (12)$$

$$S_2^k = \left|D_2^k\right| \quad (13)$$

D. Calculation of the weight map:

We need to integrate all the targeted regions into a single fused image. Weight maps representing complementary information based on salience information can automatically integrate detail layer. The weight maps W_1^k and W_2^k are calculated by normalizing the extracted saliency maps as follows:

$$W_1^k = \frac{S_1^k}{\sum_{i=1}^{2} S_i^K},\ k = 1, 2, \ldots, n \quad (14)$$

$$W_2^k = \frac{S_2^k}{\sum_{i=1}^{2} S_i^k},\ k = 1, 2, \ldots, n \quad (15)$$

E. Detail layer fusion

The detail layers are built into each k scale using the W_1^k and W_2^k weight maps using a linear combination:

$$D_F^k = W_1^k D_1^k + W_2^k D_2^k \quad (16)$$

The final detail layer D_F is obtained by combining fused detail layers obtained at each scale. This fused detail image D_F provides most of the visual information of the fused image:

$$D_F = \sum_{k=1}^{n} D_F^k \quad (17)$$

F. Base layer Fusion

The final base layer B_F is generated by taking the average of the base layers at the final scale n as:

$$B_F = \frac{1}{2}\left(B_1^n + B_2^n\right) \quad (18)$$

G. Reconstruction of the fused image

The fused image is obtained by combining the base layer $B_F$and the detail layer D_F :

$$F = B_F + D_F \quad (19)$$

Figure II.2 presents and summarizes the functional diagram of the MACBFF method and Algorithm II.3 summarizes the necessary steps of image fusion by the MACBFF method.

Algorithm 2 Image fusion using the MACBFF method

Inputs:source images I_1 & I_2 , σ_S, σ_r, r and n

Outputs: Fused image F

1. $B_1^0 = I_1, B_2^0 = I_2$

2. **For** $k = 1, 2, 3, \ldots, n$ **do**

$B_1^k = CBF\left(B_1^{k-1}, B_2^{k-1}, \sigma_S, \sigma_r, r\right)$

$B_2^k = CBF\left(B_2^{k-1}, B_1^{k-1}, \sigma_S, \sigma_r, r\right)$

$D_1^k = B_1^{k-1} - B_1^k$

$D_2^k = B_1^{k-1} - B_2^k$

$S_1^k = \left|D_1^k\right|$

$S_2^k = \left|D_2^k\right|$

$W_1^k = \frac{S_1^k}{\sum_{i=1}^{2} S_i^k}$

$W_2^k = \frac{S_2^k}{\sum_{i=1}^{2} S_i^k}$

$D_F^k = W_1^k D_1^k + W_2^k D_2^k$

End for

3. $D_F = \sum_{k=1}^{n} D_F^k$

4. $B_F = \frac{1}{2}\left(B_1^n + B_2^n\right)$

5. $F = B_F + D_F$

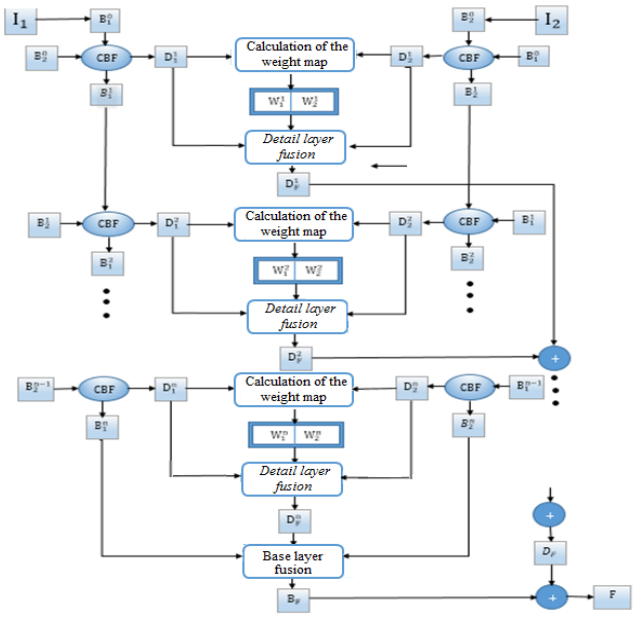


Fig. 2. . Functional diagram of the ACBFF method.

H. Extension of the CBFF method to color medical images

For medical images, there are two types of images; MRI and CT images are grayscale images while PET and SPECT images are color images. The principle of the proposed MACBFF is presented in figure 3,and have the following steps:

- Convert the three bands of the RGB space of the medical image to the YUV space.

Where Y is the luminance, U and V are the blue and red complements.

- Apply the CBFF method between the Y intensity component of the color medical image (PET or SPECT) and the intensity of the grayscale image (MRI or CT) to obtain the fused Y intensity component.
- Switching from YUV color space to RGB color space to obtain a color fused image.

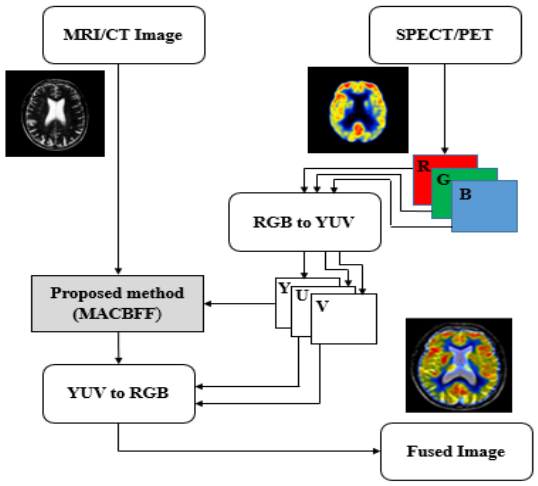
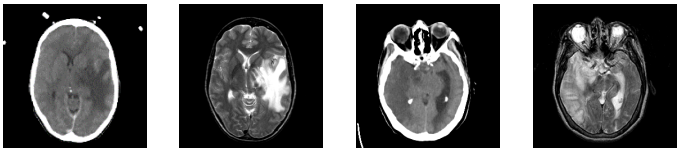


Fig. 3. Methodology used to fuse MRI/CT and SPECT/PET medical images.

4. Experiments and analysis

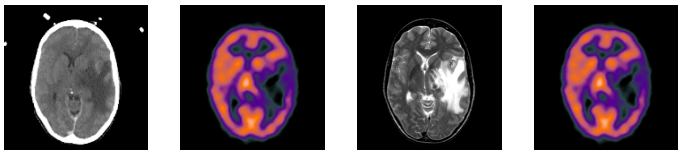
I. Image Resources

We have chosen two pairs of medical images in gray level (CT / MRI) which are represented in (figure 4.) , and three pairs of medical images in color / gray level (CT/SPECT), (MRI/SPECT and (MRI/PET) which are shown in (Figure 4) , and which are available at the web http://www.med.harvard.edu/AANLIB/home.html [10]



(a) CT/ MRI-1 Image pair (b) CT/MRI-2 Image pair

Fig. 4. Image pairs used for the MACBFF in in gray level.



(a) CT/ SPECT Image pair (b) MRI/ SPECT Image pair

(c) MRI/ PET Image pair

Fig. 5. Image pairs used for the MACBFF in in gray/ color level.

J. Objective performance evaluation

To evaluate the performance of the proposed fusion method, several objective criteria are used:

- Average Pixel Intensity (API) measures an index of contrast.
- Standard Deviation (SD) is the square root of the variance, which reflects the spread in data.

- Entropy (E) estimates the amount of information present in the image.
- Mutual Information (MI) quantifies the overall mutual information between source images and fused image.
- Information Symmetry or Fusion Symmetry (FS) indicates how much symmetric the fused image is with respect to source images.
- Correlation Coefficient (CC) measures a relevance of fused image to source images.
- Total fusion performance $Q^{AB/F}$ measures the quantity of edge information that is transferred to the fused image from source images
- Fusion loss $L^{AB/F}$ allows for assessment of the information lost during the fusion process.
- Fusion artifacts $N^{AB/F}$ allows assessing the artifacts introduced into the fused image.

Higher values of $Q^{AB/F}$, API, SD, H, MI, FS, and CC indicate a better fusion quality of the fused image , and when the values of $L^{AB/F}$ and $N^{AB/F}$ are small, the fusion performance is better.

K. Quantitative analysis

In this study, we will combine five pairs of medical images of a human brain, these images were obtained from different imaging methods, as shown in Figures 4 and 5. Image pairs are (CT/ MRI_1) and CT/ MRI_2), (CT/ SPECT), (MRI/ SPECT), and (MRI/ PET), respectively. The results obtained are analyzed with the nine validation parameters, and quantitative analysis of various image pairs used are shown in Tables 1, 2, 3, 4 and 5. Where the best values are highlighted in bold.

Table 1 Quantitative analysis of various fusion algorithms for CT/MRI-1 image pair.

Method	MACBFF	TIF	ACBFF
API	**60.246**	56.342	51.054
SD	**77.324**	73.504	66.290
E	**4.369**	4.262	4.341
MI	**3.199**	2.941	2.996
FS	**1.999**	1.979	1.952
CC	0.971	0.965	**0.971**
$Q^{AB/F}$	0.784	0.764	**0.814**
$L^{AB/F}$	0.208	0.223	**0.170**
$N^{AB/F}$	**0.006**	0.011	0.015

Table 2 Quantitative analysis of various fusion algorithms for CT/ MRI-2 image pair.

Method	MACBFF	TIF	ACBFF
API	**45.094**	44.726	44.93
SD	**56.130**	55.732	54.929
E	5.091	5.191	**5.352**
MI	3.503	3.544	**4.377**
FS	**1.962**	1.961	1.89
CC	**0.982**	0.981	0.98
$Q^{AB/F}$	**0.806**	0.791	0.802
$L^{AB/F}$	**0.171**	**0**.176	0.183
$N^{AB/F}$	0.022	0.031	**0.014**

Table 4 Quantitative analysis of various fusion algorithms for CT/ SPECT image pair.

Method	MACBFF	TIF	ACBFF
API	**53.386**	51.525	52.335
SD	**70.6**	70	70.45
E	4.094	**4.212**	4.198
MI	**3.907**	3.141	3.259
FS	**1.993**	1.992	1.941
CC	**0.996**	0.978	0.993
$Q^{AB/F}$	0.874	0.879	**0.901**
$L^{AB/F}$	0.120	0.106	**0.083**
$N^{AB/F}$	**0.005**	0.014	0.015

Table 4 Quantitative analysis ofvarious fusion algorithms for MRI/ SPECT image pair.

Method	MACBFF	TIF	ACBFF
API	**46.322**	40.774	41.192
SD	**64.902**	57.102	58.886
E	4.27	4.2	**4.29**
MI	**3.718**	2.674	3.265
FS	**1.986**	1.971	1.878
CC	**0.986**	0.974	0.983
$Q^{AB/F}$	0.793	0.793	**0.862**
$L^{AB/F}$	0.199	0.185	**0.118**
$N^{AB/F}$	**0.007**	0.021	0.018

Table 5 Quantitative analysis of various fusion algorithms for MRI/ PET image pair.

Method	MACBFF	TIF	ACBFF
API	**55.666**	45.23	38.39
SD	**79.22**	67.4	63.121
E	4.364	4.325	**4.547**
MI	3.466	2.887	**3.839**
FS	1.958	**1.99**	1.834
CC	**0.842**	0.836	0.837
$Q^{AB/F}$	0.703	0.711	**0.841**
$L^{AB/F}$	0.282	0.263	**0.142**
$N^{AB/F}$	**0.013**	0.025	0.016

Through the obtained results, the proposed algorithm showed a good ability to achieve fusion of medical images with high accuracy compared to other methods. Tables 3, 2,1, and 4 of the 2 and 3 pairs respectively show that MACBFF gives good results in most validation parameters, while Table 1 shows an equivalent performance between the proposed method and the other methods.

L. Qualitative analysis

Consider the pairs of medical images taken from the different imaging methods (CT, MRI, PET, SPECT) as

shown in Fig 4 and 5.As explained in Section 1, each imaging method can show some information about the disease to be diagnosed, but it does not show some information that could be in the other imaging method, as is the case with CT and MRI. Therefore, it is necessary to combine two images from two different imaging methods into one image using the fusion process in order to properly diagnose and treat the disease.

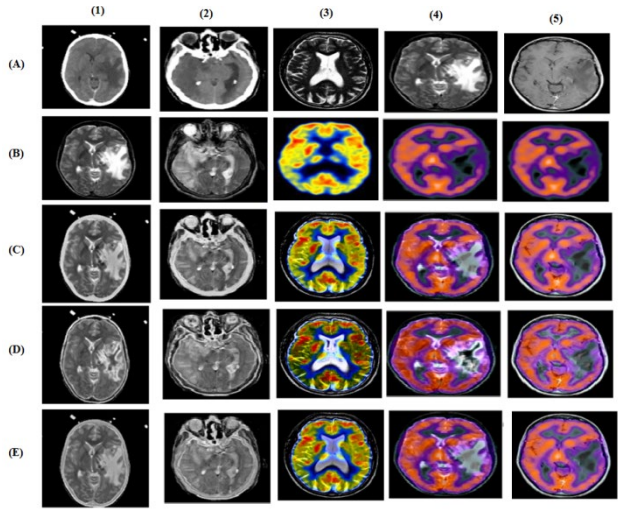


Fig. 6. Multimodal fusion results of medical images (a) Source image 1 (B) Source image 2, fused images obtained by the (C) TIF (D) ACBFF (E) Proposed method MACBFF.

Visual quality analysis of different fusion methods for images are presented in Figure 3. Figure 6a and b show the source images for the different imaging methods that have been combined, while Fig. 6C, D, and E show the visual results of the recording process using the TIF, ACBFF, and MACBFF methods, respectively. From the visual results, it appears that the proposed method gives a picture free of distortions and is clearer for the diagnosis of the disease compared to the TIF and ACBFF methods, which show some distortions in the fused image.

5. Conclusion

A new image fusion algorithm has been proposed by adopting multi-scale decomposition of source images using CBF, As this method was devised from a method "Alternative approach to CBFF" or ACBFF. To confirm the superiority of the proposed algorithm, it was applied to five pairs of different medical images, and based in nine evaluation metrics. Results reveal that proposed method is well suited for medical image processing. Our method showed promising results compared to the other two fusion methods.

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A survey of recommendation systems for companies

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Informations

Key Words :

Recommendation system,
Content based filtering,
Collaborative filtering, ,
Hybrid filtering
E-marketing.

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Abstract

Recommendation systems have became very popular in e-marketing. many of companies are using recommender systems to maximize their gain . Recommender systems have formulated in parallel with the web. Initially Recommender systems were based on demographic, content-based filtering and collaborative filtering. This is a survey paper on recommendationsystems and details the various techniques, challenges and benifits of RSs and lists some research papers aboutrecommendation systems for e-marketing.

1. Introduction

Recommender systems have become an important research area in recent years. When people purchase products, they have to make decisions which items to buy. They also have to decide which book to read in open access portal or which film to watch in multimedia store or witch product to buy in digital markets. Their choice often depends on the other users' opinion, especially in the e–commerce. So in general this is the idea of recommendationsystem it helps users to find content by aggregating and analyzing suggestions from other users, which mean reviews from various authorities, and users **[1].**

These systems use three major ways to recommend the right products to purchase for each user. Recommender systems are classified into collaborative filtering content-based , and hybrid filtering **[2].**The most latest research now use hybrid aproaches that combine both of colaborative and contenet-based methods.
Digital marketing is one of the most important reseach filed in RSs.where the last one use a logic like: customers with similar purchase and browsing histories will purchase similar products in the future. To make such a system work, you either need a large number of historical transactions or detailed data on your user's behavior on other websites**[3].**

In this paper, we organized our reseach as follows:

(1) The Domains where the recommendation systems are used the most
(2) In the second section we mentioned the major challenges and benifits of recommendation systems
(3) The known recommendation systems techniques as the collaborative filtering, contenets –based and hybrid filtering.
(4) Criteria for classification of research papers on recommender systems in E-business are presented.
(5) Conclusions are presented, and the future works are discussed.

2. Applicable Areas

Recommendation systems are important to araise gain for any business and we can see that in **[4]**:

- **E-Commerce** : it is where the recommendation systems are used the most, it generate recommendations to users witch means more data of their behavior and that whats we can find in e-commerce.

- **Media**: Similar to e-commerce, media businesses are the first to jump into recommendations. It is difficult to see a news site without a recommendation system.
- **Banking**: A mass market product that is consumed digitally by millions. Banking for masses and SMEs are prime for recommendations. Knowing a customer's detailed financial situation, along with their past preferences, coupled by data of thousands of similar users is quite powerful.
- **Telecom**: Shares similar dynamics with banking. Telcos have access to millions of customers whose every interaction is recorded. Their product range is also rather limited compared to other industries, making recommendations in telecom an easier problem.
- **Utilities**: Similar dynamics with telecom but utilities have an even narrower range of products, making recommendations rather simple.

3. Advantages of Recommendation Systems

- **Increased sales** : There are very few ways to achieve increased sales without increased marketing effort. Once you setup an automated recommendation system, you get recurring additional sales without any effort **[5].**
- **Increased user satisfaction**: Shortest path to a sale is great both for you and your customer reducing their effort. Recommendation systems allow you to reduce your customers' path to a sale by recommending them an appropriate option sometimes even before they search for it **[5].**
- **Increased loyalty and share of mind**: By getting customers to spend more on your website, you can increase their familiarity with your brand and user interface, increasing their probability to make future purchases from you**[5]**.
- **Reduced churn**: Recommendation system powered emails are one of the best ways to re-engage customers. Discounts or coupons are other effective yet costly ways of re-engaging customers and they can be coupled with recommendations to increase customer's probability of conversion **[5].**

3. Challenges in Recommendation Systems

- **Data sparsity** : the recommender system increase very rapidely and produce large and very sparse datasets and because of that the recommendation performance can degrade **[6].**
- **Scalability** : Traditional algorithms of RSs will suffers from scalability problems as the numbers of users and items increases. When it must respond with high performance **[1].**
- **Cold Start problem** : this problem showed up when a new user enter to the site or a new item has added to the system, this item cannot be in a list of recommendations unless it is rated by a substantial number of users **[6].**
- **Security** : is one of major issue of recommender system .as we know the system recommend list of items so we need to know certain infromatios about this list of data and the user s should know what information are recommended for them. This is one of major challenge faced by the developer of recommender system **[7].**
- **Vulnerability to attacks** : this problem occurs if a malicious user or competitor enters into a system and begins giving false ratings on some items either to increase the item popularity or to reduce its popularity **[6].**

5. Categories of Recommender system

The recommendation system collect information about useres using several methods in order to pridict and give them suggestions based on their preferences. Recommendation system suggest tousers a list of items after analysing their previous actions, preferences and even other's suggestions.

There are several thechniques of recommendation systems and they are classified as followed : collaborative filtering, content–based filtering, and hybrid methods. These three techniques are the most used and significant recommendation methods **[2].**

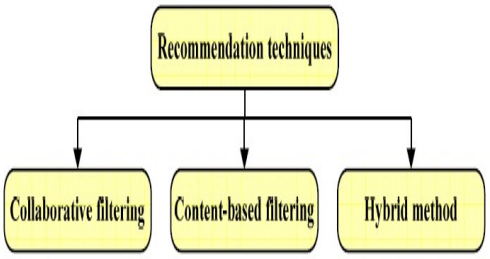

Fig. 1 : An example of Recommender Systems

5.1 Collaborative Filtering :

Collaborative filtering is known as the most used recommendation technique. Many companies like amazon and netflix use this method. CF work by collecting and examing a large amount of data about users activities or preferences and anticipanting taste for each particular user then calulating the similarity with other users **[8]**.

CF give recommendations that will be liked by the current user based on a list of items of users who may have similar profiles and preferences.

Advantages

- Although it is the oldest technique of recommendation systems but it still effective and the most successful
- This method does not require providing the representation of the object that can be easily read by the computers.

Disadvantages

- Problems with new users (cold start), and new products (the early–rated problem)

5.2 Content Based Filtering

The content–based filtering (CBF) recommend items to activate user based on description of items and content that they liked in the past. For example , if a user buy a mobile , computer and a CD, theCBF will recommend electronics product . A user profile is made by analysing the content of items that the user was interested by in the past **[9].**

Advantages

- Only the analysis of the items that one independent user has seen or bought must be done. In contrary to CF, this technique is not so complex

Disadvantages

- It is a difficult task to generate the attributes for items in certain areas.
- CBF advocate the same types of items because of that it suffers from an overspecialization problem.
- It is harder to acquire feedback from users in CBF because users do not typically rank the items (as in CF) and therefore, it is not possible to determine whether the recommendation is correct.

5.3 Hybrid Method

The hybrid aproach cobines many other methods some of them are mentionnned above. The main goal of this method is to take advantages of each method in order to minimize the disavantages of them. There are many different ways to combine the content–based and collaborative filtering. The best known are **[10]** :

- Implement both methods separately and combine the outputs of these methods
- Add some of the content–based characteristics to the collaborative filtering
- Add some of the collaborative characteristics to the content–based filtering
- Develop one model that applies both content–based and collaborative characteristics These two approaches complement each other and contribute to the other's effectiveness.

6. Recommender System for Companies

Recommendation systems have gained importance in recent years. The RSs are able topredict witch items the users will purchases and it became very popular in business .

6.1 Literature review

In this section we will discuss research papers studying recommendation system in E-Marketing.

Liu Yan propose in his paper **[11]** a personalized recommendation method for e-commerce using collaborative filtering the experimental results

achieve higher accuracy and provide more suitable products for e-commerce users .

In this paper **[12]** Przemyslaw Kazienko and Pawel Kolodziejski impliments a system named WindOwls. The results shows a full personalization that provides users with a dynamic list of products most likely to be interesting the results was more interestih using associationsrules then other methods.
Badrul Sarwar, George Karypis, and al **[13]**.This groupe presented an experimental using colaborative filtering techniques to solve the scalability in large e-commerce Data and also to improve the quality of the recommendations.
Hyunwoo Hwangbo, Yang Sok Kim and al **[14]** propose a new method of recommending products to customers by extending the existing colaborative filtering the new one decreases the intensity of preference. The proposed system generates better performances then the typical CF.

In this paper **[15]** the main contributions was to maximize Customers satisfactions using The content-based filtering and associative classification. The model predict the appeal of the specific products to the costumer witch means the personalization of services.

In this paper, Li Niu, Xiao-We Yan, and al **[16]** define business data and customer profile based on product hierarchy for E-commerce recommendation propose an incremental approach to construct customer preference profiles using a mining techniques. The study shows a very remarquable results in term of personalization.

In this paper**[17]**a new algorithm presented and experimentally evaluated concerning the collaborative filtering based on item and user. Theresults showed that the algorithm hold the promise of allowing CF-based algorithms to be adaptive todata sets in which users have many different interests or items have completely content.
In this paper**[18]**Yukun Cao, Yunfeng Li create a personalized recommendation system for the consumer electronic products .The system construct an optimal recommendations based on the costumers preferences-list the evaluation have shown very promise results.

This work proposed by Duen-Ren Liu, Ya-Yueh Shih **[19]**. They Introdcue to us an hybrid aproach using colaborative filtering an d KNN-based to gather customers in groups then extcat ruled from each group.The experimental results has impove the quality of recommendations

Yung-Ming Li, Chun-Te Wu, and al **[20]**. they propose a social recommender system that incorporates the preference similarity, recommendation trust, and social relation analyses in order to offer product recommendations in e-commerce. The experimental results improve the service quality and enhance customer relationships.

In Tables 1 we discuss papers, author names and Techniques they used to overcome recommender systems challenges and the advantages of every paper :

Table 1. Comparison between papers techniques and advantages

No	Authors	Techniques	Advantages
01	Liu Yan	Collaborative filtering	Higher accuracy and provide moresuitable products for e-commerce users.
02	Przemyslaw Kazienko and Pawel Kolodziejski	They use collaborative filtering and association rules	Offer to users dynamic list of products most likely to be interesting
03	Badrul Sarwar, George Karypis, *and al*	Collaborative filtering	Solve any scalability and increase th quality of recommendations
04	Hyunwoo Hwangbo, Yang Sok Kim *and al*	extending the existing collaborative filtering	Higher performance than the typical CF
05	Yuanchun Jiang ,Jennifer Shang, *and al*	The content-based filtering and associative classification	maximize customers satisfactions

06	Li Niu, Xiao-We Yan,*and al*	Mining techniques	Personalization of recommendation
07	Yu Li,Liu Lu, *and al*	collaborative filtering	Personalization of recommendation
08	Yukun Cao ,Yunfeng Li	Fuzzy-based recommendation techniques	Optimization of the preferences-list
09	Duen-Ren Liu ,Ya-Yueh Shih	Collaborative filtering and KNN-based	Improve the quality of recommendations
10	Yung-Ming Li, Chun-Te Wu, *and al*	Hybrid filtering	Improve the quality and accuracy of recommender systems.

7. CONCLUSION AND FUTURE WORK

Recommendation system is a powerfull technology for extracting interest of users. In this paper we dicussed the have three major techniques of RSs (collaborative, content-based, and hybrid). Further we discuss the various challenges and benifits of recommendation systems . We also discussed literature review and solutions they used for e-commerce.

With the appearance of more recommender systems in e-commerce companies, we think in the future to impliment a system that can helps companies to maximize their gain by providing better recommendations .

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An overview of machine learning and deep learning

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Informations

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Abstract

Artificial Intelligence, machine learning, and deep learning have now become commonplace in our daily lives. However, the words are sometimes used interchangeably. In this paper, we learn how to tell them apart. We will explain the field of machine learning and its concepts. Furthermore, the field of deep learning known as automatic learning is extremely important. Finally, we will present the main differences between them.

1. Introduction

How to organize to make decisions, that is, to process information, is the main problem in organizational structure study in any system. If the problem of organizational structure is the effective and efficient processing of information, then it is worth exploring the role of technology to enable automatic information processing such as using machine learning(ML) and deep learning (DL) in the current time [1]. Decision-making is the method of choosing an element from the available ones based on single or multiple criteria. Therefore, ML or DL is,increasingly,used for making the decision and development of forecasting systems. In this paper, we provide a brief overview of ML and DL by explaining the main difference among them.
In the next section, we present an overview of Artificial Intelligent with its sub-fields Machine learning & Deep learning. Then, section 3 gives a comparison between conventional Machine Learning and Deep Learning. Finally, section 4 concludes the paper.

2. Artificial Intelligence (AI)

AIhas been a topic of extreme world attention in recent years. It is a general field covering machine learning and deep learning. These latter are the subfields of AI as shown in Fig.1.AI could be defined as a system capable of interacting with its environment.

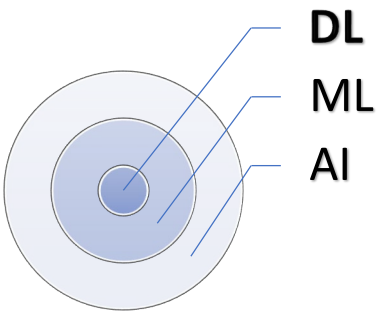

Fig.1: Relationship between AI, ML, and DL

2.1. Machine Learning

Machine learning is a tool used in the processing of large-scale data. Complex datasets with huge numbers of variables and features are well suited for this. These very large datasets use machine-learning techniques to make sense. We can say that machine learning is the brain of an AI system.
Machine learning can quickly and automatically produce models that can analyze larger, more complex data.It delivers faster, more accurate results on a very large scale. In addition,it enables the construction of accurate models [2]. It has recently emerged as a revolutionary technology to balance the difficulty of computation and the performance gap to solve NP-hard issues.

A- Different machine learning algorithms

Machine learning techniques (algorithms) can be divided into three major classes[1]:

- Supervised learning: Supervised learning algorithms are applied to learn to map between inputs and output, typically referred to like features (X) and targets (Y).

We distinguish two tasks in this class: Classification and regression

- Unsupervised learning: unsupervised learning algorithms learn patterns within the feature inputs (X) in the absence of a particular target variable. It has two tasks dimensionality reduction and clustering.
- Reinforcement learning: Their algorithms rely on determining actions that enable it to attain its goals, by interacting with the environment.

ML algorithms are the best choice when we have several criteria in one task. As shown in Fig. 2, there are many used algorithms in ML such asclassification, Support Vector Machine (SVM), Decision Tree, Logistic Regression, Naïve Bayes, Neural network, and K-nearest Neighbor (KNN) [3].

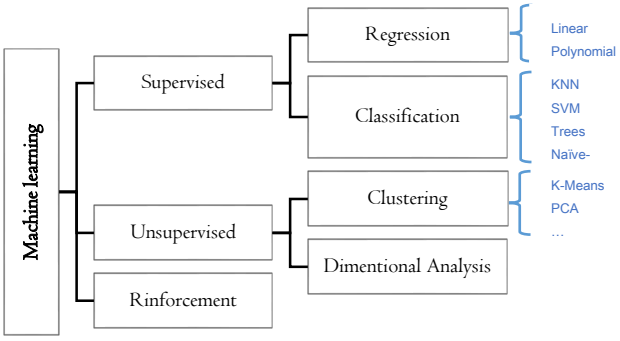

Fig.2: Machine Learning algorithms

B- Special concepts used in ML

Before discussing ML and DL architectures, we first describe the basics of some keywords, which are the foundation for such algorithms.

a) Neural network

We describe the fundamentals of **neural networks** on which such algorithms are conceptually based. As mentioned in[4],a neural network can be described as a mathematical model for information processing. Learning in a neural network means finding a set of values for the weights of all layers in a network. As shown in Fig.3, to compute the weighted sum of the input features, a neuron uses input features x_1 ; x_2 ; . . .; $x_n$and weight parameters w_0 ; w_1 ; . . .; w_n. The most well-known and very simple architecture to understand neural networkis the feed-forward multilayer network with an input layer, one or many hidden layers, and a single output layer. It can represent any function, and, generally, trained by a learning algorithm called backpropagation learning. This latter is used to reduce error in a neural network, we change the weights progressively as our algorithm finds the best solution.

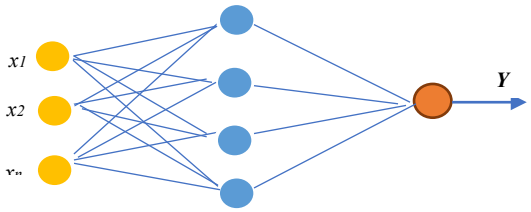

Fig. 3: Single hiddenlayer Neural network.

b) Perceptron

Perceptron is the linear model used for binary classification with simple input-output. An artificial neural is the perceptron in the field of neural network.

- *The single-layer Perceptron*

As the name implies, a single-layer artificial neural network, also known as a single-layer, has a single layer of nodes. Each node in the single layer corresponds to an output variable and is directly connected to an input variable.

- *The multilayer perceptron (MLP)*

A node, also known as a neuron or perceptron, is a computational unit that consists of one or more weighted input connections, a transfer function that incorporates the inputs, and an output connection. After that, nodes are organized into layers to form a network. The layers in a MLP can be summarized as follows[4]:

- Input Layer: Input variables, also known as the visible layer.
- Hidden Layers: Node layers that exist between the input and output layers. One or more of these layers can exist.
- Output Layer: A layer of nodes responsible for producing output variables.

In addition, we have someterms, which are used to define the shape and capabilities of a neural network, among which we can cite:

- Size: The number of nodes in the model. The number of nodes in each layer is defined as an integer, from the input layer to the output layer.
- Width: The number of nodes in a given layer.
- Depth: The number of layers in a neural network is defined as its depth.
- Capacity: The form or arrangement of functions that can be learned by a network configuration. Often referred to as "representative capacity."
- Architecture: The basic structure of the network's layers and nodes.

c) Regularization

Regularization is used when a network is overfitting.

d) Generalization

Generalization refers to the capacity to perform well on previously unobserved inputs.

e) Underfitting and overfitting

Underfitting happens when the model is unable to achieve a low enough error value on the training set. When the difference between the training and test errors is too high, overfitting occurs.

f) Transfer Learning (TL)

TL is a technique for improving a learner from one domain by transferring information from a related domain [5]. Moreover,Transfer learning attempts to transfer algorithmic operations to related tasks from a focal task. Since the algorithm does not require transfer learning with pre-trained models to learn model parameters from scratch, fine-tuning of models is not only easier but also helps avoid overfitting when small datasets are available.When target training data are scarce, transfer learning becomes essential. This may be due to the data being scarce, costly to obtain, or unavailable. Thus, in such cases, it would be beneficial if classification information of another domain could be transferred tothe desired domain.

Conventional machine learning techniques attempt to learn each task from the scratch, while transfer learning techniques attempt to transfer knowledge from previous tasks to a new task if the target has less high-quality target data[6]. This is the main difference between conventional machine learning and transfer learning as we can show in Fig.4.

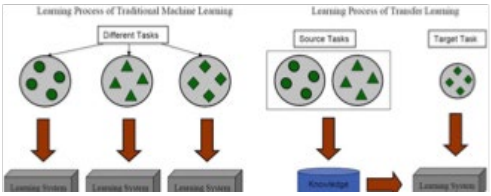

Fig.4: The learning processes between conventional machine learning and transfer learning [6]

d) Multi-task learning

The multi-task learning framework is a closely related learning strategy for transferring learning. Learning several tasks at the same time allows for the transfer of knowledge between similar tasks and increased efficiency as opposed to learning each task separately[7]. Multi-task learning seeks to increase learning efficiency and prediction accuracy by learning multiple goals from a shared representation[8]. Additionally, Multi-task learning has been used successfully across all applications of machine learning and deep learning. Multi-task learning with multiple regression and classification goals benefits multiple deep learning applications [9].

In a distributed computing environment, to make learning multiple tasks with unknown task relationships possible [10],we first derive a general dual form for a family of regularized multitask relationship learning methods.

In [11], the author partitioned the MTL architectures into four groups: architectures for a particular task domain, multi-modal architectures, learned architectures, and conditional architectures

Table 1: Architectures of MTL

Architectures	Explanation
Architectures for a particular task domain	This group of architecture is used in particular domains such as: • Computer vision, • Natural language processing • Reinforcement learning
Multi-modal architectures	Used in visual question answering with both a visual and a language component
Learned architectures	Learned architectures are fixed between steps of architecture learning. So, the same computation is performed for each input from the same task
Conditional architectures	This architecture is used for a given piece of data is dependent on the data itself.

2.2. Deep Learning

DL is a subfield of machine learning which is capable of learning the appropriate features by itself, requiring little steering by the user[12]. It is not a fixed algorithm that does not change, but rather a model or a system; we can change according to our information processing. DL is not always the best method for a given area. This is because maybe there are not enough data to allow deep learning, and or maybe it exists another algorithm that solves the problem better than it. Otherwise, its techniques are so effective as they learn how to better represent the problem while learning how to solve it. The Deep represents how many layers contribute to a model of the data. We call it the depth of the model.

2.2.1. Fundamentals steps for building deep networks

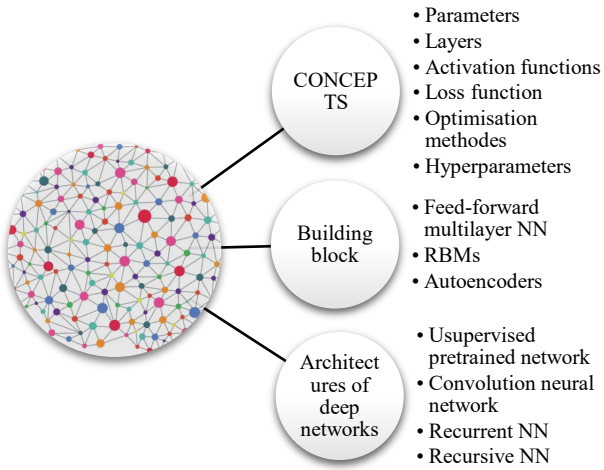

Fig. 5: Fundamentals steps for building deep networks

To build a model in deep learning, we need to grasp the fundamentals steps as we can have showed in Fig. 5. The following are some of the concepts to consider:

Parameters equivalent to the weight on the connections in the network

Layer input, hidden layers, and output layer define feedforward neural networks

Activation functions

- Output layer for binary classification. In this case, we'd use a sigmoid output layer with a single neuron to give us a real value in the range of 0.0 to 1.0 (excluding those values) for the single class.
- Output layer for multiclass classification. If we have a multiclass modeling problem yet we only care about the best score across these classes, we'd use a SoftMax output layer with an arg- max () to achieve the highest score for all the classes. The SoftMax output layer gives us a probability distribution over all the classes.

Loss Functions for classification

- Hing loss
- Logistic loss
- Negative log like a likelihood

Hyperparameters: Hyperparameters are divided into several categories as mentioned bellow:

- Layer size refers to the number of neurons in each layer.
- Magnitude (momentum, learning rate): such as the Learning rate is considered as one of the key hyperparameters in neural networks. It is how fast we change the weights.
- Regularization (dropout, drop connect, L1, L2): Regularization is a measure taken against overfitting,
- Dropout is a mechanism used to improve the training of neural networks by omitting a hidden unit.
- Activations (and activation function families)
- Weight initialization strategy
- Loss functions
- Settings for epochs during training (mini-batch size): a group or batch of vectors to be trained in the learning system. This allows using of hardware and resources more efficiently at the computer architecture level
- Normalization scheme for input data (vectorization)

3. Comparison between Conventional Machine Learning and Deep Learning

	Conventional Machine Learning	Deep Learning
Feature Learning	Using the feature extraction method with human intervention	Automatic feature extraction
Model Construction	Applying extracted features to construct a data-driven model, with shallow structures	An end-to-end high hierarchical model structure with nonlinear combining of multi-layers
Model training	Training each module step-by-step	Jointly training the parameters
Data requirement	Requiring large data	Lesser data are trained
Training Time	Long time	Less time
Transfer learning	Useful	Very useful
Multi-task learning	successful	Very successful

Conventional machine learning methods include algorithms such as logistic and linear regression, k-means clustering, decision trees, support vector machine (SVM), random forest, and Bayes learning... etc.

Among the benefits of machine learning techniques, and particularly deep learning is that when used on large datasets, they perform best, thus improving their analytical and predictive power. One of the benefits of DL over conventional machine learning approaches is that feature learning is performed automatically, so there is no need to develop a separate algorithm to do this part [13]. The main differences between conventional machine learning and deep learning are summarized in several points according to [14]. So, we show in Table 2 the conventional (traditional) ML versus DL algorithm comparison.

Table 2: The main differences between conventional machine learning and deep learning

Keys to a successful ML/DL project

As we have shown, it is best to be very precise about the issue that we are attempting to solve. That way, we will know exactly what it means when the model works and behaves correctly.
If we do plan to build our own, we will need to have a lot of data to allow for analysis and building a model. This could be data we have within your business, or sometimes publicly available data sets could be

combined and used to train a model (using transfer learning).
Once we do have a tool implemented, it is good to plan out how we'll continue to improve it using information about its results (such as multi-task learning).
Even if we do start off with all the right steps, some applications are still technically difficult and may not provide the results we're looking for. But that is always an open challenge to research.

4. Conclusion

In this paper, wehave introduced the concepts of AI with its sub-fields that we intend to use for solving the NP-hard problem. Moreover, we gave the main differences between conventional Machine learning and Deep learning.

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Selection of a cluster head for a real-time UAV application using artificial intelligence

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Informations

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Cluster head protocol

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Abstract

In recent years, the search for new wireless communication mechanisms has been highly motivated, with strong growth due to new technologies or configurations in airborne technologies, surveillance of hard-to-reach areas or in case of disaster. Drone (UAV) networks is one of the solutions.

In this project, we improved the hierarchical routing protocol using a new technique based on artificial intelligence for the selection of the cluster head in order to have an optimal choice. This technique consists in providing three input parameters to our integrated fuzzy system, which after applying the fuzzy rules and in conjunction with the inference engine will indicate the most appropriate decision to choose the cluster head In our scenario.

1- Introduction

In remote monitoring, FANETs (Flying ad hoc networks) are one of the most important parts. UAV ad hoc networks define a new form of MANET (mobile ad hoc network) where the nodes are UAVs that allow messages to be retransmitted to their destinations. Indeed, recently, research has been conducted to create collaborative multi-UAV systems as in [1], [2] or [3], where several UAVs cooperate with each other to accomplish a mission with better performance. These collaborative systems require the establishment of inter- UAV communications to ensure coordination between the different agents of the system such as the exchange of geographical positions for collision avoidance or for autonomous re-planning of tasks between the agents of a mission. UAV ad hoc networks can be applied to systems where several UAVs are used, a single UAV cannot create an ad hoc network.

2- Introduction to drones networks

Flying ad hoc networks are a sub-family of VANETs [1]. FANETs emerged in response to the need to interconnect multiple UAVs (Unmanned Aerial Vehicles) within a multi-UAV system.

A UAV is defined in [4] as an unmanned aircraft that navigate autonomously using an on-board system or with the help of a remote control system. A UAV is typically equipped with sensors to determine its position and collect information about an area of interest. UAVs promise new military as well as civilian applications such as interconnection of terrestrial ad hoc networks, search and rescue operations after natural disasters, detection and tracking of military targets, forest fire surveillance, agricultural remote sensing, etc.

In a multi-UAV system, ground or satellite base stations provide UAV-to-infrastructure communication. However, as the number of UAVs in the system increases, direct communication between UAVs is an attractive alternative to centralized communication via base stations.

Fig 1 :*FANET applications*

This can be achieved by establishing an ad hoc network between the UAVs. Indeed, the use of several UAVs in ad hoc mode has the following advantages [4]:

- Reduction of mission accomplishment time: reconnaissance, surveillance and rescue missions can be accomplished more quickly depending on the number of UAVs used.

- Reduction in total maintenance cost: instead of using one large expensive UAV, it is better to use several mini-UAVs with minimal maintenance cost for each.

- Scalability: the theatre of operations can be easily expanded by incorporating as many UAVs as necessary.

- Reduced detectability by radar: this is an important property for military applications. Due to their small size, mini-UAVs have low signatures.

3- Our Scenario

The aim of our scenario is to monitor a dense forest and to transmit the information in real time to the base station.
In order to cover this forest, we have to cooperate with other drones to have a wide coverage, because one drone will never be enough to cover a dense forest. In our scenario, we have opted for three fleets of drones that cooperate to exchange and relay information between them in order to monitor open and wild environments for life after a fire for example.

Fig 1 :*Our scenario*

CH : Drone cluster head

: Wireless communication between CH and members

: Wireless communication between CH and CH or between CH and base station

The deployment of a fleet of collaborative drones with ad hoc routing mechanisms could be one of the possible solutions to implement such applications. However, this solution will face many challenges, including the high mobility of the drones, maintaining connectivity but most importantly the choice of drone to transmit the data to the base station. This will ensure that the drones have a maximum lifespan.

Our objective here is to remedy these problems. Since the problem is wide coverage and in addition to having real-time transmission and keeping the lifetime of the drones as long as possible, we have opted for clustering routing. The purpose of clustering is to divide the UAVs into groups, each group will be led by a cluster head (CH), which will be able to communicate at any time with its members (m) or with neighboring cluster heads and also with the base station (BS).

The choice of cluster is very important in clustering routing protocols

4- Related works

In order to route information between two distant UAVs, one or more intermediate nodes in the network cooperate with each other by forwarding the data to their destinations. Indeed, routing protocols are responsible for choosing the best route to the destination that minimizes collisions, interference, or delay. The highly mobile nature of UAVs eventually leads to frequent topology changes, which causes connectivity problems for efficient communication. This mobility therefore implies instability of the routes, which have to be recalculated more or less often depending on the dynamics of the network. In recent years, several researches have been proposed to solve routing problems in FANETs as in [5],[6],[7],[8] and [9].

The highly mobile nature of UAVs eventually leads to frequent changes in topology, resulting in connectivity problems for efficient communication. The answer to these problems is hierarchical routing known as clustering. Clustering breaks down the network into subclusters. A cluster usually consists of a cluster head (CH) and its corresponding members (m). The selection of the cluster head, which is an important phase of clustering algorithms [7], is done among all members and it is responsible for managing the whole cluster for inter- and intracluster communication.

In recent years, several researches have been proposed to solve routing problems using clustering in FANET.

In [6], the authors proposed a clustering scheme for a swarm of UAVs named MPCA that uses the combination of dictionary structure prediction and

link expiration time (LET). The LET, between two drones, is calculated based on the location of the drones and their mobility information.

The CH is elected based on the highest weight of the neighbouring UAVs and the CH then broadcasts the CH announcement to the neighbouring UAVs. The drone that receives several messages consider the CH with a longer LET. Its main advantage is to reduce the instability of the clustering and thus improve the performance of the network.

In [8], the authors presented a proposal for multicluster FANETs for efficient network control, in which the submitted proposal notably reduces the value of communications, improves network performance and exploits a less complex, lowrate IEEE 802.15.4 (MAC) protocol for inter- and intra-cluster communications. They examined a mobility prototype, called Reference Point Group Mobility (RPGM). They analysed the network performance for two proactive prototypes (DSDV, OLSR) and one reactive protocol (AODV).

5- Our Contribution

The choice of cluster is very important in clustering routing protocols. Following our state of the art, we opted to integrate artificial intelligence (AI) for the choice of CH. The goal of AI is to have a maximum of parameters for the choice of our cluster head, because we have judged that a single parameter is still insufficient for the choice of CH. Artificial intelligence will allow us to make this choice based on the following parameters

- ***Energy:*** this is one of the most important parameters in FANETs as its directly related to the flight autonomy of drones.

- ***Stability***: this parameter can affect the quality of the communication as it is directly related to the speed of the UAVs.

- ***Connectivity:*** is a very important parameter as it affects the quality of communication. If the connectivity is bad then the communication will be disastrous.

Moreover, in ad hoc networks of drones, each drone has the ability to move according to a preprogrammed flight plan. Each of the drones has certain main characteristics such as an average speed of movement, a battery level, a field of view and means of communication. In addition, the CH has information on the environment (such as a map of the forest environment and the coordinates of the burnt area) and has the possibility to communicate, not only with the base but also with all other CHs. The CH will be solely responsible for the routing in its cluster.

5.1. Integration of fuzzy logic in the simulation for CH selection:

In recent years with the increasing application of unmanned aerial vehicles (UAVs), the network technology of UAVs has also raised concerns. In the context of a mission, it is necessary that the connection is maintained in order to avoid any undesirable effects. On the other hand, its need to guarantee QoS increases with time with the revolutions in FANETs, this is the reasons why we leaned towards integrating artificial intelligence to improve the performance of FANETs.

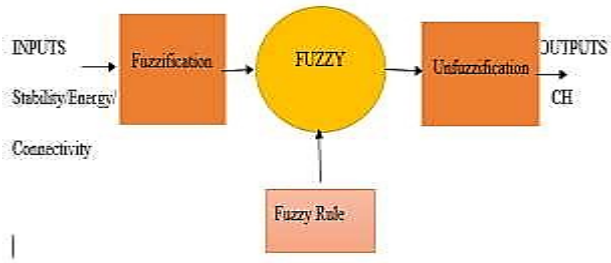

Fig 3 :*Our fuzzification model*

Precedent figure, illustrates the structure of the fuzzy inference process, which consists of four parts, namely fuzzification, fuzzy rule base, fuzzy inference engine and unfuzzification. The fuzzy inference process contains three input parameters (stability-energy-connectivity) and one output parameter, which is an approximate value:

- **Stability** is related to the speed metric, which is an important measure as it can affect the quality of communication/transmission. It is this metric that indicates the speed at which the drones move, thereby changing the network topology when approaching or leaving a particular area. For the variable, three language values have been defined: low speed (range 0-5 m/s), medium speed (range 4-13 m/s) and high speed (when the speed is greater than 11 m/s).

- Another important measure is **energy**, which is directly related to the battery capacity of the aircraft; it is related to the amount of time the UAV will be able to fly over and monitor a particular area.

The higher the battery capacity, the longer the flight range and therefore the more active the route and network topology will remain. This metric is divided into three language values that are low range (0-600 seconds), medium range (600-1200 seconds) and high range (more than 1200 seconds).

- The third and final metric used is **connectivity**. The higher the connectivity, the better the communication between the drones. Conversely, the smaller the connectivity, the worse the communication between drones. For the variable,

three linguistic values have been defined: low range (0 to 10), medium range (10 to 20) and high range (more than 20).

The input variables are collected for the integrated fuzzy system, which based on a rule table and the inference machine, will indicate the optimal choice for the CH.

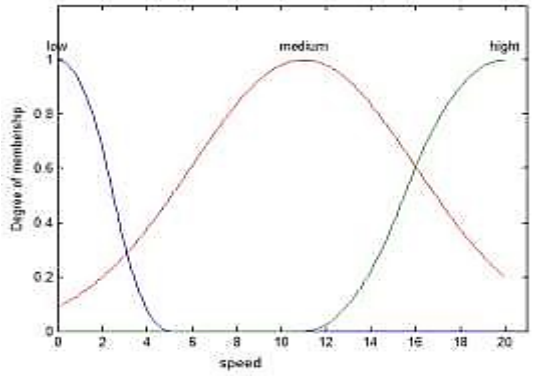

Fig 4 :*membership function of stability*

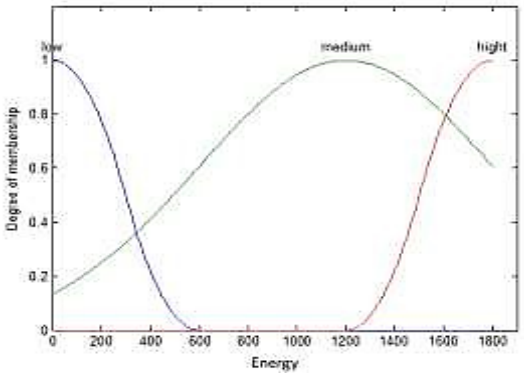

Fig 5 :*membership function of the energy*

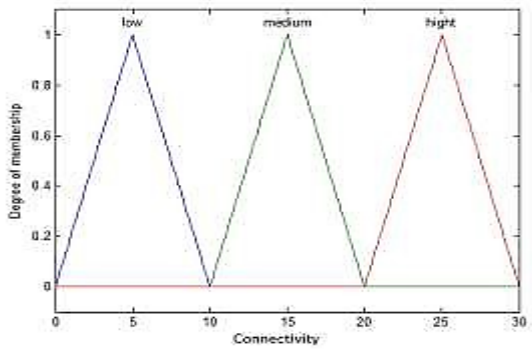

Fig 6 :*membership function of the CH output*

Figures 4, 5 and 6, shows respectively the membership degrees of the inputs and the CH output, we note that each figure contains three membership functions. For the first two input parameters (stability and energy), we have chosen to present them by the Z-form for low levels, the Gaussian form for medium levels and the S-form for high levels. For the 3rd input parameter (connectivity), we chose the triangular shape to present them.

We could have chosen other shapes such as the gbel and trapezoidal shape but it all depends on the scenario we wanted to map.

a. Our Results

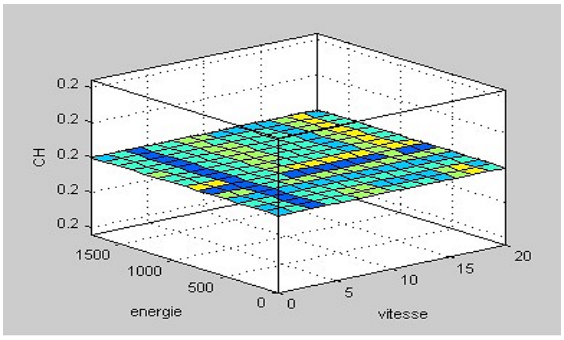

Fig 7 :*The 3D representation of CH choice for low connectivity*

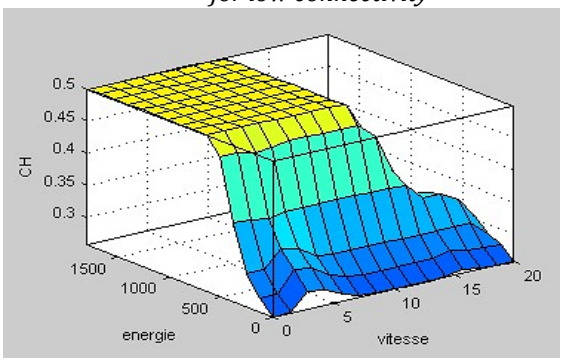

Fig 8 :*The 3D representation of CH choice for average connectivity*

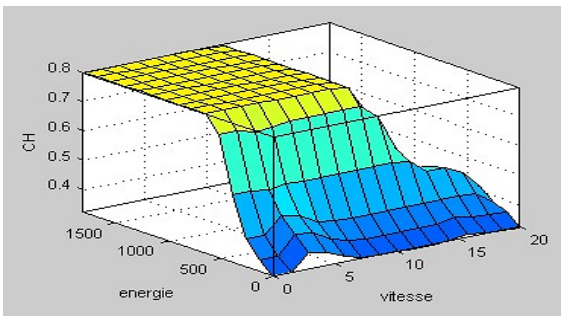

Fig 9 :*3D representation of CH choice for high connectivity*

Figures 7,8 and 9 illustrate the 3D representation of the cluster head selection. We notice that a UAV with low connectivity (0 to 10) within the cluster is not an optimal choice, regardless of its flight autonomy and speed.
This is due to the fact that the CH is responsible for all protocols within the cluster and as such it must have at least a good connectivity with its members. On the other hand, a drone with high connectivity (figure 8) is the most optimal choice as long as its speed is not too high and also its energy is not too low. This leads us to conclude that :

- The most optimal choice is a drone with low speed, high energy and high connectivity.
- A drone with low speed, high energy and medium connectivity can be considered a good choice.

- A drone with high speed or low connectivity or low energy will not be elected as a CH because it is a disastrous choice.

As already discussed in the state of the art the choice of the cluster head is the biggest problem in the hierarchical routing protocol. Several authors have tried to find an efficient solution for cluster head selection in FANETs as in [18],[17],[12].

However, if we take for example the paper of Park et al [6] they tried three approaches:

- First the selection was done randomly
- Then with energy
- And finally, they used a hybrid approach (notably through energy and distance to the base station).

They later proved that the latter approach is much more efficient compared to the two previous approaches.

Their result was acceptable as they had 70% efficiency in terms of drone lifetime.

After the analysis and interpretation of the results of our method we made a comparison between our model and the single parameter and then two parameter selection models for the choice of CH as shown in Figure 9 :

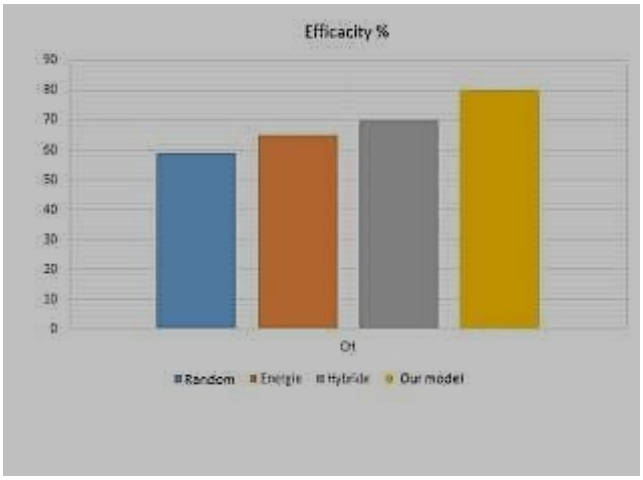

Fig 10 :*Comparison between our model and stat of art*

Figure 10, illustrate the comparison between our selection model and the selection models already performed (i.e. the selection models performed with one parameter and then with two parameters).

We notice that our model proposes 80% efficiency in terms of UAV lifetime while the other three models propose respectively 59%, 65%, and 70% efficiency.

This performance is achieved , to the integration of fuzzy logic but also and especially because the selection was made using the three parameters that we considered relevant, to maintain a good communication in the ad hoc network of drones.

By increasing the input parameters in our AI system, the efficiency of our model increases and the cluster head will be well selected to do such a mission.

6- Conclusion

We presented a detailed description of our scenario, which consists in monitoring a large region through a clustering protocol. Since the choice of the CH is a major problem in this type of routing, we used fuzzy logic, which allowed us to make a much more optimal choice.

We focused our discussions, simulations and interpretations on the usefulness of artificial intelligence in FANETs.

The results were compared to other results and we obtained a considerable improvement in terms of flight autonomy.

Finally, the integration of artificial intelligence in FANETs allowed us to make an optimal choice, to have more efficiency in terms of energy and lifetime of the UAVs and thus to improve the communication within the network.

This work opens the way to several works. The moment the cluster is formed, a communication protocol can be installed to complete a mission in real time

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AJPAN – Proposal of AspectJ Programming AssistaNtfor Learning and Teaching Introductory AOP Programming Concepts

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Informations

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Abstract

Teaching and Learning Aspect-Oriented (AO) programming paradigm usually involves learning a programming language with a large amount of complexity. Novices very often spend more time dealing with syntactical complexity than learning the underlying principles of aspect-orientation or solving the problem.
Additionally, the textual nature of most programming environments works against the learning style of the majority of novices. Consequently, an academically programming tool for teaching and learning AOP is, therefore, desirable.
To this purpose, this paper offers a preview of the first stage in our research project, which we aim to evolve a new way for Aspect-Oriented Software Development (AOSD) paradigm and to develop an academic tool for both teachers and novices:**AJPAN – A**spect**JP**rogramming **A**ssista**N**t.

1. Introduction

The "Programming" or "coding" is a very useful skill and can be a rewarding career. In recent years, the demand for programmers and student interest in programming have grown rapidly, and introductory programming courses have become increasingly popular [1]. Learning to program is hard however. Novice programmers suffer from a wide range of difficulties and deficits. Programming courses are generally regarded as difficult, and often have the highest dropout rates. It is generally accepted that it takes about 10 years of experience to turn a novice into an expert programmer [1,2,13,26].

Programming is an abstract subject. It is believed to be hard to teach and to learn and many students in programming courses have difficulties to master all required competencies and skills. At the introductory level of programming, that problem is even more notable. The biggest learning problems are that the students have to handle concepts to which they do not have a concrete model in their everyday life, that they tend to approach programs line by line, and that they are not able to handle the larger wholes of the programs [7,12,13].

Generally in the programming phase, the adopted method depends on writing source-code by hand according to a specific language syntax. For a long time, programmers have done their work using tools that depend on the text-based style, and were often confronted with the difficulty of evolving their codes. During the understanding process, they may execute several tasks all together such as reading, searching, thinking, translating, recall and mental modeling, which make much harder the focus on specific problems [1,27].

Programming languages are the primary vehicles for supporting the practices of software engineering. To address various issues, it is important, therefore, that they should be well designed and implemented along with their supporting tools [10]. The latter must offer simultaneously a high-degree of flexibility and efficiency in code editors, so that making the programming process more efficient and also teaching and learning tasks [28]. There are many different attempts and a major effort has been directed to overcome this challenge. The modern editors come with some helpful features like *code outline, syntax coloring, highlighting and checking, code auto-completion*, and so on, in order to make the traditional programming style less

disheartening and boring, especially for novices having only basic understanding of concepts and programming-language constructs [2]. However, usually most of abstractions that are meaningful at the design may be lost when implemented at the coding phase [10].

In spite of these advances, using text-based editors still requires programmers to spend effort and focus on implementation details. A considerable research issues have been identified for making the act of "coding" relatively easy and effective, and researchers are focusing on bringing more improvements to the coding process [12]. In fact, numerous projects have investigated the ability of the Graphical User Interface (GUI) through other techniques like *Templates, Code-generators, Assistants*, and *Designers* in almost modern Integrated Development Environments (IDEs). In the last few years, the tendency of programming environments to support graphical techniques has been emphasized to provide the development, the execution and the visualization of the programs [11,32]. Unfortunately, most of them have proven success within limited domains as the case of *Visual Zero*[15], Tersus [41], etc. Most recently, a significant attention from the research community has been given for assisting the general-purpose programming tasks. The codeless program development represents one direction for prototyping and building quickly programs in a high-level of interactivity. It is a convenient way that tries to lessen the focus on formalisms by exploring the idea of code structure editor [40].

Aspect-Oriented Programming (AOP), a relatively new paradigm, recently earned the scientific community's attention. Nowadays, AOP is widely used in both academic and industrial world. Practice shows that AO-programs are in many cases shorter, have more modular structure and are easier to understand. Numerous publications discuss the advantages of AO-design and implementation. The complexity of an AO-program depends on the OOP components and the AOP specific constructs. Therefore the complexity could be scattered between the AO-specific parts (in pointcuts-definitions, advices, etc.), the OO-constructs (classes, inheritance, etc.), and even in the procedural-style implementation of the methods [27].

It has emerged initially at the programming level using strong implementations such as AspectJ, the de facto AOP standard language [25]. AspectJ encapsulates crosscutting concerns into new modular programming abstractions called "aspects" to preserve modularity instead of scattering them in the core modules "classes" [25]. However, programmers and especially novices experience some difficulties in using syntactic formalisms of some concepts and features [2,35].

In addition, the conventional coding is a tedious task that hinders their understanding, and often an impediment to effective programming. It can lead to repetitive stress due to the syntactic formalisms, what consequently, affects negatively the programmer's ability to be more creative. There is, therefore, a need for solid support tools to facilitate programmers' tasks. At the opposite, the codeless program development, which we advocate here, represents a way for building programs, with a significant decrease in the amount of code written, and less focus on detailed formalisms.

Learning AOP usually involves learning a programming language with a large amount of complexity. Students very often spend more time dealing with syntactical complexity than learning the underlying principles of aspect-orientation or solving the problem. Additionally, the textual nature of most programming environments works against the learning style of the majority of students. Consequently, an educational tool for teaching and learning AOP is, therefore, desirable. To this purpose, the aim of the first phase in our research project is to develop a programming assistant to support teaching of the AO-basic concepts with AspectJ, the most widely-used [26,27].

The remainder of this paper is organized as follows: Section 2 presents an overview of relevant background to the Aspect-Oriented Programming (AOP) paradigm, the learning and teaching of introductory programming concepts and the Visual Programming (VP) capabilities. Section 3 is devoted to introducing a preview of the first stage in our project, the overall architecture, followed by the process and technologies used in development. Finally, in Section 4, we summarize the conclusion from our preliminary work and future work avenue.

2. Background

2.1 Aspect-Oriented Programming (AOP) paradigm

Aspect-Oriented Programming (AOP) is a dynamic research field that focuses on the modular implementation of concerns (i.e., *non-business operations* such as: logging, authentication, threading, transactions...) that cut across a system's functionalities (i.e., *business logic*) [25].

It came to provide and to deliver a better separation of concerns (SoC). *Gregor Kiczales* coined the term as a complement to the object-oriented programming (OOP) paradigm rather than as a replacement to it [25]. However, there are still some problems, like implementation cost and its complexity were not in view, that defined by *Gail C. Murphy* as the main factors to keep in mind while

evaluating a software engineering methodology [14].

As with any new technology, AOP has both strengths and limitations in terms of their impact on software engineering. *Roger T. Alexander* and *JamesM. Bieman* reported a number of studies that explore these challenges [24]. *Muhammad Sarmad Ali et al.* [22] have performed a systematic literature review of empirical studies that explore the benefits and limitations of AOP-based development from the perspective of its effect on certain characteristics. According to their findings, a majority of the studies reported positive effects for code size, performance, modularity, and evolution related characteristics, and a few studies reported negative effects, where AOP appears to have performed poorly on cognitive dimensions of software development (i.e., cognitive burden issues) due to the new language constructs and mechanisms offered. Cognitive outcomes were measured by looking at two relevant factors: the time taken for understandability and development efficiency, which is measured in terms of the amount of time and effort spent to build programs. Obtained results were insignificant and not encouraging [23].
Although AOP is much more efficient and has been in existence for more than a decade, it has not gained the expected adoption as OOP, the most popular paradigm today. The reasons that have hindered its wide acceptability are: (1) the awareness (it is still less user friendly); (2) the lack of universal supporting framework; and (3) it has been still less heard of so technical experts are very few in number [24]. In addition, AOP introduced new dimensions and standards to programming. This, in general, creates complexity and possible resistance, but it was also the case when OOP was introduced, which indicates that this is a normal scenario [24].

Over the last few years, it has matured and received increasing attention from researchers across the world. Numerous works has been carried out on strong AOP-based implementations such as AspectJ language [25]. However, their acceptance in mainstream software development is still limited. They are mainly used only for maintaining, rather than for developing the initial version of a system. The prominent reason for this is the fact that support tools purely depend on the text-based style, which generally do not facilitate development tasks, as is the case of AJDT (AspectJ Development Tools [25, 42]) in spite of its completeness and maturity. A good overview of the AOP scene can be found at [44].

2.2 Teaching and learning programming concepts

A textual programming language can be learnt only through extensive training or education through books. One must have prior programming knowledge to advance his skills pertaining to textual languages. These languages provide facilities to express algorithms according to how computers operate but not according to how the human mind works. Since the medium of expression is text, which is one dimensional, algorithms are expected to be sequential. In addition, textual programming usually has a complex syntax, which is inherited from its natural language ancestry. Usually, the programmer is forced to follow strict rules to ensure that the program executes. This prohibits the programmer from being more creative and becomes more focus on the language syntax [28].

Programming allows novice students to explore creative topics and learn problem-solving skills. Programming learning is complex for many novices. The most important problem for many is their low ability to develop an algorithm that solves a given problem. The application of basic concepts or the design of simple algorithms can be difficult obstacles [2,5,9].

Teaching programming to novices has proven to be a challenge for both staff and students. Many students find the programming module difficult and disheartening in particular AOP and this could have an impact on their attitude to software development throughout the course and as a career choice. For staff involved in teaching programming it can also be very disheartening when students apparently fail to understand and be able to apply even the basic constructs [3,6,27]. These difficulties have prompted researchers to investigate tools and approaches that may ease the difficulty of teaching and learning programming [4,6]. Popular novice programming tools include *Verificator* [4], *ProfessorJ* [20], *RAPTOR* [37], *Alice* [38], *BlueJ* [39], etc. One of the most approaches that are being used for teaching programming is Visual Programming (VP) [1,3,4,31,33,34].

2.3 Visual Programming (VP) capabilities

AOP is the act of modelling systems in terms of aspects/objects-software descriptions of the behaviour of a part of the system. Researchers and developers are exploring how to combine VP with AOP to improve the ease of systems development, by investigating how the basic concepts of aspect and object-oriented programming create new opportunities for expressing systems in terms of visual construction.

How does one design a system in such a way that it allows novices (young programmers) to become experts without requiring the novice to abandon his or her hard won skills? The need for increased usability isn't something restricted to novices; even experts perceive the need for higher level

abstractions, leading to the development of graphics toolkits like *Open Inventor* [36].

The task of specializing programming environments for novices begins with the recognition that programming is a hard skill to learn. The lack of student programming skill even after a year of undergraduate studies was noted and measured in the early 80's and again in this decade [14]. We know that students have problems with looping constructs, conditionals, and assembling programs out of base components [8]— and there are probably other factors, and interactions between these factors, too. Not all of these potential environments have been built and explored, however. The field of Computer Science Education Research is too new, and there are too few people doing work in this field [5, 9]. According to *Nong Ye* and *Gavriel Salvendy* [10], technical experts have better knowledge of programming at an abstract level, and novices tend to have more concrete knowledge. Current research works seek to provide a higher-level of abstraction for developers by exploiting various graphical techniques during the development process [16,29]. They tend to make programming tasks easier for those having little background in the field, and may also be useful for the experienced ones for a fast software development or prototyping [32].

Visual Programming (VP) is a subject of current active research that has transformed the art of programming in recent years, aimed at reducing some of the difficulties involved in creating and using programs [16,11,19]. The main reason for using such techniques is that they are often more convenient to users than the traditional text-based style [33]. It allows representing the coding itself entirely or partially using graphical constructs instead of, or in addition to, the text-based coding [11]. In many cases, handling interactively visual representations offer significant advantages (for comprehension and development of large systems) over textual descriptions [12,29,30,31,34].

However, there is a common misunderstanding, which assumes that the research targets to eliminate the text-based method. In fact, this is a fallacy; most visual programming languages (VPLs) include text to some extent, in a multidimensional context. Their overall goal is to strive for improvements in the design of programming languages and associated tools. The opportunity to achieve this comes from the fact that in VP, we have fewer syntactic restrictions on the way a program can be expressed interactively, and this affords an independence to discover programming mechanisms that have not been possible formerly [11, 16, 17,30].On the other hand, unlike the text-based style that can be used for any coding tasks, the visual style is only suitable for certain tasks (limitation of suitability). For instance, in some cases of complex control structures like loops and recursion, the textual description is often more efficient and economic, and the code is usually more compact than visual programs.

3. AJPAN, an AspectJ Programming AssistaNt

3.1 Overview and Discussion

AOP provides new concepts that allow programmers to control the execution of programs acting on their control and data flows. A Responsible action on the two flows can implement a number of concerns ranging from the management of the competition to the persistence of the data; see the optimization of the calculations. Unfortunately, faced with these assets, the programmers facing difficulties to design and implement programs including concerns. In addition, the productivity is still restricted by a text-based primary input method at coding level, what makes program understanding, building, and maintaining more difficult.

Especially for novices without highly technical backgrounds, AOP complicated programming by combining two programming levels; for the low base code (core concerns: classes & interfaces) and domain-specific concepts (crosscuttingconcerns: abstract & concrete aspects). Our opinion on this issue is the use of a hybrid approach, a visual and text-based oriented method. It is a seamless integration between both to support novices' difficulties at coding time when combining these two levels.

The idea of codeless program development, such as under the tool *Limnor Studio* [40] whither it enhances the OOP by adding actions for reducing the hand-typing, is to make a general-purpose visual style that is simple and preserves the programming power. The trend was towards moving farther away from traditional editors through elevating the level of abstraction. The associated tools are changing the role of software engineering and allowing novice programmers to more easily developing and even getting quick overviews of large source-codes, which is difficult without higher abstractions. It is likely that this kind of tools will make the next-generation of development systems [10,21].

Significant advantages can be mentioned as follows:

- Developers can focus more on the design and innovations,
- Higher quality of code by avoiding potential and the most common programming mistakes, and
- Less time and effort to accomplish tasks efficiently, this boosts the productivity for huge systems.

The visual paradigm capabilities may not completely replace the conventional style of programming but it can enrich the textual view. The two forms can support each other in the educational context, development and maintenance activities. It is expected that the student will begin with the visual view, perhaps later moving on to the textual view as it allows them to perform some useful visual programs with a small investment of time and then go on to more advanced levels of understanding textually when they are ready [21].

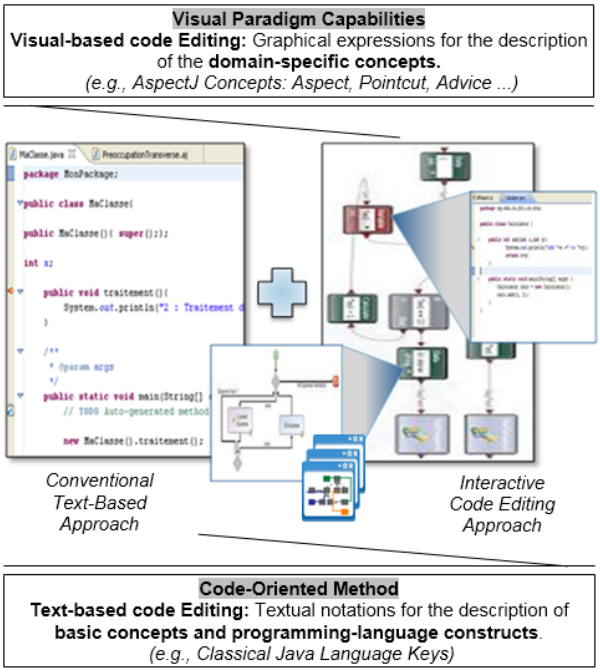

Figure 1. An Illustration of a Partially-Visual Code Editing.

An AO-programming language can be based on any programming approach—text-based, visual programming, or a combination of both. Incorporating a visual front-end to AspectJ language makes it more attractive and flexible. AO-programming concepts can be recognized and modified efficiently, and program structures can be parsed, understood, and manipulated more easily.

Our project is intended to better support the coding process by introducing more interactivity and a high-degree of flexibility. We seek to minimize the influence of language syntax on overall usability by using the ordinary drag-and-drop technique to overcome the weaknesses of text-based style.

We propose to take the AOP out of the conventional style of coding by using a new approach, which is partially visual. As the tool support is closely related to its base AspectJ language, mixing textual and visual programming is straightforward. We call it AJPAN. The name is an acronym for "AspectJ Programming AssistaNt", the language together with the tool are an attempt to integrate the visual and textual programming paradigms for one of the most AO-implementations applied to the Java language— AspectJ. The prototype tool presented here is currently being implemented as a set of plug-ins under Eclipse platform.

When displaying AO-concepts visually on screen, we can ideally combine the benefits of traditional score representations with the novel and dynamic possibilities of the computer. However, if the system becomes overly oriented toward visual programming, then having a visual front-end can become counterproductive, resulting in patches that are crowded and confusing. In these cases, the textual approach is often more economic and efficient. Thus, the user should ideally be able to switch to whatever programming technique is appropriate to a given problem.

3.2 Overall Architecture

The development of the **AJPAN** (**A**spect**JP**rogramming **A**ssista**N**t) tool begins with proposing the architecture, which consists of two parts, the structural architecture and the functional architecture. Both parts of architecture are discussed as follows.

Figure 2 depicts the overall structure of an open architecture of the tool. Open means that there are no limits for both internal and external extensibility. Basically it is implemented as a front-end to the AspectJ compiler (ajc). An AJPAN program is created on the tool editor by connecting a graphical objects or icons using a directed arrow that will produce a directed graph, which will show the flow of the program. This graph is also known as a source program (or an input file of data representation with the extension of .vaj). The front-end of the tool consists of three components, which are the syntax analyzer, semantic analyzer, and the code generator. The latter will initially produce an AspectJ source code (.java and .aj). Finally, an AspectJ code compiler used to produce a Java byte code (i.e. *.class), which is a target program.

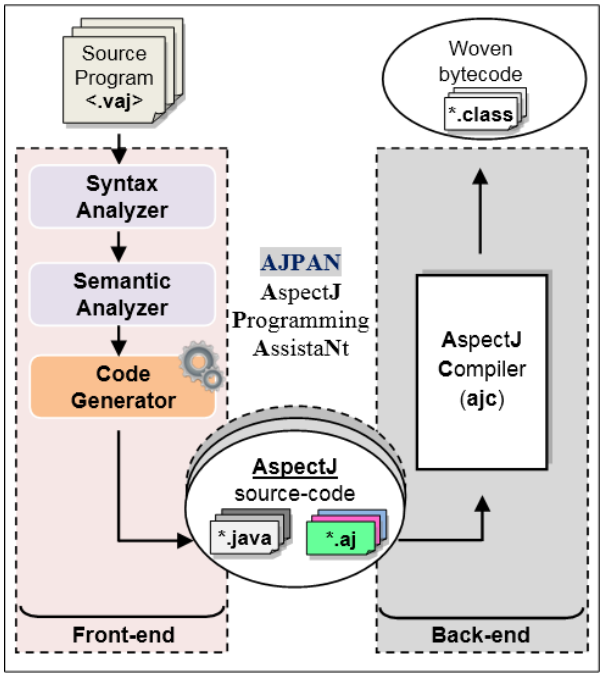

Figure 2. Structural Architecture of AJPAN tool support.

Figure 3 depicts an overview of the functional architecture of the AJPAN tool support prototype. It is an arrangement of functions and their sub-functions and interfaces, which define the steps sequencing for both control flow and data flow throughout the coding process. The facing down arrows represent the flow or steps of functionalities. The horizontal arrow shows the control flow, while the horizontal dash arrow shows the data flow.

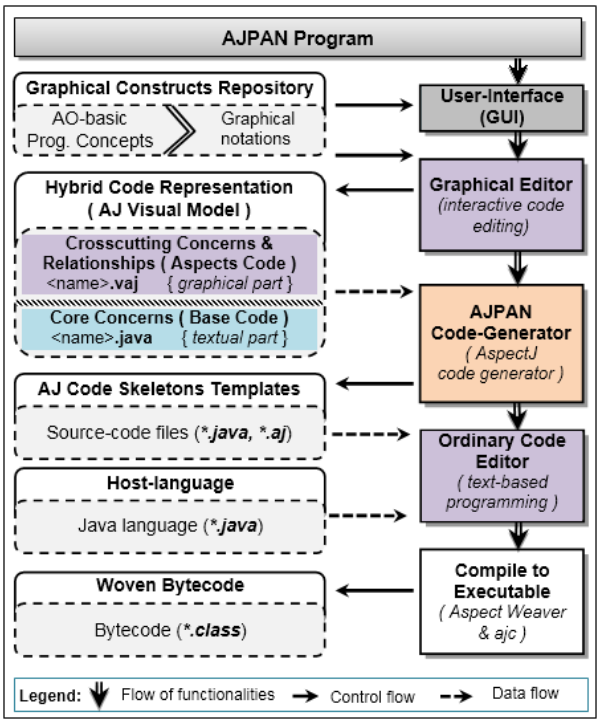

Figure 3. Functional Architecture of AJPAN tool support.

- **Interactive code editor**: is an innovative editor assistant, where the user can manipulate visual, interactive objects to build an*AJ Visual Model* (*.vaj) for code skeletons of the target program. It is a graphical editor of code structure providing a clear view that permits to obtain quick overview of concerns to be considered from the preliminary specification of the model. This tool is built as a novel class of visual, highly interactive code editor. Some of its important features include:
  - ✓ Less hand-typing of codes.
  - ✓ Exploring, navigating and modifying effortlessly the structure of program and its entities by means of its model, and without the need to look more deeply the source-code, and then regenerate corresponding templates.
  - ✓ Importing and exporting the already created models, what consequently allow reusing their constituent elements using a drag-and-drop technique.

- **AJPAN Code Generator**: this component is a template-based AspectJ code extractor based on Acceleo technology [43]. It takes as input the model already built, and produces as output textual templates of an AspectJ code.

- **AJ Visual Model**: describes the structure of the target program. In its simplest form, it seems as an interactive code visualization that may assist in understanding the overall program source. It consists of a set of *Model Elements* described in the form of graphical notations that represent AspectJ programming constructs and features. Each element can be customized, and has a specification according to the syntactic formalism description of the corresponding concept. The whole specification of the model data is stored as a relatively small file (*.vaj), defined in the XMI format.

  Furthermore, to elaborate additional details, the model can contain important artifacts such as a consistent documentation at different levels of abstraction (e.g., *UML models, graphs, tables, textual descriptions and comments, voice recording*, etc.). Having together such extra data in a single repository allows creating useful links between the generated code and these artifacts.

3.3 Design and Implementation

The AJPAN is an Eclipse-based prototype tool. In our approach processing, the compilation and execution of an AJPAN program is achieved in three phases.
First, the AJPAN program is a hybrid code, splited into graphical part (i.e. a set of *visual objects* or *V-*

expressions) and textual program and then replacing all the visual objects by unique identifiers. Additionally, a graphical constructs repository (predefined graphical notations & artifacts) indexed by these identifiers is created.

The second phase is the translation of each *visual term* (extracted from *V-expressions*) into its textual equivalent with a customized graphical parser.

In the last phase, the text-based produced code is parsed according to an attribute grammar for V+L and is then recombined with the textual equivalents of visual objects by means of syntax directed translation (an ordinary textual parser). The resulting program L-Program (i.e. a standard AspectJ program) is processed by a standard compiler for L (i.e. *AspectJ Compiler*).

The visual paradigm capabilities can facilitate programming tasks by using explicit and intuitive representations to express various aspects and entities of source-code [11]. To this end, it is desirable to provide carefully designed graphical notations for fundamental AO-basic programming constructs and features, such as aspect-constructs (*pointcut, advice, inter-type declarations, and weave-time declarations*), class-constructs (*method, field,* etc.), inheritance, and structured constructs (*package, class, interface, aspect, loops, conditions,* etc.) [21].

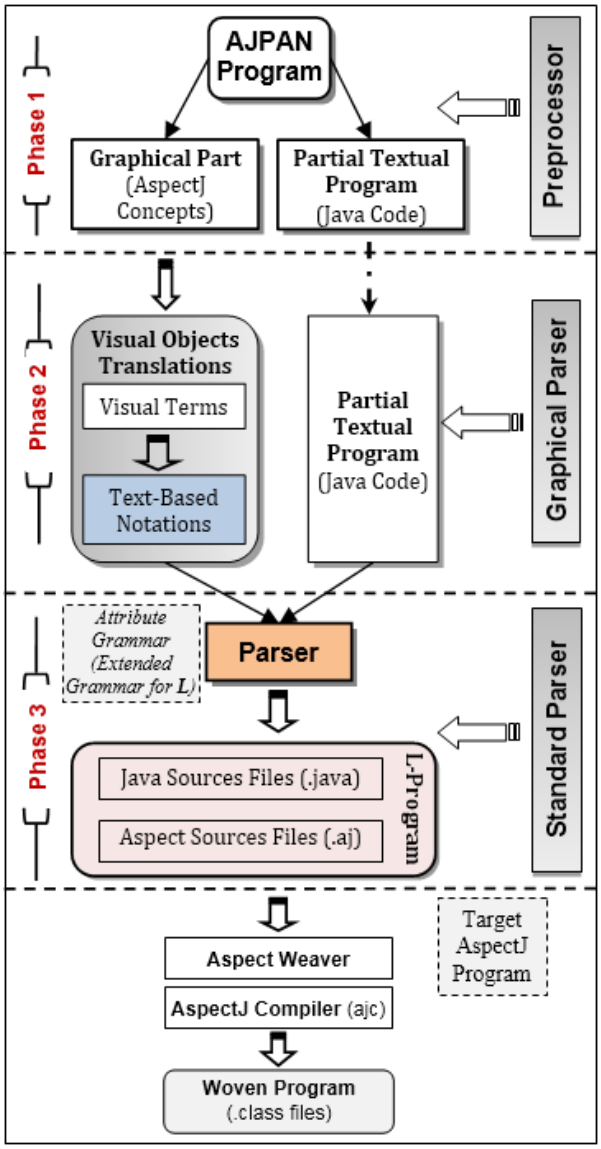

Figure 4. Overall process of Compilation and Execution of an AJPAN Program.

In more advanced implementation, it is good to let the program source take the form of a visual, interactive document [18]. In order to facilitate navigation, these representations must be coupled with efficient interaction techniques that permit to support two main functions: (1) controlling programming concepts through their corresponding constructs in a high-degree of flexibility; and (2) specifying parameters and properties for each model element selected. Based on this requirement, we have selected the following features to be implemented: (a) semi-separation among users and the language syntax; (b) no restrictions; and (c) an ordinary graphical user-interface. In this trend, the high-level descriptions encapsulate the underlying implementation technology adopted, which eases its replacement, e.g., replacing AspectJ implementation with AspectC++ [21].

4. Conclusion and Future Work

The AOP paradigm introduced new dimensions and standards to programming. Just reading about AOP concepts confuses the novices, let alone programming using these concepts. This, in general, creates complexity and possible resistance, but it was also the case when OOP was introduced, which indicates that this is a normal scenario.

For a long time developers have done their work using the text-based primary input method at coding level, but that is about to change. The success of new programming paradigm, such as the AOP, relies mainly on solid support tools and advanced development environment. We address the next steps towards successfully applying visual techniques to the software development process. Besides technical issues, one of the main concerns when defining a *partially-visual code editing* is finding a balance between the *expressiveness* and *implementability* of the tool support. Languages that are too expressive tend to be very difficult to formalize and therefore to implement. But by restricting the expressiveness of the language, we also restrict its usability. For that, we suggest to take the code-oriented method for describing the components, and the visual paradigm capabilities for expressing the structure and relations (i.e. the architecture) with a high-level of interactivity.

A new way for AOP and a preliminary work to develop, **AJPAN**– **A**spect**JP**rogramming **A**ssista**N**t, an academic programming assistant for AspectJ are presented and discussed in this proposal paper. In our current project, we suggest to use visual expressions for the description of the domain-specific concepts (e.g., *AspectJ Concepts: Aspect, Pointcut, Joinpoint, Advice* ...) in combination with textual notations for the basic concepts of the conventional (or standard) programming language (e.g., Java). Throughout its design, we are considering the aspect of understandability, easy to program, readability, writability and correctness of the language.

AJPAN will hopefully make programming less frustrating, more productive. We hope to be used for learning and teaching introductory AO-programming concepts. We suggest its adoption in the training levels of education as a goal of near-term, and to improve the quality and accessibility of information exchange between programmers and the computer, while at the same time supporting programs that solve large and complex problems as a goal of a long-term.

We believe that our programming assistant, AJPAN, will open a new-direction in the aspect-oriented software programming area. On the other hand, our proposal can be used to help researchers identify fruitful topics of future novice programming research, and towards a Hybrid methodology for the construction of AO software systems.

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A system for management of intelligent containers household waste in a city

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Informations

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ABSTRACT

The economic and technologies development also the increasing population of large urbanization, has a huge increase in the production of solid waste which has become a major threat to both the environment and human health. Despite the development of industrial intelligence and its uses in various fields, the process of waste management still follows traditional methods, which are both expensive and tiring. No the solutions to the problem in line with technologies development a smart containers with indicators to measure the level of waste in them and a communication system based on the technology of internet communication or cellular methods to transfer data to the data bank located in the center of waste management and collection.

1. Introduction

For the past few years, we have noticed that the quality of air and land has deteriorated due to certain parameters, including pollution and the increase in the number of wastes. This is why currently, many countries are looking for alternatives to alleviate this problem. For experts in the field, it is the management and know-how of a branch of the modern economy which considers that whatever the waste produced, it first has an economic value, for this reason it is of paramount value to integrate an automation technology for this problem.

Technology continues to make progress in all sectors, and waste treatment is no exception.
The goal of our work is working on the realization of a system capable of controlling the level of rings to improve the collection of waste in a city, for this will create an application capable to:

- Test the level of waste in the bins and send a message to the control post.
- Monitor all processes related to waste management and control the level of bins remotely based on RFID technology.
- Manage material and personal resources.

According to the study we did in the field, several issues were selected :

- Unexpected filling of the tanks before the trucks turn.
- Waste of time caused by unnecessary rounds to empty or not completely plain tanks.
- The long journey that the trucks follow to collect the waste.
- Poor management of staff and professional equipment.

In order to correct the problem, we put a system capable of improving the situation which is summarized in the following points:

- Based on an application that can control and monitor the levels of full bins, we will improve the situation to eliminate several drawbacks.
- The application will control the level of each bin and send data to the administrator who will manage

the human and material resources and the journeys of each truck.

The objective of our work is to develop an application to manage waste by respecting the following points:

- A sensor capable of measuring the level of waste in a bin and sending messages to the administrator.
- A system capable of managing all waste collection operations.
- The application can manage material resources and ensure good management of human resources.

The structure of this paper is as follows:
In the first section, we will talk about waste management, RFID and ARDUINO technology. The second section presents the design phase to detail the proposed system.
The third section is dedicated to show some screens of the system. Finally, the last section presents the implementation of arduino, sensor and wifi card.

2. Background material

2.1. *Waste management*

The term waste can be defined as any residue from a production, transformation or use process, any substance, material produced or more generally any movable property abandoned or which its holder intends to abandon and which are of a nature to wear damage to human health and the environment [1].

The National Waste Agency was created by Executive Decree No. 02 - 175 of May 20, 2002. Placed under the supervision of the Ministry of Environment and Renewable Energies, it is responsible, as part of a mission to public service subject to inform and popularize the techniques of sorting, collection, transport, treatment, recovery and elimination of waste. It must capitalize on and constitute a documentary background on waste management and ensure its dissemination to local authorities and the business sector. [2]

The missions of the agency:

- Provide assistance to local communities in the field of waste management.
- Process data and information on waste.
- Establish and update a national data bank on waste.
- In terms of sorting, collection, transport, treatment, recovery and elimination of waste, the Agency is responsible for:
- To initiate, carry out or contribute to the carrying out of studies, research and demonstration projects.
- Publish and disseminate scientific and technical information.
- To initiate and contribute to the implementation of awareness and information programs.
- Implement and operate the public system for the recovery and recovery of packaging waste EcoJem. [2]

2.2. *National waste management strategy*

The waste management policy is part of the National Environmental Strategy (NES), as well as the National Environmental Action and Sustainable Development Plan (PNAE-DD), which took the form of the promulgation of law 01- 19 of 12 December 2001 on the management, control and elimination of waste, dealing with aspects inherent in the management of waste, and the principles of which are:

1. Prevention and reduction of the production and harmfulness of waste at source.
2. The organization of sorting, collection, transport and treatment of waste.
3. The recovery of waste by reuse and recycling.
4. Environmentally sound treatment of waste.
5. Information and awareness of citizens on the risks presented by waste and their impact on health and the environment. [2]

2.3. *National cooperation*

A framework agreement has been signed between the National Youth Employment Support Agency (ANSEJ), the National Waste Agency (AND) and the National Conservatory of Environmental Training (CNFE) in order to promote micro company in the environmental field.

This agreement aims to define a framework for consultation, cooperation and

coordination between the parties, for the upgrading of micro-enterprises in the field of projects related to the environment sector in order to achieve:

- The establishment of a privileged consultation and partnership framework that will promote the creation of activities by young entrepreneurs linked to the environment sector.
- Dissemination of information for the benefit of young entrepreneurs who are interested in events related to project activities in the environment sector.
- Train and support young entrepreneurs during the creation of micro-enterprises.
- Promotion of expertise in this area among young entrepreneurs.

The National Waste Agency is also involved in the following:

- Technical support for companies at various stages of projects related to the environment.
- Provide companies with the necessary information on the technical and scientific levels which allow them to develop their activities in the field of waste management.
- Provide support through their participation in the experience gained.
- Involve these micro-enterprises in seminars and workshops relating to waste management. [2]

2.4. *International cooperation*

The projects developed with Belgian cooperation are on two levels:

1. Study and expertise fund: in this context, the DNA benefited from an internship by the team in charge of Eco-Jem with FOST+; the Belgian organization approved for the recovery and recovery of household packaging waste. Also, an environmental consultant has been seconded to the DNA since August 2014.
2. The AGID program: a cooperation project serving local communities for waste management.

AGID (Support for Integrated Waste Management) is a cooperation project between Algeria and the Kingdom of Belgium in the field of waste management. This project will be implemented in three wilayas (Mascara, Mostaganem and Sidi Bel Abbès). The budget allocated for this project is as follows:

- A Belgian donation of € 11,000,000, the implementation of which is entrusted to the Belgian Technical Cooperation,
- Algerian funding of 1,000,000,000 Da, the implementation of which is entrusted to the National Waste Agency.

Supporting local communities is one of AGID's priorities. This support covers all aspects of waste management such as the collection organization, the operation of infrastructures, the technical control of equipment and awareness campaigns. A wide range of instruments will be made available to communities in the intervention area:

- Staff training in managerial, technical and relational tasks;
- The twinning of Algerian actors with their counterparts in Belgium;
- The development of management and monitoring methods as well as the acquisition of tools;
- The development of master plans and integrated waste planning;
- Assistance by specialists (especially for technical landfills).

In a broader context, AGID also aims to develop industries to recover waste and, thus, promote the circular economy. This primarily concerns the recovery of household and similar waste. Selective collections will be organized and sorting centers will be built. On the basis of which, recovery channels will be developed according to the needs and opportunities specific to each wilaya. Actions are also planned for inert waste and special household waste.

The AGID offices will be located at the headquarters of the Regional Environmental Inspectorate in Oran. [2]

2.5. *RFID*

Radio Frequency Identification is an automatic technology that encodes digital data in an RFID tag (Figure 1) affixed to a product, and allowing a radio wave device to read them remotely. In contrast to barcode technology, which requires that the codes printed on a label pass in direct view in front of an optical reader to allow the reading of the corresponding data, RFID tags can be read without direct line of sight. This ease and speed of reading makes RFID technology particularly suitable for a large number of applications for which the individual reading of each barcode would slow down the process of acquiring information. RFID allows data to be transmitted in real time, without a wired connection or any human intervention. It is ideal for situations that require instant critical data to ensure traceability in a company's supplies. It is also suitable for use in harsh environments [3, 4].

Fig. 1 :RFID tag.

2.6. *ARDUINO*

The Arduino card is a printed circuit specifically designed to house a microcontroller and provide access to all of its inputs and outputs. It also includes a few other electronic components that operate or extend the functionality of the microcontroller. A microcontroller is a small computer confined to a single integrated circuit (a chip). It is an excellent way to program and control electronic equipment. There is a wide variety of such microcontroller cards, some of the most used are the Wiring board, the PIC, the Basic Stamp and of course Arduino. You write source code in the Arduino development environment to tell the microcontroller what you want it to do. For example, by writing a single line of code (an instruction), you can flash an LED. If you connect a push button, you can add another line of code so that the LED lights up when the button is pressed. With other instructions, you can have the LED only flash when the button is pressed. So you can easily make the system behave in a certain way, which would be difficult to do without a microcontroller. Like a desktop computer, Arduino can perform a multitude of functions, but it doesn't do much on its own. It needs something to be connected to at least one of its inputs and / or outputs to be useful. Like a computer keyboard and mouse, these communication channels allow the Arduino to sense and act on real-world objects. Before proceeding, it may be useful to discover the broad outlines of Arduino's history. [5, 6]

3. Our approach

3.1 System requirements

- We need a system that would be able to monitor the fill level as soon as possible.
- A system that would notify or present this information to affected collection trucks concerned.
- A user-friendly and interactive system.
- A secure and confidential system.
- A system that can provide historical usage reports.

3.2 Functional requirements

These are the basic requirements of the system that it must fulfill to be considered to solve the research problem.

They understand:

- **Adjustment of the filling level**: This allows the system to specify the filling level that it considers as a limit for the collection of waste.
- **Check the status of the tank**: This allows the user to view the filling level at any time via a Web application.
- **Notifications**: This feature will allow the user to be notified each time the filling level is full.
- **Reports**: This functionality allows the system to generate reports when necessary.

3.3 System architecture

The general architecture of the waste monitoring system that we want to achieve, describes the interaction and communication between garbage cans or smart containers distributed in different neighborhoods and buildings in the city. After being registered in a system database,

The system administrator browses and retrieves the information processed for monitoring and

collecting waste via a developed web application or platform.
A simplified version of the system architecter is shown in Figure 2.

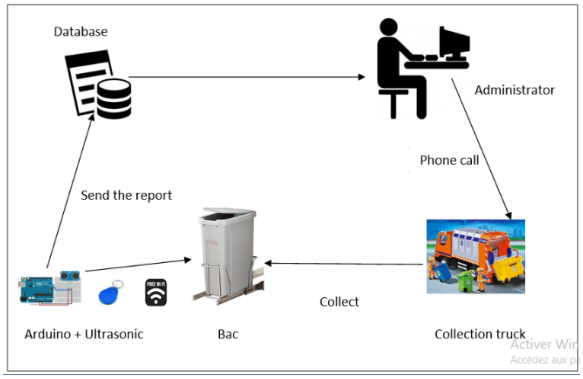

Fig. 2 : The system architecture.

3.4 Building the database

We created a database under the name "garbage-collector", this database contains a set of tables, as is shown in Figure 3.

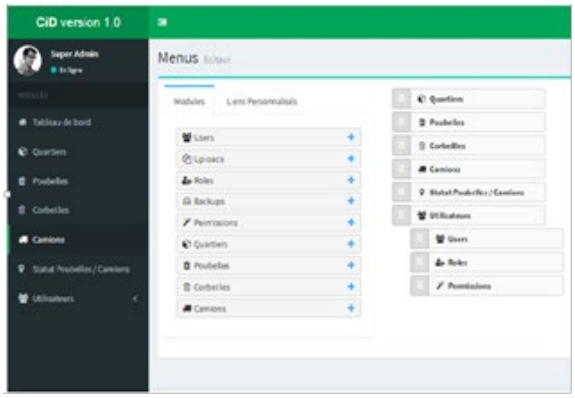

Fig. 3 : The database table.

3.5 Arduino UNO card

The Arduino UNO card (Figure 4) is a programmable ATmega328 microcontroller for operating components (motor, LED, etc.). It has "ports" for example to connect to a computer or to power. The Arduino UNO card is the centerpiece of any electronic circuit for beginners. It has: [7]

- 14 inputs / outputs (6 of which provide the PWM output).
- 6 analog inputs.
- A crystal at 16 MHz.
- A USB connection.
- A power jack.
- An ICSP header.
- A reset function.

Fig. 4 : The Arduino UNO card.

3.6 Ultrasonic distance sensor hc-sr04

The ultrasonic distance sensor HC-SR04 (Figure 5) is an inexpensive device that is very useful for robotics and test equipment projects. This tiny sensor is capable of measuring the distance between itself and the nearest solid object, which is very good information to have if you are trying to avoid entering a wall!

The HC-SR04 can be connected directly to an Arduino or another microcontroller and operates on 5 volts. It can also be used with the Raspberry Pi. However, since the HC-SR04 requires 5 volt logic, you will need two resistors to interface it with the Pi's 3.3 volt GPIO port.

This ultrasonic distance sensor is capable of measuring distances between 2 cm and 400 cm (that's roughly an inch to 13 feet for those who don't "speak" metric). It is a low current device, so it is suitable for battery powered devices. And as a bonus, it even looks cool, like a pair of Wall-E robot eyes for your latest robotic invention!

Fig. 5 : The ultrasonic distance sensor HC-SR04.

4.Some screens

In this section, we present some screens of our intelligent system (Figure 6, Figure 7, Figure 8, Figure 9).

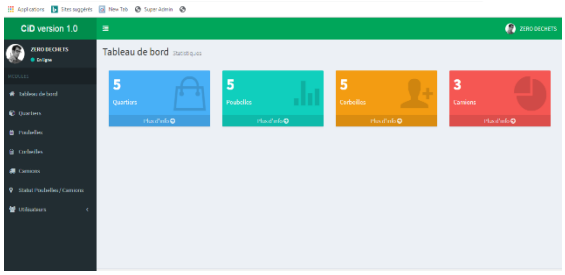

Fig. 6 : The dashboard.

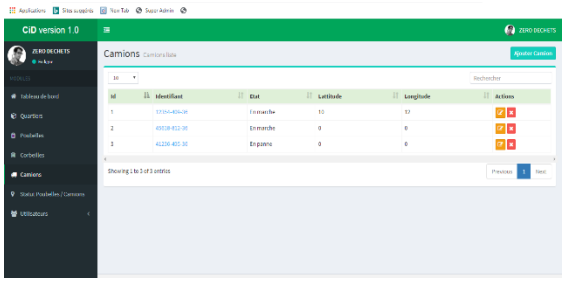

Fig. 7 : The trucks.

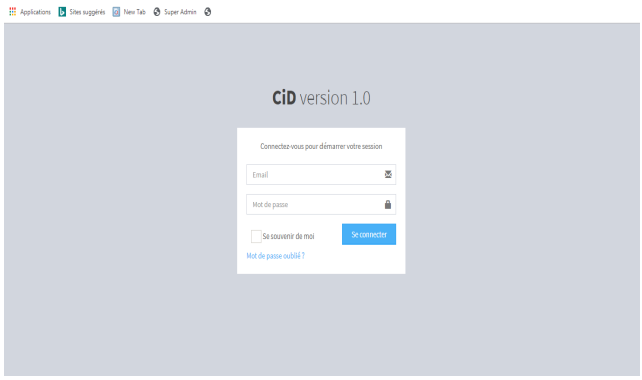

Fig. 8 : Login page.

5. Arduino, sensor and wifi card implémentation

The Figure 9 presents the implementation diagram of Arduino, sensor and wifi card.

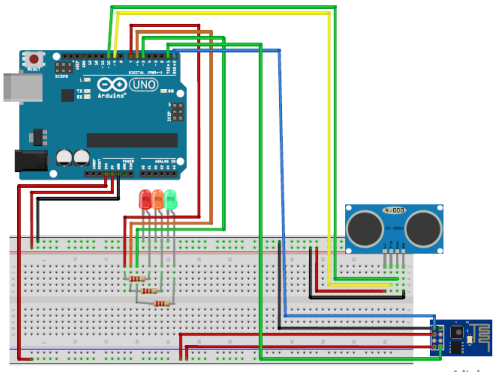

Fig. 9 : The dashboard.

6. Conclusion

The objective of this work is the realization of an intelligent system capable of facilitating the task of management and collection of waste with RFID technology. This realization was carried out in three stages, the first, is the analysis of the needs of our project, the second, is the modeling of the database used, and the third stage is the study of the proposed tools and their capacities. During the realization of this project, we tried to cover the maximum of needs, as well as to increase the efficiency of the functionalities of the applications, all this to facilitate the task for the administrator on the one hand and for the trucks on the other. In addition, this project was an opportunity to acquire assets and technical knowledge of existing software tools in the areas that use arduino. Finally, if we had more time, we could have achieved more functionality at the application level. and add other options and features.

In the future, we hope to inserts other types of sensors (gas, weight), make work on the geo-localization MAP and finally, Extend the work on several waste containers.

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Handwritten Digit Recognition: Developing an Efficient ML and DL Model to Recognize Handwritten Digits

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Informations

Keywords:

machine learning, deep learning, handwritten digit recognition, Pattern Recognition, Neural Networks, Convolutional Neural Networks.

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Abstract

Deep learning DL is a new subfield of machine learning ML area which is used during the last decades to develop more sophisticated algorithms allowing high performance in some popular recognition fields, such as: pattern recognition, computer vision and image classification. Among the most used methods in DL, we find CNNs (Convolutional Neural Networks) which can be considered as the best used technique. In the present work, we have developed an automatic classifier that permits to classify some given grayscale images representing handwritten digits into one of 10 classes (digits from 0 to 9), inclusively. For this purpose, we have used ML and DL approaches. First, we proceeded to the classification task using many ML algorithms including: LR, LDA, KNN, CART, NB, and SVM. Second, we proposed a new CNN model composed of many convolutional layers. Finally, we established a comparison between different algorithms.

1. Introduction

The main idea of ML algorithms is how to perform important tasks by generalizing from a large number of given examples. So, ML systems automatically learn programs from large amount of data. In the last years, many IA tasks such as: spam filtering, web search, text categorization, recommender systems, credit scoring, fraud detection, etc, are based essentially on Machine Learning approaches ML which gave a high performance. The Mckinsey Global Institute asserts that ML discipline will be the guide of the next big wave of innovation [16], [17], [25]. Currently, we are able to use larger datasets to learn more powerful models, and better techniques to avoid overfitting and under-fitting. Many algorithms have been developed in this area of research, including: logistic regression, k-nearest neighbors, naïve Bayes, decision trees, support vector machine, artificial neural networks, etc. Researches on Artificial Neural Networks ANN can be considered as the oldest discipline in ML and AI that dates back to McCarthy in 1943, but these researches were quickly interrupted for a long time due to their high requirements in term hardware, software and running time. Many years later, they were revived in parallel with the apparition of new sub-field called deep learning DL. The DL approach greatly simplifies the feature engineering process especially in some vital areas such as: medical imaging analysis. Among the DL methods, CNNs are of special interest. When exploiting local connectivity patterns efficiently which is the case of those used in the ImageNET competition [8]. There are many works trying to apply CNNs on image analysis [9, 10] using a variety of methods like the rectified linear unit [11] and deep residual learning [12].
The organization of the rest of the paper is the following. In Section 2, we introduce the Deep Learning Background .in section 3 and 4, then Proposed Model, Experimentation, also a famous MNIST dataset using TensorFlow, keras and python as language and its libraries. Illustration of Obtained Results as user enters the respective digit the machine would recognize and show the results with accuracy percentage in Section 5. In section 6 and 7, presenting Discussion, Comparison between ML and CNN approaches. Finally, Section 8 presents some concluding remarks.

2. Deep Learning Background

During the last decade, Deep Learning DL becomes one of the most popular sub-field of IA and ML, espe-cially in speech recognition, computer vision and some other interesting topics. Its success is motivated by three factors: the increased amount of available data, the

improvement and the lowest cost of hardware and software [9, 10, 11, 12, 13], the increased chip processing abilities (e.g., GPU units) [14]. DL is based essentially on the use of ANNs with two layers or many hidden layers. The convolutional neural network CNN is a specialized feedforward neural network that was developed to process multidimensional data, such as images. Its origins refer to the neocognition proposed by Fukushima in 1980 [15]. The first model of CNN was proposed by LeCUN et al., [16] in 1998 for the purpose of character recognition. Furthermore, many other alternative ANN architectures have been developed later, including: recurrent neural networks RNNs, autoencoders, and stochastic networks [17, 18, 19]. Deep learning also refers an efficient solution to the problem of input data represen-tation which is a critical phase in ML especially for complex problems such as im-age and speech recognition [20]. DNNs are able to learn high level feature represen-tations of inputs through their multiple hidden layers. The first DNNs had appeared in 1960's, but abandoned, after that for long time in favor of ML approach, due to its high requirements in term difficulties in training and inadequate performance [21]. In 1986 RumelHart et al., [22] proposed the back-propagation method to update effi-ciently neural network weights using the gradient of the loss function through multi-ple layers. Despite the promising results given by DNNs in the late of 1980's [23] and 1990's [24], they were abandoned in practice and research due to many prob-lems. In 2006, researches in DL were revived especially when some new methods for sensibility initializing DNN weights have been developed by researchers [25, 26]. It is the case of deep belief networks DBNs which proved their efficiency in image and speech tasks in 2009 and 2012 [11]. In 2012, Krizhevsky et al., [17] proposed a deep CNN for the large-scale visual recognition challenge (LSVRC) [27] reducing the error rate from the previous year's 26% down to just 16%. This CNN has been im-plemented on multiple graphics processing units GPUs for the first time, This new technique has allowed the training of large datasets and increase significantly the speed of processing and the research productivity. Furthermore, the use of a new activation function RELU (Rectified Linear Unit) has ended the problem of gradient and allowed faster training of data. Dropout technique is also used as a regulariza-tion method to decrease overfitting in large networks with many layers. All these interesting improvements and the increasing internet in DL let the leading technical compagnies to increase the research efforts, producing many other advances in the field. Many DL frameworks abstracting have tensor computation [12, 13, 14, 15] and GPU compatibility libraries [16] have been developed and made available to re-searchers through open source software [28] and cloud services [29, 30]. On the other hand, many compagnies have met the challenges of big data when exploring large amounts of data to predict value decisions [30]. The concept of big data refers to data that exceeds the capability of standard data storage and data processing sys-tems [31]. This large volume of data requires also high-performance hardware and very efficient analysis tools. Some other ML challenges appeared with big data in-cluding: high dimensionality, distributed infrastructures, real time requirements, feature engineering. Najafabadi et al [32] discuss the use of DL to solve big data challenges, the capacity of DNNs to extract meaningful features from large sets of unlabeled data is extremely important as it is commonly encountered in big data analytics. The automatic extraction of features from unstructured and heterogeneous data, e.g., image text, audio is very useful and difficult task. But this task becomes easy with the use of DL methods. Other tasks including: advanced semantic-based information retrieval systems like semantic indexing and hashing [33, 34] are also became possible with these high-level features, furthermore, DL is also used to tag incoming data streams allowing to classify and organize fast moving data [32]. In general, high capacity DNNs are suitable for learning from the large volumes of data issued of big data sources. As conclusion, we can say that DL is currently growing faster than over before.

3. The Proposed Model

In the present work, we have developed an automatic classifier that permits to classi-fy some given grayscale images representing handwritten digits into one of 10 classes representing integer values from 0 to 9, inclusively based on two approaches: the classic ML approach and DL approach. Below shown is a small workflow of how CNN module will extract the features and classify the image based on it. The architecture shows the input layer, hidden layers and output layer of the network. There are many layers involved in the feature extraction phase of the network which involves convolution and subsampling .Initially, we proceeded to the classification task using many ML algorithms including: LR, LDA, KNN, CART, NB, and SVM. Then we proposed a CNN model composed of many convolutional layers, many Max-Pooling layer and one full connected layer. Finally, we established a comparison be-tween the different algorithms. As programming tools,

we have used Python, Tensor-flow, and Keras which are the most used in this field. Fig 1 summarize the classification task based on the two approaches, while Fig 2 presents a detailed diagram of the proposed CNN model in order to improve the performance of the classification task.

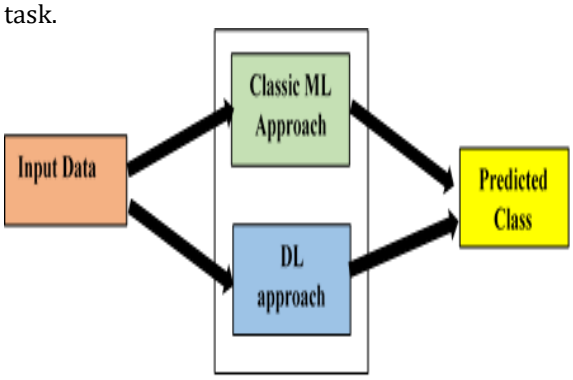

Fig 1. Handwritten Digit Classification Process (big size)

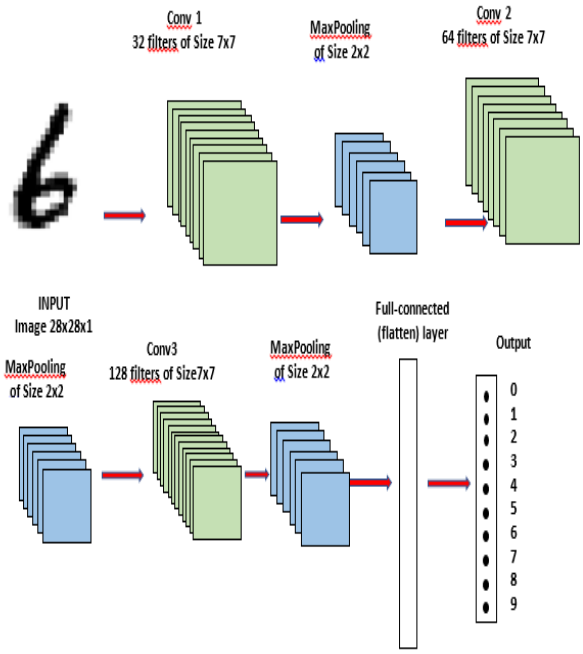

Fig 2. Architecture of the proposed CNN model

4. Experimentation

4.1.*Used dataset*

In our experiments, we have used Digits Mnist dataset contains 60,000 small square 28×28 pixels grayscale images of handwritten single digits between 0 and 9.

4.2.*Programming Tools*

Python: Python is currently one of the most popular languages for scientific applications. It has a high-level interactive nature and a rich collection of scientific libraries which lets it a good choice for algorithmic development and exploratory data analysis.

Tensorflow: TensorFlow is a multipurpose open source library for numerical computation using data flow graphs.

Keras: Keras is the official high-level API of TensorFlow.

4.3.*Evaluation*

In order to validate the different ML algorithms, and obtain the best model, we have used the cross-validation method consisting in: splitting our dataset into 10 parts, train on 9 and test on 1 and repeat for all combinations of train/test splits. For CNN model, we have used two parameters which are: loss value and accuracy metric.

5. Illustration of Obtained Results

To build the best predictive model and achieve the higher accuracy rate, we have performed two tasks:

1. Applying many classic ML algorithms, including: Logistic Regression LR, Linear Discriminant Analysis LDA, K-nearest Neighbors KNN, Decision Tree (CART variant), Gaussian Naïve Bayes NB, Support Vector Machine SVM. For this purpose, we used scikit-learn library of python containing the most known learning algorithms.

2. Designing a CNN (Convolutional Neural Network) model composed of many layers as it is explained in Figure 1:

- ✓ A first convolutional layer Conv1 constituted of 32 filters of size (7x7).
- ✓ A dropout layer to avoid overfitting.
- ✓ A MaxPooling MaxPool of size (2x2) allowing to reduce dimensions (weigh, high) of images issued of the previous layer after applying the different filters of Conv1.
- ✓ A second convolutional layer Conv2 constituted of 64 filters of size (7x7).
- ✓ A dropout layer to avoid overfitting.
- ✓ A MaxPooling MaxPool of size (2x2) allowing to reduce dimensions (weigh, high) of images issued of the previous layer after applying the different filters of Conv2
- ✓ A third convolutional layer Conv3 constituted of 32 filters of size (5x5).
- ✓ A dropout layer to avoid overfitting.
- ✓ A MaxPooling MaxPool of size (2x2) allowing to reduce dimensions (weigh, high) of images issued of the previous

layer after applying the different filters of Conv3

- ✓ A full connected layer FC allowing to transform the output of the previous layer into mono-dimensional vector.
- ✓ An output layer represented by a reduced mono-dimensional vector having as size the number of classes.

For all the previous layers a Relu activation function and a softmax function are used to normalize values obtained in each layer.

Table 1. Description of the Proposed CNN Model

Layer Type	Output Shape	Nb. parameters
conv2d_1 (Conv2D)	(None, 28, 28, 32)	1600
batch_normalization_1 (Batch)	(None, 28, 28, 32)	128
max_pooling2d_1 (MaxPooling2)	(None, 14, 14, 32))	0
conv2d_2 (Conv2D)	(None, 14, 14, 64)	100416
batch_normalization_2 (Batch)	(None, 14, 14, 64)	256
max_pooling2d_2 (MaxPooling2)	(None, 7, 7, 64)	0
conv2d_3 (Conv2D)	(None, 7, 7, 128)	401536
dropout_1 (Dropout)	(None, 7, 7, 128)	0
max_pooling2d_3 (MaxPooling2)	(None, 4, 4, 128)	0
batch_normalization_3 (Batch)	(None, 4, 4, 128)	512
flatten_1 (Flatten)	(None, 2048)	0
dense_1 (Dense)	(None, 128)	262272
dropout_4 (Dropout)	(None, 128)	0
batch_normalization_4 (Batch)	(None, 128)	512
dense_2 (Dense)	(None, 10)	1290
Total parameters		768,522
Trainable parameters		767,818
Non-trainable params		704

Table 2. Accuracy after applying different ML algorithms

Algorithm	Accuracy
LDA	86.41
KNN	96.90
CART	86.27
NB	57.04

Table 3. Loss value and accuracy value obtained when applying the proposed model

	Loss value	Accuracy value
Training set	0.059	99.86
Test set	0.633	98.29

Curves

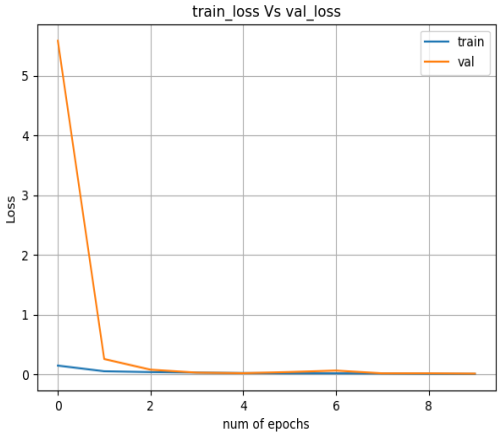

Fig 3. Training loss Vs Validation loss of the CNN model.

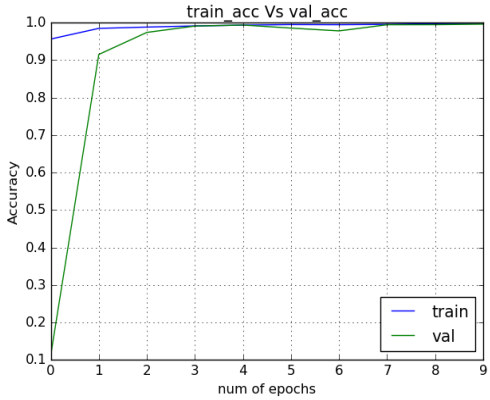

Fig 4. Training accuracy Vs Validation accuracy of the CNN model

6. Discussion

Table 2 summarizes the obtained results when applying the different ML algorithms including: LDA, KNN, DT (CART), NB. We observe that LDA , KNN and DT (CART variant) give a high classification accuracy (86.41, 96.90, 86.27), while and NB give a relatively low value of accuracy (57.04)compared to the previous algorithms. We note also, that the similarity metric used with KNN algorithm influence directly on algorithm performance.

Table 3 presents the obtained results when applying the proposed CNN model on the training set and the test set. Two performance measures are considered in this case, the loss value which calculates the sum of errors after

training the model, and the accuracy value which gives the rate of correctness.

In the same way, Fig 3shows the evaluation of training loss and validation loss over time and in function of the number of epochs. It begins very high for the training set and ends very low because of the large number of samples, but its variation for the validation set is not very quick and appears relatively stable.

Similarly, Fig 4plots the evolution of training accuracy and validation accuracy in function of the number of epochs. Contrary to the loss value, the accuracy starts very low and ends very high. This property is clearer with the training set because of its large size.

7. Comparison between ML and CNN approaches

In this section we try to establish a comparison between different algorithms, ML algorithms and the CNN model. The result of this comparison appears on table 4

Table 4. Comparison between ML approach and DL Approach

Algorithm	Accuracy rate
LDA	86.41
KNN	96.90
CART	86.27
NB	57.04
CNN model	99.86

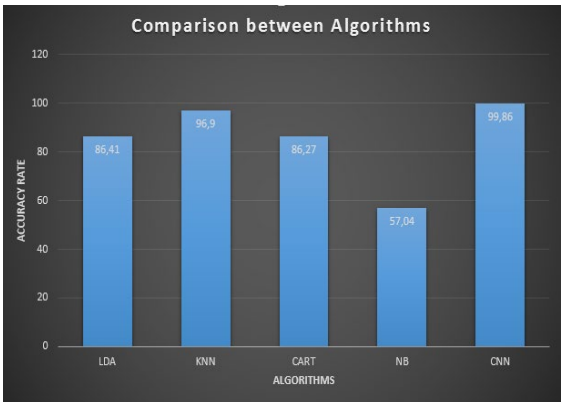

Fig 5. Comparison between different Algorithms

According to Table 4 and Fig 5, The comparison favors CNN model over ML algorithms.

8. Conclusion and Perspectives

In the last years, object recognition is based essentially on ML approach that gives a high performance. Few years later, some important progress on ML area have been made especially with the apparition of a new sub-field called deep learning. It is mainly based on the use of many neural networks of simple interconnected units in order to extract meaningful patterns from a large amount of data to solve some complex problem such as: medical image classification, fraud detection, character recognition, etc. currently, we are able to use larger datasets to learn powerful models, and better techniques to avoid overfitting and underfitting. Until our days, the ob-tained results in this area of research are very surprising in different domains. We talk about very high values of accuracy which often exceed the threshold of 90%. For example, the accuracy rate on digits set is over 97%.

In the present paper, we have performed a task of classification on a clothing article dataset. We have used in a first stage many ML algorithms including: LR, LDA, KNN, DT (CART), NB, SVM. We obtained good result of accuracy especially on LR, LDA, KNN. In a second stage, we have built a CNN model to perform the same task of classification. The achieved performance is very surprising. We concluded our work by establishing a large comparison between different algorithms. The result of this comparison was in favor of DL approach through the CNN model we have built. As perspective of this promising work, we propose to improve these results by improv-ing the architecture of CNN built model by changing some model parameters such as: the number of filters, the number of convolution and maxpooling layers, the size of each filter, the number of training epochs and the size of data batches. Another sug-gestion seems important, is to combine CNN with recurrent networks Resnets.

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