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Journal Computer Technology

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Knowledge Area

The works must be unpublished and refer to topics of Data Management, Establishment of Computer Networks, Design of Database Systems, Software Design, Computer Science, Software, Computer Technology with Services, Business Process Outsourcing, Hardware and other topics related to Engineering and Technology.

Presentation of content

In volume six, issue seventeen, as the first article we present, *Organizational structure of software development companies located in the city of San Francisco de Campeche*, by MEX-ALVAREZ, Diana Concepción, HERNÁNDEZ-CRUZ, Luz María, URIBE-SANTIAGO, Heribé Felipe and DÍAZ-ROSADO, Martina, with secondment at the Universidad Autónoma de Campeche and Instituto Tecnológico Superior de Champotón, as a second article we present, *Methodology for mechanical design using augmented reality as a learning tool*, by FERNÁNDEZ-PÉREZ, Vladimir Damián, MIRANDA-SÁNCHEZ, Francisco Javier and FERNÁNDEZ-GÓMEZ, Tomas, with an appointment at Instituto Tecnológico de Orizaba, as a third article we present, *Control through artificial neural networks of direct current motor*, by RODRÍGUEZ-FLORES, Oliver, ESCOBEDO-TRUJILLO, Beatris A., GARRIDO-MELÉNDEZ, Javier and COLORADO-GARRIDO, Darío, with secondment at Universidad Veracruzana, as fourth article we present, *Online store: integrative activity in computer engineering in times of pandemic*, by MORA-LUMBRERAS, Marva Angélica, SÁNCHEZ-PÉREZ, Carolina Rocío, PORTILLA-FLORES, Alberto and SÁNCHEZ-SÁNCHEZ, Norma, with secondment Universidad Autónoma de Tlaxcala.

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Organizational structure of software development companies located in the city of San Francisco de Campeche

Estructura organizacional de las empresas desarrolladoras de software radicadas en la Ciudad de San Francisco de Campeche

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Abstract

This research presents the results of the diagnosis of the current situation of the software industry in the City of San Francisco de Campeche, as well as the context in which it is at a national level. In March 2022, a survey was made to 83% of the software development companies in the city, with the use of the software called "Virtual Observatory" where an instrument consisting of 65 specific, observable and measurable indicators, classified in 3 categories referring to the organizational structure: Composition of Departments, Human Resources, Research, Innovation, Development and Technology. The indicators in turn were organized in 20 questions of closed format, which allowed to know the characteristics of the personnel, as well as the technologies that request to be mastered, and the different areas with which the companies operate. In this way, we contribute to the state of the art of the software industry in the community and thus detect areas of opportunity that detonate the economic development of the community.

Organization, Human Resources, Software

Resumen

En esta investigación se presentan los resultados del diagnóstico de la situación actual de la industria de software en la Ciudad de San Francisco de Campeche, así como el contexto en el que se encuentra a nivel nacional. En mazo de 2022, se realizó una encuesta al 83% de las empresas desarrolladoras de software de la Ciudad, con el empleo del software denominado “Observatorio Virtual” donde fue vertido un instrumento que constituido de 65 indicadores específicos, observables y medibles; clasificados en 3 categorías referentes a la estructura organizacional: Composición de Departamentos, Recursos Humanos, Investigación, Innovación, Desarrollo y Tecnología. Los indicadores a su vez se organizaron en 20 preguntas de formato cerrado, que permitieron conocer las características del personal, así como las tecnologías que solicitan ser dominadas, y las diferentes áreas con las que operan las empresas. De esta manera se contribuye en el estado del arte de la industria de software de la comunidad y con ello detectar áreas de oportunidades que detonen el desarrollo económico de la misma.

Organización, Recursos Humanos, Software

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Introduction

Manufacturing industries represent the third place of economic units (UE) in Mexico according to data from the economic census 2019 (INEGI, 2020) with a total of 579,828 UE, with employed personnel of 6,493,020 employees. Campeche contributes with 3,851 which represents 0.67 % of the economic units and 17,206 employed personnel representing 0.27 %. The manufacturing industry in Campeche as an economic entity generates 945.547 million pesos in remunerations representing 0.12% compared to the national level and a value of 6,596.046 million pesos in income representing 0.05% data from the 2019 census (INEGI, 2020) hence the relevance of this sector in the economy.

Campeche is one of the largest economies in the country, occupying the seventh place and the first place in the GDP of secondary activities where the manufacturing industry is part of (Hernández, 2018). As Campeche is an economic management entity, it is a good opportunity to generate and promote activities that improve the economy, such as the software industry.

In Mexico, computer sciences and information and communication technologies have a large number of people employed, of which 68% are men and 32% are women. Regarding their specialisation in the area 43% in computer science and 57% in information and communication technologies data from the national survey of occupation and employment (ENOE) (National Institute of Statistics and Geography (INEGI), 2019).

In 2018 Mexico reflected a 2.2 % gross domestic product (GDP), where the manufacturing industry of the state of Campeche contributed 0.4 %, data obtained from the Mexican National Accounts System (Cuéntame de México, n.d.) (Hernández, 2018). The state of Campeche has approximately 928,363 inhabitants, which represents 0.7% of Mexico (Cuéntame de México, n.d.).

Hundreds of young people are currently studying and working in the different areas covered by this industry. On the other hand, innovation and technology continue to advance, giving birth to new careers that strengthen the foundations and thus prepare new young people interested in being part of this great team, contributing new ideas, building new foundations and generating an economic contribution that allows the development of Mexico as well as the states in growth of the software industry.

According to INEGI data, the type of occupation of personnel working in the software industry is that 55% work as professionals and technicians, 14% in auxiliary jobs in administrative activities; 10% in activities related to commerce, 7% as civil servants, directors or managers; industrial and handicraft jobs occupy 6% and other activities such as transport, surveillance and personal services 8%, as can be seen in Graphic 1.

Graphic 1 Type of occupation of personnel in the software industry
Source: INEGI. National Occupation and Employment Survey, ENOE. First quarter of 2020.

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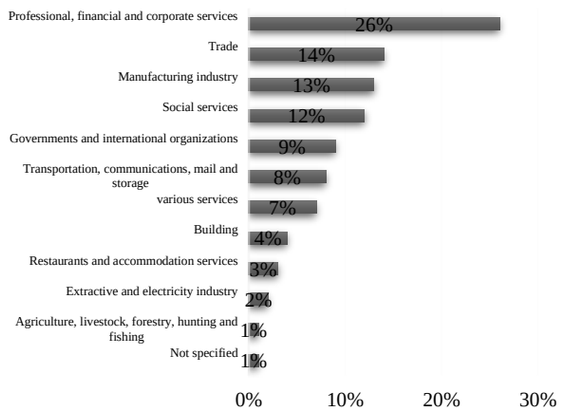
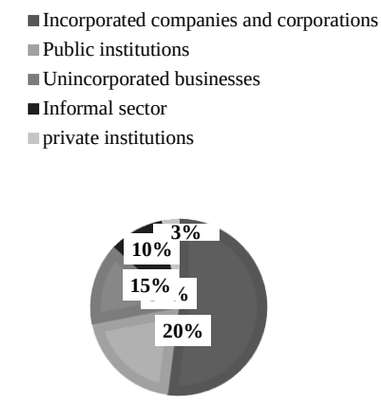
The economic sector in which professionals in the software industry work is distributed according to the activities in which they specialise: 26% are employed in professional, financial and corporate services, 14% in commerce; manufacturing industry is one of the busiest areas with a total of 13%, social services 12%, governments and international organisations 9%, transport, communications, mail and storage 8%; miscellaneous services with 7% and construction with 4%; 3% is distributed in the restaurant activities and accommodation sectors, 2% in the extractive and electricity industries; agriculture, livestock, hunting and fishing account for 1% and non-specific sectors also account for 1% in employment Graphic 2.



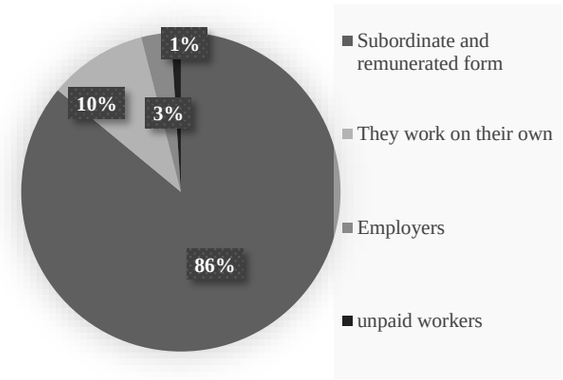
Graphic 2 Activities in which software professionals specialise
Source: INEGI. National Occupation and Employment Survey, ENOE. First quarter of 2020.

Many of the software workers are found working in 3 main fields; 52% belong to incorporated companies and corporations, 20% to public institutions and 15% to unincorporated businesses; the rest of the workers are found working in the household sector or informally with a percentage of 10% and private institutions represent 3% Graphic 3.



Graphic 3 Main fields of work
Source: INEGI. National Occupation and Employment Survey, ENOE. First quarter of 2020

Regarding the fields in which each of the software specialists work, a percentage is found according to the type of contract of the institutions, i.e. the performance of the population is mainly reflected in a subordinate or remunerated form with a value of 26%, those who are self-employed 10%, employers correspond to 3% and 1% by unpaid workers (Graphic 4).



Graphic 4 Type of contract of the institutions
Source: INEGI. National Occupation and Employment Survey, ENOE. First quarter of 2020

The state of Campeche is part of the group that contributes in areas of science and technology or better known as the manufacturing industry, the entity has areas such as Material and intellectual infrastructure occupying the 6th position of the state at the national level, Public and private investment in science, technology and innovation occupies the 27th position; the 30th is represented by Scientific production and Information Technologies the 18th, data obtained from the Analysis Centre for Research in Innovation (CAIINNO, 2016).

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Campeche is a developing state and more and more young people are interested in the various areas of the manufacturing industry contributing to improve the index of science, technology and innovation.

In the Human Development Report Mexico 2016 Inequality and Mobility (UNDP, 2016) apud by Cabrera, 2022, it is considered that innovation is no longer an exclusive task of research centres or industries, but opens the possibility for companies, businesses or non-productive sectors to intervene in the design of technological, social or educational solutions. (Cabrera, 2022).

Methods

The methodology used for this work was the creation of an instrument to help measure the software industry in the city of San Francisco de Campeche.

A. Instrument design

For the design of the instrument to measure the software industry in the State of Campeche, indicators were generated, so that from them a complete instrument could be generated to measure the organisational composition of the software industry. The instrument was generated using the systematic review methodology, developed for the purpose of compiling and evaluating the available evidence pertaining to a topic (Biolchini, Gomes, Cruz, and Travassos, 2005).

1. Development of the protocol

a) Formulation of the question.

(1) Question focus:

To identify the set of indicators that will help to recreate an instrument to be able to evaluate the software industry in the city of San Francisco de Campeche.

(2) Breadth and quality of the question.

(a) Problem:

Currently there are no recent studies that indicate or detail the condition in which the software industry is currently in San Francisco de Campeche, which is why it is of utmost importance to propose a set of indicators that will help recreate an instrument to be able to measure the performance of the software industry in the state.

(b) Question:

What are the most relevant indicators to evaluate the software industry in the city of San Francisco de Campeche?

Is it possible to classify the indicators that help to evaluate the software industry in the city of San Francisco de Campeche?

(c) Keywords and synonyms:

The definitions used to solve the research question were Software, software industry, technology, growth, boom, economy, investments, ICTS, Software Clusters, 2004, 2005, 2007, 2008, 2009, 2012, 2014, 2018.

(d) Intervention:

Indicators to assess the Software industry of the city of San Francisco de Campeche.

(e) Outcome:

Studies to identify the strengths, weaknesses, opportunities and threats of the software industry sector in the city of San Francisco de Campeche.

(f) Field of research:

Publications related to the quality area of the software industry from countries around the world.

B. Construction of the Indicators Instrument

The instrument was created based on a methodology presented in the work "Propuesta de indicadores para evaluar la industria de software de una región", (Mex et al, 2021).

In this work, 3 categories are presented referring to the organisational structure that includes: departmental composition, human resources and research, innovation, development and technology.

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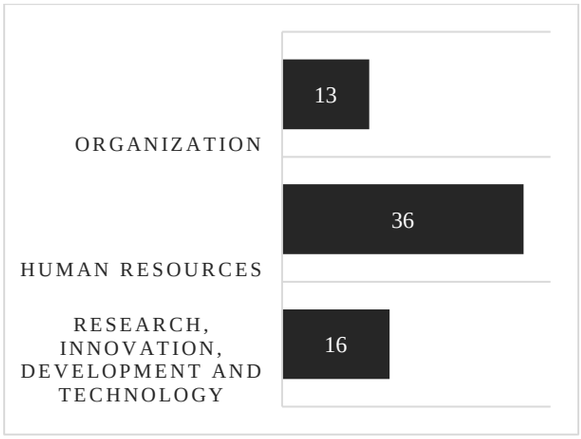
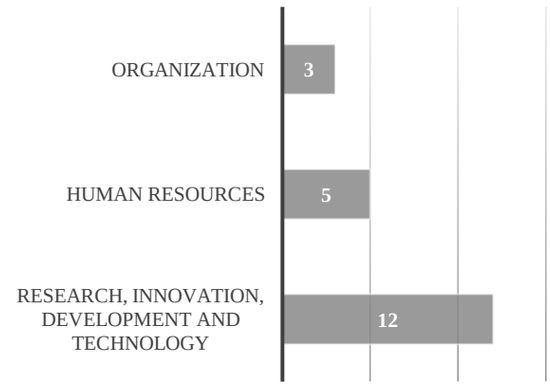
The number of indicators that were established per category are shown in Graphic 5.



Graphic 5 Number of indicators by category
Source: Own elaboration

In order to be able to collect the indicators, the required questions were designed to include several indicators, distributed into 3 questions on Organisation, 5 on Human Resources and 12 on Research, Innovation, Development and Technology (Graph 6) (Graphic 6).



Graphic 6 Number of questions per category
Source: Own elaboration

C. Target population

The target population of the instrument is constituted by all the software development companies that have their fiscal domicile in the city of San Francisco de Campeche, being a total of 6, of which 3 belong to the AhKinTech cluster and 3 do not belong to any association.

D. Application of the SME Instrument

The application of this instrument was carried out during the month of March 2022, where a total of five developer companies participated, two from the Ah Kim Tech cluster and three that are not affiliated, as shown in Figure 1.

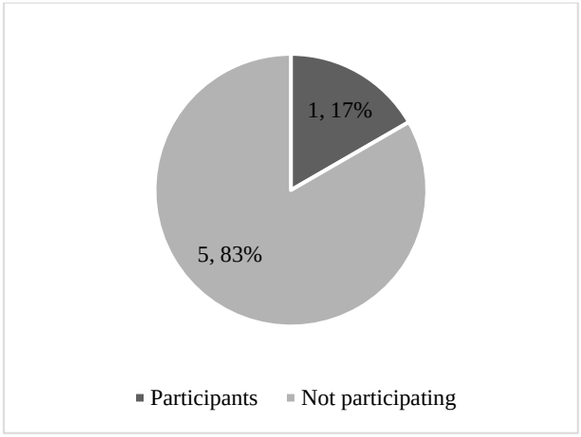


Figure 1 Participation of software development SMEs
Source: Own elaboration

The software developed, called "Virtual Observatory", automatically performs the statistical analysis of the data thanks to the definitions of variables and formulas that were established in the construction of the instrument, therefore, it offers us the option of visualising the results from different perspectives.

In order for the surveyed companies to be identified by the system, accessing as System Administrator, the entities must be registered with their name, contact telephone number and e-mail address. Figure 2 shows the registration window.

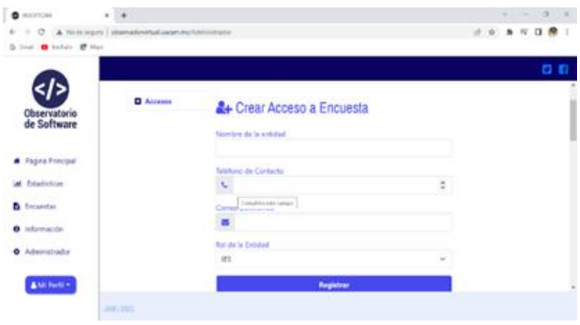


Figure 2 Registration window
Source: Own elaboration

Once the entity is registered, a TOKEN is generated which will be active until the survey is completed. Figure 3 shows the window where tokens are administered.

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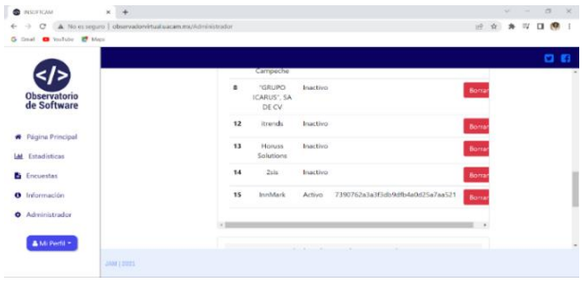


Figure 3 Token administration
Source: Own elaboration

Registered companies will be able to access the questionnaire by entering the URL: http://observadorvirtual.uacam.mx/

Subsequently, they must enter the token, which was previously sent by e-mail. Figure 4 shows the access window.

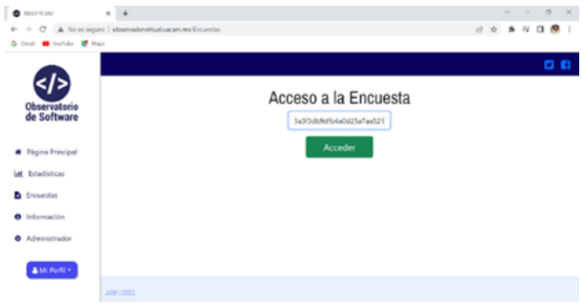


Figure 4 Access window
Source: Own elaboration

Once the TOKEN has been validated, you can start filling in the corresponding answers, as shown in (Figure 5)

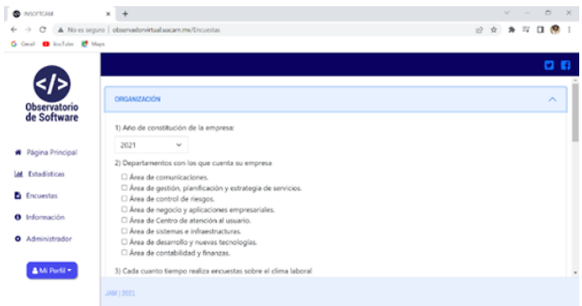
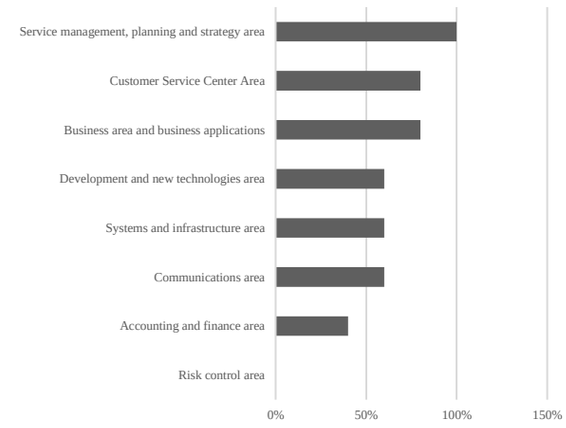


Figure 5 Filling out the survey
Source: Own elaboration

Results

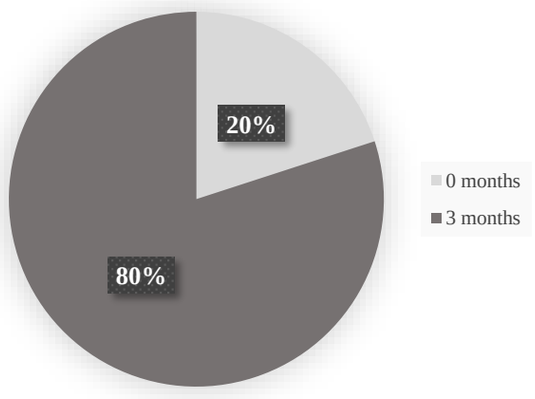
The average age of the SMEs in Campeche was found to be 10.5 years.

Graphic 7 shows the organisation of the areas within the companies, so that the risk control area is not included in any of them, as a priority is the area of management, planning and service strategies which will be responsible for setting the direction of the company as well as coordinate, manage and organise major tasks that promote their development; On the other hand, they also have areas such as the user service control area and the business and business applications area. The accounting and finance area represents a smaller percentage compared to the areas of communication, infrastructure systems and the area of development and new technologies.



Graphic 7 Company departments
Source: Own elaboration

Graphic 8 shows that 20% of the SMEs, i.e. one of them does not carry out any kind of work climate survey and the remaining 80% carry it out regularly within a maximum period of 3 months.



Graphic 8 Time taken to carry out surveys
Source: Own elaboration: Own elaboration

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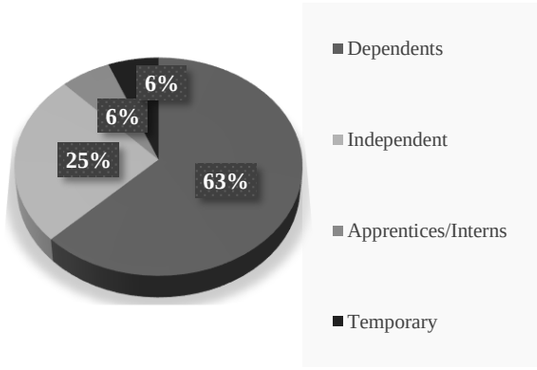
With regard to recruitment criteria, Graphic 9 shows that for SMEs, teamwork skills and willingness to learn are fundamental and of great importance. SMEs consider that these criteria complement different areas and generate quality work by obtaining new knowledge. On the other hand, problem-solving skills are also relevant according to 60% of the SMEs and 40% consider innovation important, not only the creative mind but also the construction and development of new ideas that generate software infrastructure. 20% of SMEs consider time management and responsibility to be important among the skills of their employees. Experience, certifications and being responsive were not chosen among the main criteria, because they are characteristics that are obtained in a certain time frame and that with the main criteria are possible to achieve.

Graphic 9 Main recruitment criteria
Source: Own elaboration: Own elaboration

The SMEs handle different types of contracting, the most used with 63% being a dependent who follows the orders of a boss, receives a salary determined by the hours or months that he/she has been working in the company, contributing to the company's performance, and is paid by the number of hours or months that he/she has been working in the company. The independent contracts or outsourcing consist of a contract with the company.

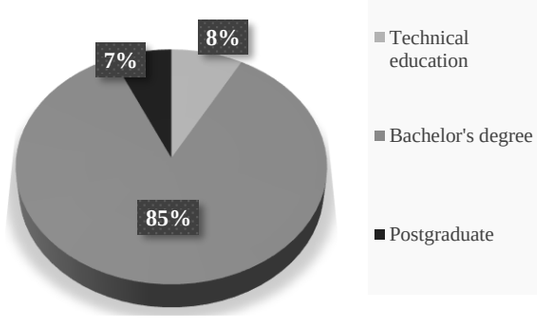
Independent contracts or outsourcing consist of delegating an activity of a company to a specialised professional in order to obtain better performance indicators. 25% of the employees of software development SMEs in the city of San Francisco de Campeche work under this scheme.

Temporary employees are those who are under a governmental programme scheme that at the end of it will no longer be part of the company and represent 6%. Apprentices and/or trainees are students of various degrees who provide their services or professional internships and represent 6% as can be seen in Graphic 10.



Graphic 10 Type of recruitment
Source: Own elaboration

86% of the personnel hired have a bachelor's degree, 8% have a technical education and 6% have postgraduate studies, as can be seen in (Graphic 11).



Graphic 11 Level of studies
Source: Own elaboration

With regard to the number of programmers by level of studies according to the type of contract, the majority of programmers are at undergraduate level with a percentage of 91.30%, followed by 6.52% with technical education and 2.17% with postgraduate studies (Graphic 12).

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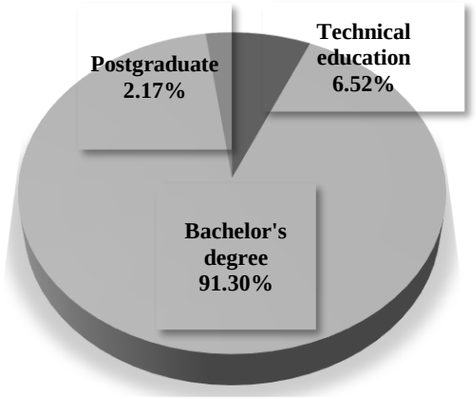
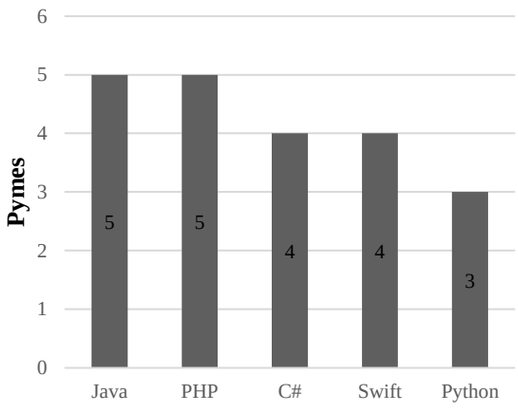


Graphic 12 Programmers by level of education
Source: Own elaboration

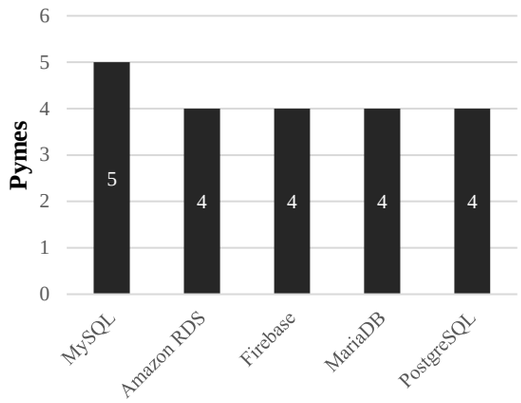
Staff rotation is a practice rarely employed within the software industry in the city of San Francisco de Campeche, as can be seen in Figure 17.

In (Graphic 13) we can observe the programming languages most used by the SMEs, where Java and PHP are the most required, leaving in second place the languages like C# and Swift, Python occupies the third place, each one of them are a fundamental base for the complete development of the software industry.



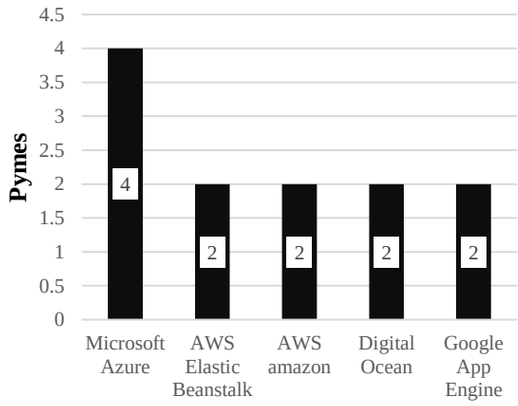
Graphic 13 Programming languages
Source: Own elaboration

Databases allow to store, organise, maintain privacy, as well as to avoid redundancy of large amounts of information or data which can be consulted anywhere. Graphic 14 shows the databases most used by SMEs, firstly MySQL, followed by Amazon RDS, Firebase, MariaDB and PostgreSQL.



Graphic 14 Database
Source: Own elaboration

Graphic 15 shows the technologies implemented for development in the cloud, where Microsoft Azure is requested by 4 companies, followed by AWS Elastic Beanstalk, AWS Amazon, Digital Ocean and Google App Engine, requested by 2 SMEs each.



Graphic 15 Technologies for development in the cloud
Source: Own elaboration

Acknowledgement

We are especially grateful to the software companies based in the city of San Francisco de Campeche for opening their doors to us and giving us the opportunity to gather information about them.

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Conclusions

SMEs have several areas that allow each of the employees to perform adequately, most of them consider the work climate surveys and give more weight to soft skills with willingness to learn, responsibility and teamwork, as high hiring criteria, leaving experience and certifications in second place, as over time these criteria can be obtained. The phenomenon described above makes them hotbeds of talent.

Most of the companies are under the regime of dependent employees with a salary and legal benefits, while a smaller percentage is occupied by independent contracts, highlighting that this type of regime benefits the fiscal interests of subordinates.

On the other hand, the level of hiring of employees with programming skills is more specified, i.e. they prefer people with technical education rather than postgraduate studies, due to the level of salaries they can offer.

Carrying out the application of the "Virtual Observatory" and being able to visualise the results from different perspectives allows us to know the economics and development of the different companies in the software industry; the advancement and empowerment of the various areas.

It is noteworthy that none of the companies consider an area of risk control or specialised personnel to ensure better development and growth. Therefore, this becomes an area of opportunity to prevent and cope with the risks they may face that could lead them to failure.

It is suggested that in future research, a qualitative evaluation should be carried out to complement the data provided by the instrument with the companies' appreciation of the different reasons that influence their organisational structure.

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Methodology for mechanical design using augmented reality as a learning tool

Metodología para diseño mecánico utilizando realidad aumentada como herramienta de aprendizaje

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Abstract

Augmented Reality is a tool that is being gradually developed in university institutions based on the boom caused by the use of mobile devices and Internet access from almost anywhere.

Education, Tools, Augmented reality

Resumen

La Realidad Aumentada es una herramienta que está siendo desarrolla gradualmente en las instituciones universitarias partiendo del auge provocado por el uso de los dispositivos móviles y el acceso a Internet desde casi cualquier sito.

Educación, Herramientas, Realidad aumentada

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Introduction

Current trends in education recognise the importance of integrating Augmented Reality (AR). It is a tool that is gradually being developed in university institutions due to the boom caused by the use of mobile devices and access to the Internet from almost anywhere.

Therefore, the changes significantly affect the teaching processes, at this moment the incorporation of novel methodologies that seek to exploit ICT is presented. This is due to an important fact which is the new degree of ease with which educational content, or objects of study, are presented for the creation of more realistic, creative, motivating and collaborative learning environments.

Now, AR is defined as a tool that allows us to enrich our environment by combining digitally generated information with physical information in real time, by means of instruments such as tablets or smartphones. The modern world is preparing for the entry of technology into the consumer sector and presents great potential for its application within the educational sector in the coming years.

For a proper evaluation of the effects of this new method in educational and teaching-learning environments, it can be argued that through detailed monitoring of students, the level of effectiveness of AR, as well as ICT, can be determined. In this way it can be concluded that it is possible to measure the performance of the new methodologies oriented to the instruction of topics within the study grid.

Nowadays, new generations are growing up immersed in technology, therefore we can point out the importance of understanding the teaching processes within Mobile Learning and Augmented Reality. This implies that teachers will have to leave behind the traditional ways of teaching, incorporating new ways of transmitting information.

Situation and trends

They identify 2 trends that can be achieved within the study centres. It derives from the progress in the learning process in universities, thanks to the technological improvement of the present Morales, Bellezza, & Caggiano. Achieving flexibility and driving innovation, with a collaborative approach capable of creating solutions in higher education, considering digital literacy as the problem to be solved.

A virtual framework is developed with the intention of standardising and implementing online resources with the aim of improving key skills specific to emerging technologies, seeking to detonate the application of new digital resources such as Augmented Reality in educational environments, with the aim of promoting a greater degree of use of the knowledge acquired by students. Identifying qualified teachers for an innovative, effective pedagogy, solving the problem of school deficiency, with a universal approach.

They have as their main objective long-term trends. to obtain a suitable innovation, for higher education institutions which seek to structure forms that give malleability, creativity and motivation to the student body, achieving new approaches, as well as methodologies based on models that stimulate the change of analysis, being implemented in a wide range of collective environments, using technology as a catalyst to initiate a more widespread culture of discovery, without losing sight of the profitability during the implementation of these new techniques.

In higher education, students are considered as consumers, for this reason there is a need to improve their expectations by achieving an evolution of their behaviour or student achievement, within the different areas of knowledge that are taught in university careers. A change is promoted through the use of technologies that are part of everyday life such as smartphones, extending them to learning, as this is a necessity in today's global environment.

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The technology oriented teaching-learning process in higher education classrooms has strengthened the trend towards open communities. Administrators and faculty alike have recognised that collective action is needed to achieve capable and sustainable methods to support the improvement of specialised ICT-oriented infrastructure, enhancing collaboration between universities, recognising collective social work as a sustainable method of human growth, and providing an opportunity for the adoption of AR.

At this time there are medium-term trends in an expanding interest in the use of new sources of information, with the aim of personalising the learning experience, making ongoing formative assessment of instruction reach optimal levels of performance. The key element to master is learning analytics to achieve an analytical application that can harness the vast amounts of existing data and extrapolate it into new applications for student learning within the classroom of higher education institutions.

Nascent development of models aimed at universities raises the level of bet that is given to innovation aimed at the new digital environments that currently exist, which are considered as advantages when providing new ideas, products, services or methodologies for the application of augmented reality, combined approaches were found that can be of great use in the classroom; it can be considered that students can achieve advantages by implementing learning materials through the use of virtual environments.

New teaching processes require the creation or adaptation of spaces that meet current requirements necessary to implement new trends in education.

Universities provide emerging models, rearranging student environments for more active development. Accommodating scenarios that facilitate project-based interactions with attention to mobility, flexibility and the use of multiple devices by creating smart rooms.

Emerging issues

The digital society is marked by changes that lead to new ways of communicating, transmitting or constructing knowledge information, this implies that educational institutions should not be left behind or static, this means that they must make changes that meet the requests that today's society demands.

Higher education institutions cannot ignore the need to integrate into the so-called digital revolution. For this it will be important to take into account the information systems that society currently possesses, this implies that time and resources must be invested in ICT, in order to facilitate the correct adaptation of education to the needs of students, aiming to draw an achievable future using the tools available to achieve significant progress.

Technological trends within the educational area depend on the degree of adoption or incorporation of ICT in training processes. Triggering organisational or didactic changes that enable students to obtain quality learning, which are combined with the so-called formal education. Responding appropriately to digital literacy trends.

Educational possibilities

Augmented Reality currently has a wide field of implementation in the area of knowledge. This implies that the educational sector is the one that benefits the most from the application of new currents of thought. This means that there are possibilities of application within universities. This technology undoubtedly constitutes a new resource in the classroom.

Therefore, this technology provides a degree of ease within the development of constructivist teaching-learning methodologies, the idea being that the student becomes an active part of the process, making his or her own discoveries, making a connection with previous knowledge, generating ideas or carrying out experiments. At this point it is essential that teacher training seeks the application of emergent knowledge.

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The objective is to know and analyse the needs for its correct incorporation, to investigate the resources that are given to teachers through the application of Augmented Reality, since there is an opportunity to implement new technologies within the educational area, analysing the statistical results to demonstrate the possible training benefits that can be achieved.

Benefits of the application of augmented reality

The use of AR, as a strategy for the development of learning, manages to create an interaction between the physical world and the virtual one, allowing inclusion in education by implementing the so-called self-learning, enhancing the intellectual connection with the physical experience, improving the assimilation and understanding of information.

Augmented Reality, when included in educational teaching, provides a number of benefits such as increased interest on the part of students. Achieving self-learning, this enhances the interaction in real time with the information to be developed within each subject, allowing a connection between the physical and the theoretical. This tool is aimed at working in a practical way in the classroom, producing extra motivation in the students.

The elimination of barriers in education can be achieved through AR. This means that experiments can be carried out in virtual reality that are not possible in the physical world because of their costs, dangers or risks. In this way, the elements are supported with technological features which, generated by software, help with the analysis of different points of view that were previously not possible to achieve.

What is augmented reality?

We can define Augmented Reality as an innovative tool capable of providing virtual objects embedded in an existing environment, through technological devices, therefore, it is stated that it allows to complement the scenario, without replacing it, through a virtual environment with the benefit of presenting relevant information increasing the development of the individual.

They show that AR in conjunction with virtual reality facilitates the entry of universities into the digital era, by being able to apply and present knowledge using emerging technologies. The aforementioned authors point out that the relevance that both terms have currently achieved is thanks to their wide implementation within today's society, through different digital applications that can be manipulated in their daily lives, achieving a generalisation, becoming tools, therefore, their implementation in higher education cannot wait.

They describe AR as a virtual experience that can be understood as a technology that seeks to implement a combination of digital information in conjunction with physical objects or data in real time, allowing users to see and interact with an environment superimposed on the world. In this situation, the subject coexists in a complementary environment, this indicates that there is a relationship that is achieved through the use of mobile devices, such as smartphones or tablets, facilitating their incorporation into the educational sector, as a motivating tool that seeks to increase academic development.

They are able to describe some basic characteristics of Augmented Reality. The first condition speaks of the ability to integrate a real environment in conjunction with a virtual one. As a second issue it indicates that it must be real time and as a third consideration it must be applied in a three-dimensional space generating a precise embedding between the elements. In this sense it allows a combination that transfers information to the individual's visual perception.

4 levels

In the area of Augmented Reality it can be stated that the technology has managed to mature and reached a point where it is possible to achieve a widespread application in all areas of professional training, in this way this tool managed to enter the education sector where it is positioned as a valuable tool used in teaching methodologies.

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Currently we can define that Augmented Reality is composed of 4 levels of immersion as it can be expressed. As shown in table 1. It is observed that for its correct application it is necessary to take into account the elements that make up this system, so this can be expressed that the necessary parts for a correct application are shown in Table 2. It should be stressed that it is important to know that if any of the elements is missing, its application will not be possible.

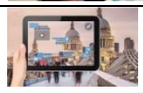
Level 0: Hyperlinks in the physical world	
Level 1: Marker-based augmented reality	
Level 2: Augmented reality without markers	
Level 3: Augmented Vision	

Table 1 Levels of augmented reality
Source: Own elaboration

Physical Reality	Perceived by the observer as dependent on a perspective or physical location in reality
Camera	Capture the real environment or images of the environment to be integrated with the virtual objects
Software	Interprets real world information captured by the camera, processes the information or virtual objects to be superimposed on the virtual world.
Activating Element	Device that triggers the augmented reality process examples: QR codes, markers, images, objects, compasses or GPS.
Screen	Device or element where we can visualise the content of physical reality by integrating augmented reality elements
Observer	Target audience for the digital experience, it is important to determine characteristics such as age, technical knowledge or special abilities, to define how it will be displayed on the screen or device.

Table 2 Elements of augmented reality
Source: Own elaboration

In accordance with the existing levels as they say. It can be concluded that with its generalised use it is possible to obtain information on specific data, such as its history, name or transcendental data, which, in accordance with the existing levels, strategies can be suggested which make use of applications oriented towards information management and knowledge management within the universities.

With markers

It is called with markers those objects that are presented in the form of printed symbols, this means that there is a superimposition of 3D digital information on a conventional 2D medium that when recognised by a camera undera software can be seen embedded information in a conventional medium.

This level is referred to as marker-based. The information will be displayed by means of a trigger, which is that graphic part, which can be a symbol, book, photograph, magazine, infographic, or an image that with the support of a smartphone or tablet will be able to detect the exact place or the information to be displayed, thus to launch the digital experience. The reproduction of this content will be appreciated by means of the electronic device used to read the activating object.

With the advancement of technologies the markers can be designed in a simple way, without highlighting or affecting the aesthetics of the research design that may be present Abularach, Gallardo, & López, (2017). Since generally the applications used for this purpose seek to be flexible, QR symbols, images and objects with characteristics that can be detected can be used to achieve an optimal presentation of the information.

Marker less

Augmented Reality called marker less is based on the recognition of images, objects or GPS locations, without the need for a specific visual indicator that triggers the experience, therefore, the world becomes an interactive canvas, in which practices are presented without limitations that facilitate the control of the experience.

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The so-called level 2 or marker less. To activate these resources, images, objects or GPS locations are used, there is no specific visual indicator that activates the experience. In this context it is concluded that the environment around us becomes a space in which we can appreciate relevant information free of limitations. Allowing the user greater control of their learning, achieving an immersive experience.

In accordance with the levels that currently exist within Augmented Reality, strategies can be suggested in which it is possible to visualize applications directed or oriented towards the handling and management of knowledge information, achieving a motivating immersion that drives the search for knowledge by students, obtaining measurable benefits in the teaching-learning process.

Mobile applications

The digital revolution achieved a technological advance capable of modifying psychosocial interaction, this implies that the way of interacting with the environment has changed, since, thanks to the massification of electronic devices, we are now able to use tools that communicate through the internet no matter where they are located.

They express that Augmented Reality is able to adapt effectively to the new methodologies used within the teaching process. It implies that students demand knowledge effectively created by this technology, being this the starting point for the development of innovative teaching practices, focused on academic training. Through the use of Android or IOS applications, which have gained popularity by delivering unparalleled flexibility, concentrated in a single digital device that seeks to group different tools in one place.

There are now professionals focused on the creation of infrastructures and interfaces, aimed at the integration of hardware and software in new generation devices. This vision turns an emerging technology into a current tool that seeks Augmented Reality as a perfect way to interact with virtual layers that surround the user, providing an environment conducive to educational improvement.

Learning tools

Information and communication technologies

Nowadays, conventional teaching processes are being displaced by new teaching methodologies based on the implementation of Information and Communication Technologies. They originate from the projection of contents or objects of study through the creation of realistic, creative, motivating and collaborative learning environments.

Within this new context it can be seen that teaching methods are used to achieve a high educational development thanks to the innovation presented by the application of ICT in conjunction with the use of Augmented Reality. This means that there has been a remarkable increase in the advancement of a technology that promises to provide possibilities of interaction capable of significantly transforming the learning process by creating new pedagogical techniques.

Evolution is a word commonly used in the field of education, due to the different stages that have occurred over time, which are closely related to the needs that arise in teachers or students over the years. Therefore, it will always be convenient to apply methodologies and strategies in conjunction with ICT management, with the aim of adapting to the new technological tools present today within the so-called digital society.

Simultaneously, the progress made in the development of the internet has allowed the evolution of numerous technological instruments such as tablets, smartphones or applications that provide the opportunity to access virtual environments. These types of environments can provide new forms of interaction based on the combination of virtual and real elements, due to AR, thanks to this new technique society is able to obtain intellectual benefits with greater ease of interpretation.

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Augmented reality and mobile technology

We consider that from the year 2000 presented a rapid advance in mobile technology, leading to significant investments in the education sector, giving students or teachers access to these new tools, which combined with AR allows a more effective teaching-learning process.

This new teaching methodology, managed to increase the benefits obtained by educators or students, through the extended use of existing devices such as smartphones, which are currently relatively simple tools to use, this allows to improve didactics by merging theory with practice. But this brings with it economic disadvantages due to a lack of resources to acquire the necessary equipment for the correct application of AR, together with a lack of knowledge on the part of teachers to achieve its implementation in the classroom.

Nowadays, the so-called technology society has a facility to own technological devices that allow an internet connection 24 hours a day, which means that these tools have become an essential part of everyday life. Therefore, augmented reality is gaining more acceptance within education as it allows combining these technologies in order to improve teaching within universities.

Mobile devices

Nowadays, the progressive popularity of these devices, such as Android or iOs worldwide, has led to their generalised use in the daily life of modern society, which is why their impulse to reach the educational sector was imminent, since thanks to these instruments, the generalised use of AR in mobile devices has become a growing phenomenon.

It must be remembered that young students currently have a competitive advantage which is described as the massive use of devices such as tablets, smartphones or the internet, thus achieving a digital integration that spans from their private life to their education, therefore, higher education institutions cannot miss this trend. Discovery-based learning is often established with this technology, which, combined with AR, allows contextualised learning experiences to be explored by chance or on one's own initiative.

Therefore, the technological means that give users the opportunity to interact, partially or totally, through a mobile device, in an environment that allows mixing the digital with the real, have the hardware and software necessary to achieve together with Augmented Reality a usable tool in training, which have focused on applications for educational environments.

The internet of things

Nowadays, individuals present an ease never seen before to obtain technological devices, with the purpose of having an internet connection, obtaining digital applications that allow us to develop with greater disposition in daily tasks, becoming an essential part of daily life both in the private and in the educational or work segment-.

It is pointed out that the use of digital devices is used by students not only to communicate, but also to manipulate them in an infinite number of educational and leisure applications, all made possible by the use of internet connection which provides unprecedented information management, due to the evolution of the digital era which allows access to online resources from anywhere, through the use of mobile devices.

There are several voices, which point to the fact that universities must take the responsibility to prepare their teachers in order to be able to adopt new technologies that allow them to take advantage of the immense flow of information that exists within the internet and to improve the conditions of the educational infrastructure.

Augmented reality and education

Technologies are capable of innovating in the educational field, generating evolution in the way subjects are taught. The way of relating processes with tools changes, seeking to improve the productivity of the individual, as well as the methodology used in the teaching-learning process. The changes therefore point in the direction of the progress that training must be willing to undergo.

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Not all subjects implement the new sets of techniques to the same extent, detecting that this method is still poorly linked to the formation of learning, identify curricular areas that make contributions to augmented reality: engineering, architecture, urban planning, mathematics-geometry, art, history, physics, design, technology or even medicine. We can therefore confirm that there are fields of opportunity for future research, which motivates the development and focus of this work.

The development of so-called specialised content, together with technological and methodological progress, within the development of augmented reality in the academy, favours the creation of a creative environment, encouraging the development of projects related to each professional functional area. Adapting learning approaches, as well as the type of interaction that subjects can use.

Intellectual capital

It was identified that in Higher Education Institutions it is vital to share the intellectual capital generated in the processes of creation, transfer and dissemination of teaching. However, within universities, a system for managing information must be guaranteed. In accordance with the theory of knowledge management on campuses, which identifies three areas of reflection.

A) The identification of research priorities, B) The study of intellectual capital and intangible assets of universities, C) The projection of the institution in its environment to promote the social appropriation of knowledge. Educational institutions are aware that management is a vital element for maintaining competitive advantages, and it is here where information technologies offer tools to achieve strategies for the management of education, that is, to promote student development, achieving a solid structure.

In order to consolidate the scientific value in the field of education, the use of augmented reality is proposed as a means to achieve this, as one of the strategies for consolidating appreciation. In this way achieving a transfer of knowledge under different applied strategies, proposing a use that allows to obtain tangible benefits.

Media strategy

It should be understood that the media strategy is related to the understanding of knowledge management, directly related to document processing, teamwork and basic forms of data visualisation. The perspective that is required is that of a development of platforms capable of building strategies for understanding information.

As a reference, a structure with three categories of knowledge management processes is presented. Firstly, it is said that a value system is needed that contains the consolidation of information, with innovation in processes. Secondly, it is necessary to take into account human capital, in order to facilitate the development of competencies and valuable practices. Third we find instrumental capital which is referred to as the formative knowledge base of research products.

Achieved through mass popular acceptance of the importance of audiovisual communication, which is common nowadays, this means that generating digital teaching material is commonplace, this production has a great pedagogical potential, therefore Augmented Reality makes its way into innovative development in the field of education.

In the field of education

Nowadays, society is immersed in technological changes presented in the last decade, offering challenges in the educational processes according to the plasma in particular, its pedagogical use must be an element with high priority within the instruction and its didactic application in the formative context granting benefits, propitiating a more dynamic learning.
AR allows the creation of inverse environments with virtual layers that allow students to be positioned in a simulation of situations or contexts that can only be possible in real environments. For example, medical students can see the inner organs of the human body in three dimensions, achieving an improved understanding of how they work, through audiovisual material. This feature helps students to acquire the required knowledge more easily.

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AR improves generic competences in university environments, through the integration of active methodologies, understanding complex processes from the inverse possibilities, the use of this technology presents high indicators of motivation and satisfaction, improving the results. This means a qualitative leap in teaching, transforming students' perception of physical reality.

RA technology in educational practices

Current trends within the higher education sector recognise the importance of the integration of teaching-learning with a comprehensive application, making use of methodologies that allow a better understanding of curricular information, in conjunction with methods for the improvement of knowledge instruction.

They formulated a proposal for the improvement of the teaching-learning process based on AR, called "RA4 Educa", creating an innovative didactic resource that emerges from a media experience through the visualisation and interaction with virtual objects superimposed on real entities, reaching curricular contents that constitute a potential improvement for educational development, establishing an active and motivating methodology aimed at the student body.

There are significant improvements in academic performance together with the digital competences that students integrate through Augmented Reality, concluding that the dynamic activities in the academic intervention, make the application possible, bringing benefits in the teaching processes, promoting an innovation of educational improvement with the use of technology.

Context of augmented reality in university education

Nowadays, emerging technologies have become increasingly relevant in educational contexts. AR has been deployed in a large number of research or innovation experiences in the teaching area, which have managed to demonstrate the positive aspect of its use for learning, due to the fact that it combines the real world with the virtual world, providing a mixed view of an element.

Augmented technologies allow an introduction of the individual in a context of practices that help to experience activities of everyday life in the classroom, as well as unconventional experiences, this means that situations are presented without any danger, this provides the student with a visual guide, which helps him to better understand the contents explained in the classroom, which brings the existing reality outside the educational context. This enhances the diversity of representations of a concept.

- Helps in the development of cognitive, spatial, perceptual-motor and temporal skills in students, regardless of age or educational level..
- It manages to reinforce short-term memory, attention, concentration, (mediated memory). By activating cognitive processes in the teaching and learning process, AR is defined as an active technology that allows to confirm, refute or expand knowledge, generating new ideas or opinions about the world.
- It forms attitudes to reflect on educational issues by providing solutions to specific problems.
- It provides an effective communication transfer environment within educational work. Reduces the uncertainty of knowledge around an object of study.
- It increases the positive attitude of students within the learning process, as well as the motivation or interest of the student, reinforcing skills and competences.

Table 3 Main advantages of Augmented Reality in the academic context
Source: Own elaboration

It concludes that the elements, whether positive or negative, managed to converge in the fact that when AR is well used, interest in the curricular content grows, the key element in this case being motivation. In this way, it can be seen that the teacher is in charge of arousing interest in the students both in the application of the contents taught in the classroom and those outside the educational center.

Motivation within the training and learning process

The key element for AR, the so-called motivation, is considered as the necessary variable to achieve school success. The activities to be carried out by teachers to attract the student's attention focus on the set of processes involved in activating, directing, persisting and concentrating attention on a task or activity, these are the indicators of motivation. Motivation can usually be considered to be determined by intrinsic or extrinsic variables, placing information and communication technologies in the second type.

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It is possible to visualise that there are different works in which they help to know the degree that these awaken on the external variables, marking that their use increases the motivation of the students, looking for as purpose to be able to improve the academic performance, on the other hand they indicate that it is an internal state or condition that directs us towards the action in situations of teaching.

Finally, all the components will have an impact on the creation of satisfaction that establishes the continuation of motivation to undertake. The foundations on which these ideas are based refer to the teaching strategies and methodologies used by the teacher that are perceived as useful by the students to achieve objectives or competences in educational instruction.

Conclusions

The development generated in the last decade, achieved an inclusion of mobile devices in the daily life of society seeking to bring these technologies to the educational field, obtaining an emergence of the diversity of computer applications. They run on a mobile platform, which can enhance the teaching process.

The AR is able to offer possibilities to analyse study entities, be assimilated the advantages offered by this tool in the teaching process, through the use of mobile devices. Its incorporation in the educational area is technically simple, however, the great challenge is the need for teachers to change their traditional pedagogical roles, which are strongly marked by those of transmitter of information and evaluator. Teachers must be trained, at the same time as they are aware of the power of communication and motivation that this tool is capable of endowing them with.

It is worth mentioning that the gender and age of the student does not determine the degree of acceptance of AR, as it can be affirmed that the vast majority of students have managed to achieve a significant level of knowledge in the different subjects that were mediated by this technology, its use being very intuitive.

Facilitating the learning processes, allowing to decide the knowledge that will be shown to the user, in this way the content is more attractive, increasing considerably the attention in relation to the teaching.

The implementation of this tool oriented to education needs to train teachers at a pedagogical and technological level because it is necessary to have a guide figure throughout the teaching process. Being able to provide manuals that promote the use of AR by the teacher, this topic should be approached from the technological or content competences for a complete application in the classroom.

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Control through artificial neural networks of direct current motor

Control mediante redes neuronales artificiales aplicado a un motor de corriente continua

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Abstract

The main objective of this work is to present the methodology to control the speed of a DC motor experimentally through artificial neural networks of the NARX type (Nonlinear Autoregressive Neural Network with exogenous inputs). To achieve this, the artificial neural network was trained (ANN) on the Matlab platform, the speed of the motor was controlled in real-time with the LabVIEW software and a CompactRio data acquisition system, and it was possible for the speed of the motor to follow a constant reference, obtaining a steady state error less than 3 %.

Artificial neuronal networks, DC motors, Control

Resumen

El objetivo principal de este trabajo es presentar la metodología para controlar la velocidad un motor de CC de forma experimental a través de redes neuronales artificiales de tipo NARX (Red Neuronal Autorregresiva no lineal con entradas exógenas), para lograr lo anterior se entrenó la red neuronal artificial (RNA) en la plataforma Matlab, se controló la velocidad del motor en tiempo real con ayuda del software LabVIEW y un sistema de adquisición de datos CompactRio, se logró que la velocidad del motor siga una referencia constante obteniendo un error en estado estacionario menor al 3 %.

Redes neuronales artificiales, Motores de corriente continua, Control

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Introduction

Currently the vast majority of processes are controlled automatically, due to the need to improve safety and reliability, as well as quality control of products, so every day new control methods are sought, an alternative are artificial neural networks (ANN), due to its characteristics are able to control different types of processes.

The process to be controlled is a DC motor, which is a machine widely used in industries, robots, training equipment such as treadmills where it is desired that the speed of the belt is constant and applications that demand high torque.

An artificial neural network can be described as a massively parallel combination of simple processing units that can acquire knowledge from the environment through a learning process and store the knowledge in their connections (Haykin, 1994). The basic structure of a neuron is shown in Figure 1.

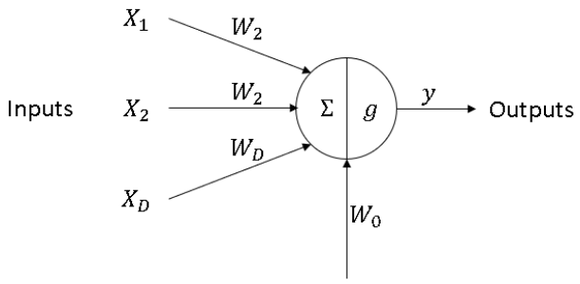

Figure 1 McCulloch-Pitts neural model

From Figure 1, the elementary formula for the output of a neural network can be extracted and is expressed as:

$$Y = \sum_{I=1}^{D} W_i X_i + W_0$$

where $Y\ and\ X_i$ are the outputs and inputs of the neural network, W_i are the weights of the neurons and W_o is the bias.

ANNs can be trained relatively easily, which is one of the main advantages over other types of controllers, in which it is necessary to know the dynamics of the system to be controlled, whereas an ANN only needs to know the inputs and outputs of the system to be controlled.

Related works are presented by: Martínez, Palacios & Velázquez (2012), which use ANNs for the speed control of an internal combustion engine, for the design of this control they used engine speed data, injection time, accelerator pedal angle and pollutant emissions, Martínez & Díaz (2013) apply a PI control, PID and an ANN for the speed control of an AC engine and compare their performances.

Llopis, Vallés & Navarro (2018) designed 3 types of control for a DC motor theoretically using controllers: PID, fuzzy control and control by ANN, their results presented were in simulation unlike the present work which was done experimentally.

This work focuses on the creation and training of an ANN to experimentally control the speed of a DC motor, obtaining a steady state error of less than 3%.

The work is divided as follows: section 2 explains the methodology used to create andtrain an ANN to control a DC motor, section 3 presents the results of applying the controller with ANN experimentally, and finally section 4 presents the conclusions.

Methodology

Figure 2 shows a block diagram of the ANN control scheme, where the input represents the reference value, in this case is the motor speed in Revolutions Per Minute (RPM), the ANN control will perform the necessary calculations to deliver the amount of voltage that must generate the power stage that feeds the motor to reach the reference speed, the output is the measured speed of the motor in RPM.

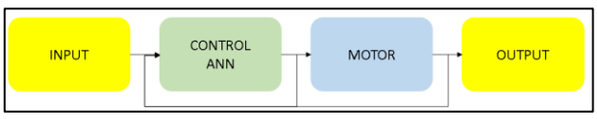

Figure 2 ANN control scheme
Source: Own elaboration

The methodology for obtaining control by means of an ANN is described below.

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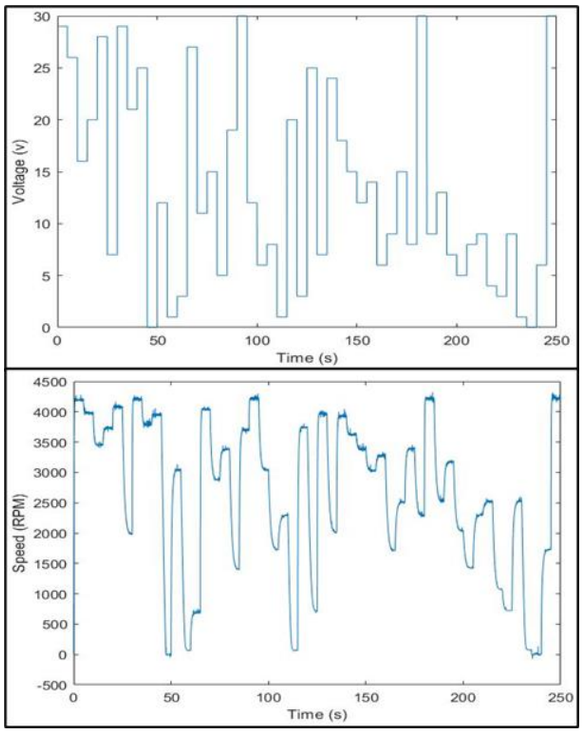
The first step is to obtain an ANN that models the DC motor, for this, a series of step inputs of different voltages with a duration of 5 s were applied, this generated voltage feeds the motor and will make it rotate at a speed in RPM, which is equivalent to each voltage. Graph 1 shows the data of voltages (top) and speeds measured in the motor (bottom). Once the input and output data of the motor are obtained, the ANN is trained with the help of Matlab software. The trained ANN has a two-layer structure with two neurons, it has a hyperbolic tangent activation function, in the output layer it has one neuron and its activation function is linear as shown in Figure 2.



Graphic 1 Voltage data applied to a DC motor (top). Motor speed data in RPM (bottom)
Source: Own elaboration

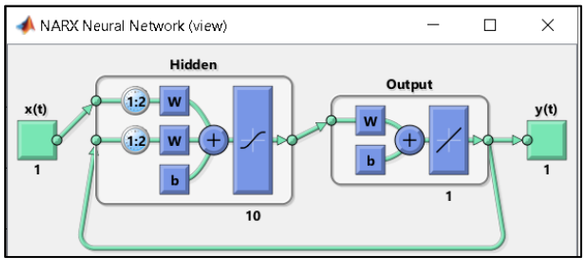
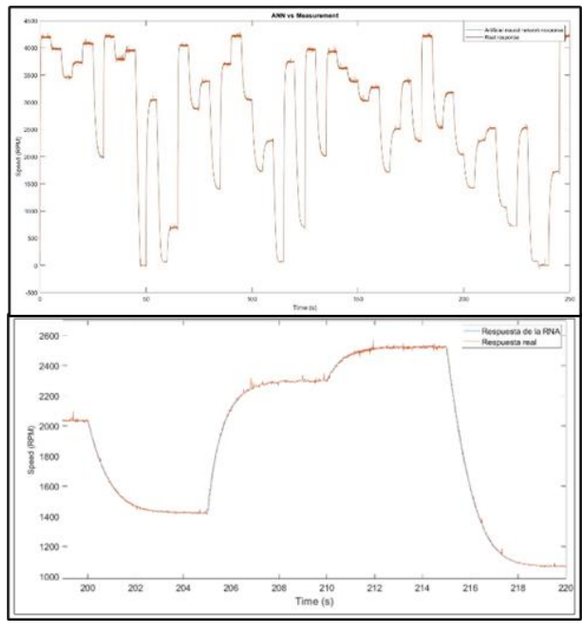


Figure 2 NARX-type artificial neural network with one input (voltage) and one output (dynamic behaviour of the engine in revolutions per minute)
Source: Deep Learning Toolbox, Matlab

To validate the ANN, the coefficient of determination was checked, obtaining a value of R= 0.9995, which indicates that the network estimates the output data correctly.

Graphic 2 shows the speed estimated by the network and the measured motor speed (top), and an enlargement of the measured and estimated speed (bottom).



Graphic 2 Validation of the ANN. Estimated and measured velocity (top). Close-up of the estimated velocity and measured velocity (bottom)

The second step is to train a network that is made up of two parts: one that represents the motor and one that will function as the control. The result of this second training is an artificial neural network as shown in Figure 3. It can be seen in Figure 3 that the new network is divided into 4 layers, the first two layers represent the control, while layer 3 and the output layer represent the engine. The input data in this case will be the reference RPM and the output data corresponds to the speed generated by the second network which simulates the dynamic behaviour of the engine.

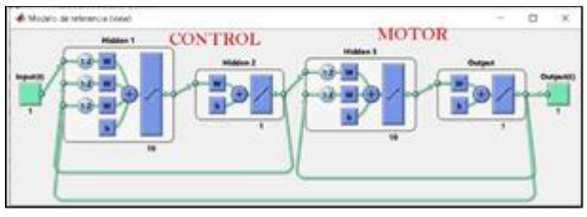
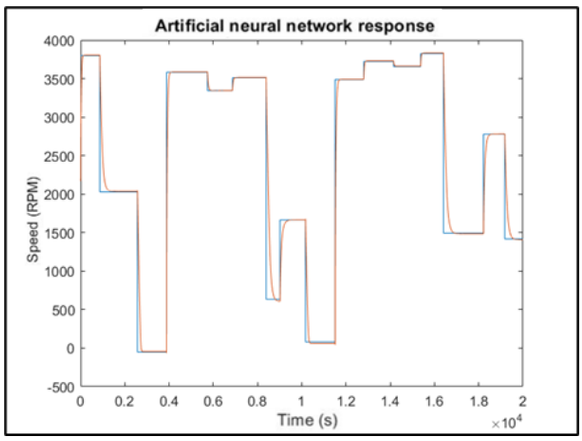


Figure 3 NARX-type artificial neural network representing DC motor and its control

The training is performed with the help of Matlab software. Figure 3 shows the simulation results with reference signals with a duration of 100 s each, and the signal estimated by the neural network.



Graphic 3 Behaviour simulated by the control of an ANN with different step inputs

The final step is to copy the data of the weights of the first two layers of the trained network, so that the controller can be programmed using LabVIEW software and then applied in real time.

Results

In this work a DC motor was used which is connected to a CompactRIO (CRio) data acquisition system, shown in Figure 4.

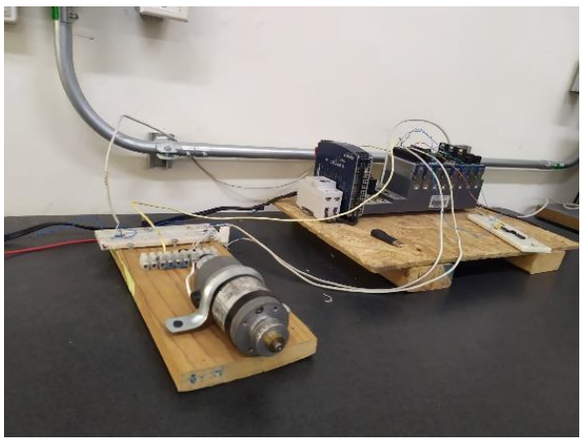


Figure 4 DC motor and its connections to the CompactRIO

The Crio data acquisition system is integrated by the NI 9220 analogue voltage input card, which is used to measure the motor voltage and the voltage of the generator coupled to the DC motor, which is proportional to the motor speed. The NI 9403 digital output board is used to drive the IGBT through a PWM to control the voltage supplied to the motor. Figure 5 shows the electrical diagram of the prototype.

Parameters	Valor
DC voltage	30.8 V
Current	3 A
Speed	4200 RPM
Torque	1.6 $\frac{N}{m}$

Table 1 Engine nameplate data

Figure 6 shows the Human Machine Interface (HMI) for the control of the motor through ANN which was programmed in Labview, then, each of its parts is described:

- Reference speed: it is understood as the speed in RPM requested to the ANN to generate a voltage and the motor reaches the reference.
- Actual speed: this is the speed that is being measured in the DC motor by the CRio.
- U or network output: this value indicates the voltage calculated by the ANN and sent to the power stage.
- The graph shows the steady state behaviour of the measured motor speed in RPM.

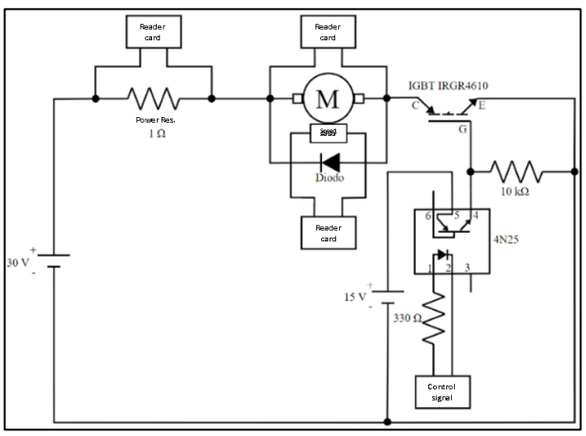


Figure 5 Electrical circuit for sensors and motor control
Source: (Hernández-Santiago et al., 2021)

Figure 6 shows that the reference speed is 3500 RPM, and the DC motor has a measured speed of 3594 RPM, i.e., 94 RPM above the desired value, which represents an error of 3 %.

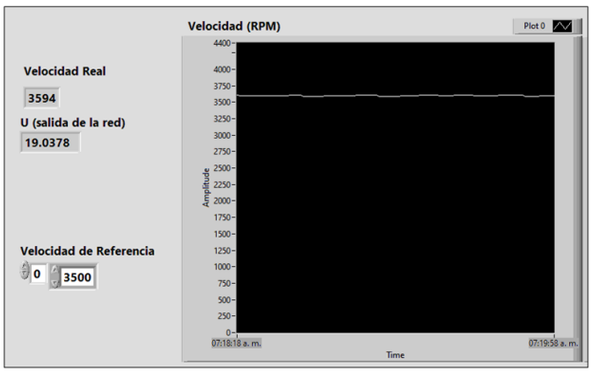


Figure 6 HMI for speed control of a DC motor at 3500 RPM

Tests were carried out at different reference speeds and the following results were obtained and are shown in Table 2.

Reference value RPM	Average RPM	Average RPM	Percentage error (%)
2500	2491	9	0.4
3000	3094	94	3
3500	3594	94	3

Table 2 Experimental results of the artificial neural network controlling the engine

Conclusions

The objective of controlling the speed of a DC motor through artificial neural networks of the NARX type was achieved since the motor is able to reach the reference value in the whole range of motor speeds with an error below 3%.

One of the main advantages of this type of control by means of an ANN is that only one database is needed to train the ANN which consists of: the voltage applied to the motor and the motor speed in RPM. It is important to highlight that for the control to work correctly, the range of data must change from the minimum to the maximum of the motor supply voltage, that is, throughout the motor operating range, and the more precise and accurate the data is, the better its performance in controlling the motor speed.

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Article

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Online store: integrative activity in computer engineering in times of pandemic

Tienda en línea: actividad integradora en ingeniería en computación en tiempos de pandemia

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Abstract

This paper presents the Integrative Activity of an online store that has been worked with students over three semesters: fifth, sixth and seventh, the idea of making an online store arises because this project began at the time of confinement due to the COVID-19 pandemic. The Activity was divided into three phases, the first phase covering the subjects of: Requirements Engineering and Estimation, Database Consultations and Optimization and Human-Computer Interaction. The second phase covers the subjects of Design and Modeling of Software, Design of Virtual Environments and Computing for mobile devices. The project ends with the third phase with the subject of Software Testing and Implementation. The main contribution is the joint realization of different subjects in three semesters for the construction of a quality online store under quality practices.

Integrative Activity, Online Store, CMMi

Resumen

En este artículo se presenta la Actividad Integradora de una tienda en línea que se ha trabajado con estudiantes de Ing. en Computación a lo largo de tres semestres: quinto, sexto y séptimo. La idea de desarrollar una tienda en línea surge debido a que este proyecto se inició en época de confinamiento por la pandemia de COVID-19 y como parte de la formación de su licenciatura. La Actividad quedó dividida en tres fases, la primera fase cubriendo las materias de: Ingeniería de Requerimientos y Estimación, Consultas y Optimización de Bases de Datos e Interacción Humano Computadora. La segunda fase abarcó las materias de Diseño y Modelado de Software, Diseño de Ambientes Virtuales y Cómputo para dispositivos móviles. El proyecto se finaliza con la tercera fase con la materia de Pruebas e Implantación de Software. La contribución principal es la realización en conjunto de diferentes materias en tres semestres para la construcción de una tienda en línea siguiendo prácticas de calidad.

Actividad Integradora, Tienda en línea, CMMi

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Introduction

Carrying out Integrating Activities at the Autonomous University of Tlaxcala is an important part of complementing student learning, so it has been implemented in the Bachelor's Degree in Computer Engineering that in the fifth, sixth and seventh semesters they carry out the development of a software project that has three subjects in the area of Software Engineering as its axis. In the Software Engineering subjects, the complete software development life cycle is studied, applying good documentation and programming practices throughout the development process. At the same time, the CMMi level 2 model is used, resulting in quality software. In this case we worked on an online shop, taking advantage of the boom that the pandemic gave to this type of systems.

Integrating activity

The IA Integrating Activity is a pedagogical strategy that favours active learning through the convergence of knowledge from different disciplines (know what), processes and procedures (know how and know how to do), and the application of knowledge and learning of students to solve a problem situation in the national context (know how to be). Therefore, the Integrating Activity demands reflection, dialogue, critical capacity and sensitivity to the social context of all participants [1].

The integrative activity at the Autonomous University of Tlaxcala involves both the formation of student work teams and collegiate groups of teachers whose main purpose is the integration of declarative, procedural and attitudinal learning from the different learning units in an interdisciplinary work that generates situated learning by confronting students with problems of social relevance and, consequently, contributing to the development of the competences set out [2] [2].

Description of the method

The CMMI model for development defines a set of specific practices oriented to the development of software products, the model in its level 2 defines practices for requirements management, project planning, monitoring and control, quality assurance, measurement and analysis, configuration management and follow-up with suppliers [3], in this work we present the experience in the development of a software project in the framework of the integrative activity with the application of practices of the CMMI Dev level 2 model.

Integrating Activity: Online Shop

First phase:

The first phase consisted of developing and applying knowledge related to the analysis, design and construction of an online shop, integrating concepts of query construction and database optimisation, requirements engineering and estimation, as well as interface design. In addition, knowledge was applied that allowed the student to identify good practices in the definition of requirements of a software system under a quality approach.

Subjects involved and work carried out

- In the subject of Requirements Engineering and Estimation, the Requirements Specification and Detailed Project Planning document was worked on.
- In the subject of Database Queries and Optimisation, the E/R model to be used in the project was designed, as well as a list of 10 queries of the shop.
- In the Human Computer Interaction subject, the Online Shop Interfaces were designed.

During this Integrating Activity 14 teams participated, belonging to two groups: 5A and 5B, each developing a different online shop. As an example, the project Mingo's Pizzas will be used to show some deliverables:

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In the subject of Requirements Engineering and Estimation, the Requirements Specification and Detailed Project Planning document was worked on. This article shows the System Functionality Listing consisting of 17 use cases of the Mingo's Pizzas project.

No.	Use case name	Priority	Complexity	Actor to whom it is addressed
1	CU01_Log in	Essential	Simple	User
2	CU02_Register users	Essential	Simple	Customer
3	CU03_Arm your pizza	Essential	Medium	User and Client
4	CU04_Select promotions	Essential	Simple	User and Client
5	CU05_Pay by credit card	Essential	Medium	User and Client
6	CU06_Generate purchase ticket	Essential	Simple	User and Client
7	CU07_Modify profile	Esencial	Simple	User
8	CU08_Consult shopping cart	Essential	Medium	User and Client
9	CU09_Select extra products	Essential	Medium	User and Client
10	CU10_Close session	Útil	Simple	User
11	CU11_Add pizzas	Esencial	Simple	Administrator
12	CU12_Manage pizzas	Essential	Simple	Administrator
13	CU13_Add extra products	Essential	Simple	Administrator
14	CU14_Manage extras	Essential	Simple	Administrator
15	CU15_Add promotions	Essential	Simple	Administrator
16	CU16_Admin_Administer promotions	Essential	Simple	Administrator
17	CU17_Close administrator session	Útil	Simple	Administrator

Table 1 List of system functionality

For the subject of Database Queries and Optimisation, the E/R model is presented. It is worth mentioning that MYSQL was used to create the tables: Users, Pizzas, Extra products, Inventory products, Suppliers, Offers and Orders, the corresponding relationship is indicated in the model.

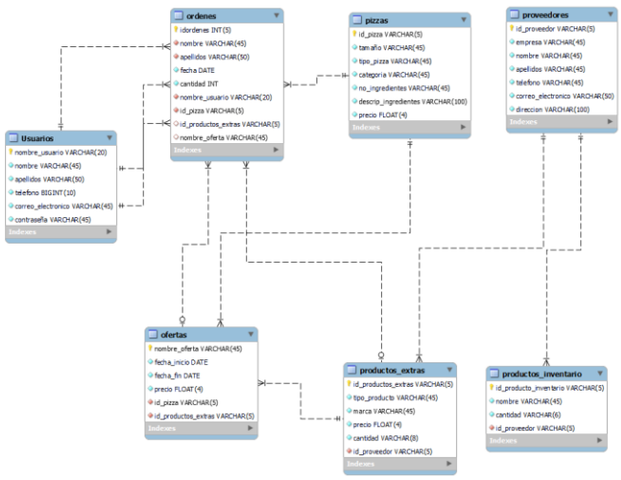

Figure 1 Model E/R

In the subject of Human Computer Interaction the Online Shop Interfaces were designed. This section presents the home interface for the customer view.

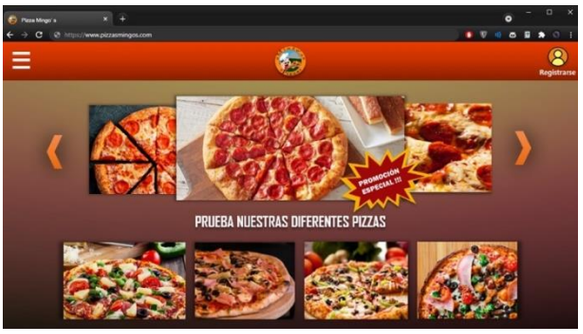

Figure 2 Client interface

Second phase:

For the second phase it was established that the student should know and apply tools for the design and development of a software system, including an activity on the design of virtual environments and another on mobile devices.

Subjects involved

- In the subject of Software Design and Modelling, the student carried out the logical design with different UML diagrams, as well as the construction of the same.
- In the subject of Virtual Environment Design, the modelling of 3D objects in the online shop was carried out, as well as their holograms for the dissemination of the items on sale.
- In the subject of Computing for Mobile Devices, an Augmented Reality application was developed.

Figure 4 shows how Mingo's Pizzas allows you to assemble the pizza, Figure 5 shows that it has payment options, and Figure 6 shows the Mingo's Pizzas administrator options.

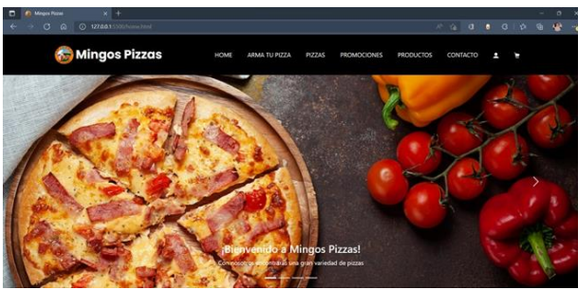

Figure 3 Mingo's pizzas online system

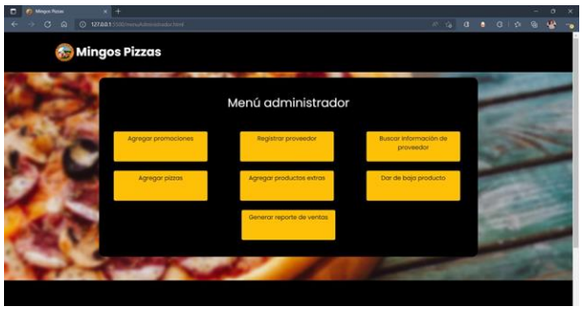

Figure 4 Mingo's Pizzas allows you to assemble the pizza

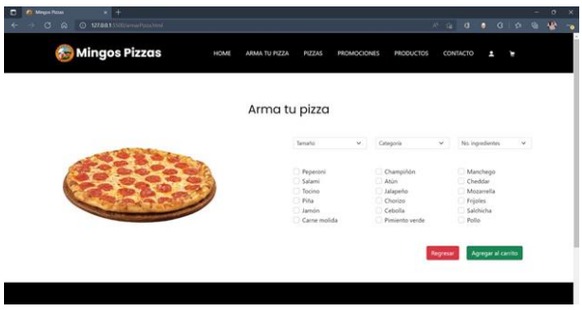

Figure 5 Mingo's Pizzas payment method

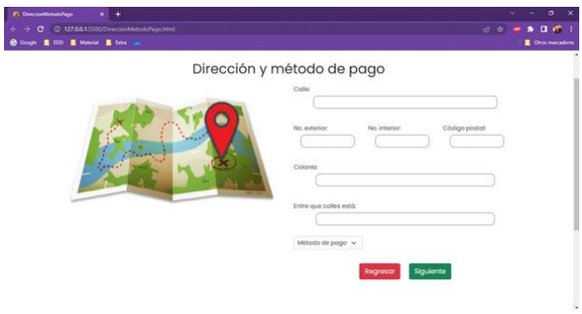

Figure 6 Administrator section

In the Virtual Environment Design course we worked on the 3D modelling of the products of the online shop using Blender [4] and the Virtual Reality methodology of [5], Figure 7 shows a 3D pizza, Figure 8 shows how the 3D pizza is prepared to be presented holographically, to be used in an acetate or glass pyramid.

Figure 7 3D modelling of a pizza

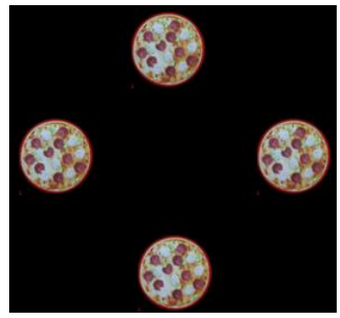

Figure 8 Modelling of a pizza ready for pyramid holography

In the subject of Computing for Mobile Devices, an application was developed using augmented reality. For the creation of the application, the video game engine Unity [6] and Vuforia Engine were used.

For the Augmented Reality application, targets, 3D objects were used, an illustrative video, name and price were added, so that when the target was displayed, this information would be shown.

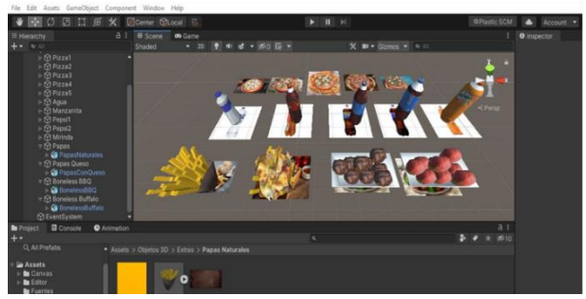

Figure 9 Building Augmented Reality from Unity

Figure 10 Augmented Reality of Mingo's Pizzas

Third phase

In the seventh semester, the completion of the system is planned with the elaboration of supporting documents such as user manuals, operation manuals and maintenance manuals. As well as a letter of completion of the system and a letter of satisfaction and recommendation to the work team.

Conclusion

Currently the software development industry requires software development professionals who know and apply all the phases involved in the implementation of a software system, in this case an online shop, covering the most demanding activities of the software life cycle in a real context.

- The development of a software system from its initial phases to its construction allows the student to understand the requirements involved in the analysis, modelling, design and implementation of computer systems for the construction of quality systems.

- Quality standards were used in modelling, design and construction using software engineering methods and practices, in a professional and relevant manner for the implementation of computer systems.

- Relevant solutions were built using design aspects and implementation alternatives under different computational paradigms for technological innovation.

- The ability to work collaboratively for the development of computational projects was developed.

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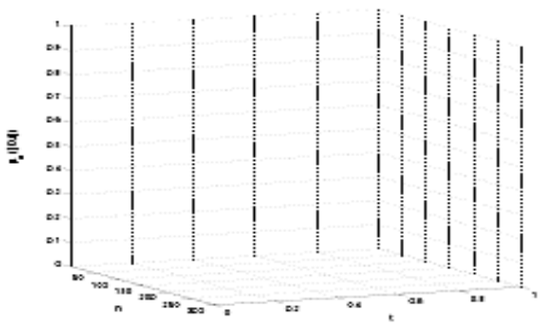

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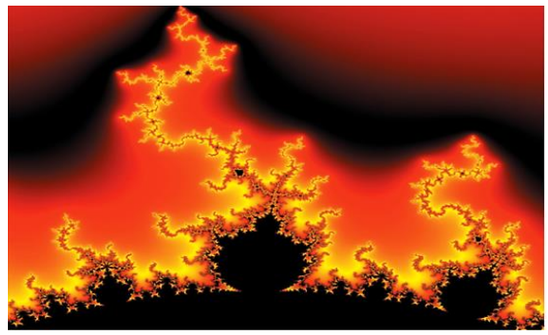

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