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Presentation of the Content

In the first article we present, *Problem Based Learning as a strategy for teaching algorithms*, by HERNÁNDEZ-CRUZ, Luz María, MEX-ALVAREZ, Diana Concepción, FLORES-GUERRERO Mayra Deyanira and MARTÍNEZ-GÓMEZ, Sarahi Del Jesús, with adscription in the Universidad Autónoma de Campeche, as the next article we present, *Proposal of a computer security scheme for a Comprehensive Planning System*, by ROJAS-ALONZO, Jhon Henry, ARRIOLA-ESCALANTE, Claudia Ivette, MENA-CANTORAN, Rocio Lilia and CEJAS-LEYVA, Nohemí, with adscription in the Tecnológico Nacional de México Campus Agua Prieta, as the next article we present, *Integration and programming of delta-type parallel robot prototype*, by RODRÍGUEZ-FRANCO, Martín Eduardo, JARA-RUIZ, Ricardo, LÓPEZ-ÁLVAREZ, Yadira Fabiola and DELGADO-AGUILERA, Jorge, with adscription in the Universidad Tecnológica del Norte de Aguascalientes, as the next article we present, *Design and implementation of a fuzzy control of temperature for a plastic aging chamber*, by MEDINA-MARTÍNEZ, Sergio Iván, JUÁREZ-TOLEDO, Carlos and MARTÍNEZ-CARRILLO, Irma, with adscription in the Universidad Autónoma del Estado de México.

Content

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Problem Based Learning as a strategy for teaching algorithms

El aprendizaje basado en problemas como estrategia para enseñar algoritmos

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Abstract

This study proposes applied research to adopt problem-based learning as a learning strategy for educational programs in computer science. The use of the seven-step methodology is available to implement problem-based learning in a case study within the Autonomous University of Campeche. It refers to the basic algorithmic subject of the logical of programming studied in the first semester of the curriculum map. As an added value and promoting the quality of education, the didactic sequence is added as a technique to apply said strategy and the integration of technological tools that promote, in the same way, educational innovation. The results demonstrate that the adaptability of problem-based learning is efficient and effective in acquiring meaningful learning specifically in the silver case. Likewise, it opens a path for new related research and contributes to the achievement of the graduation profiles of university students. Finally, it is relevant to mention the ease, flexibility and usefulness of the PSeInt software as a tool for algorithm design.

Problem Based Learning, Algorithms, Didactic Sequence

Resumen

El presente estudio propone una investigación aplicada para adoptar el aprendizaje basado en problemas como estrategia de aprendizaje para programas educativos en ciencias de la computación. Se dispone del uso de la metodología de los siete pasos para implementar el aprendizaje basado en problemas en un caso de estudio dentro de la Universidad Autónoma de Campeche. Particularmente, se refiere al tema implementación de algoritmos de la asignatura lógica de la programación cursada en el primer semestre del mapa curricular. Como valor agregado y promoviendo la calidad de la educación se añade la secuencia didáctica como técnica para aplicar dicha estratégica y la integración de herramientas tecnológicas que impulsen, de igual forma, la innovación educativa. Los resultados demuestran que la adaptabilidad del aprendizaje basado en problemas es eficiente y eficaz para adquirir el aprendizaje significativo específicamente en el caso plateado. Asimismo, se abre un camino para nuevas investigaciones afines y se contribuye al logro de los perfiles de egreso de estudiantes universitarios. Es relevante mencionar la facilidad, flexibilidad y utilidad del software PSeInt como herramienta para el diseño de algoritmos.

Aprendizaje Basado en Problemas, Algoritmos, Secuencia didáctica

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Introduction

The word algorithm comes from the nickname of a 9th century Arab mathematician, Mohammed al-Khowarizmi, who was recognized for stating step-by-step the rules for basic mathematical operations with decimals (addition, subtraction, multiplication and division). An algorithm is a group of consecutive orders that present a solution to a problem or task. An algorithm "is a method to solve a problem", "it is a detailed, ordered, finite, sequential description of the steps that allow you to reach an objective or solve a problem" (Ferreyra, 2015).

In the area of computer science, an algorithm must be the precise and clear description of the ordered steps to solve a finite problem showing a beginning and an end (Pérez, 2010).

Educational programs in computer science commonly include subjects that allow students to learn to design algorithms and develop skills that allow them to solve problems using the computer.

Given this, the idea of applying Problem-Based Learning (ABL) as a learning strategy in the Logic subject of the programming of the educational program Computer Systems Engineer (ISC) of the Faculty of Engineering at the Autonomous University of Campeche (UAC) arises.).

Problem-Based Learning (ABL) is emerging as one of the most innovative approaches in current professional and academic training, gaining more and more space in the world's leading universities (Sastre, 2008). This learning method allows you to acquire the following generic skills:

- Analyze and solve problems
- Develop critical thinking
- Master interpersonal skills
- Teamwork
- Develop metacognitive skills, self-confidence and self-control
- Manage change
- Learn to learn
- Apply continuous improvement strategies

The difference of the problem-based method with the traditional learning design is that in the latter the trainer transmits information and then seeks its application, while in problem solving, the problem is first presented and then what knowledge is necessary to work it out. In this model, the role of the trainer follows the patterns of the mentor, tutor or facilitator (López Camps, 2005).

The learning strategy, by itself, does not lead to the generation of meaningful knowledge in students. It requires a set of activities, tasks and tools that define the teaching-learning process aligned to the strategy and carried out in a particular context.

Specifically, a didactic sequence is a unit of strategic planning, that is, a design guided by an educational purpose (what is to be achieved) and aimed at helping our students achieve specific learning objectives, considering their needs and possibilities, and the particularities implementation context.

Didactic sequences are sets of learning activities. Learning activities, that is, actions carried out by the student to build new knowledge, are an essential component of didactic proposals. All teaching sequences must meet a series of requirements (Taboada, 2021):

- Each included activity must be meaningful in itself and designed with specific objectives in mind.
- All activities must be articulated and organized in such a way that they work together to allow the fulfillment of a greater learning objective.
- They respond to a design in which each activity constitutes a learning opportunity and in which the sequence of activities proposed to the students is not accidental but intentional, based on the learning objectives set.

On the other hand, the integration of Technologies in education implies taking into account the relationship that must be established between the use of new media and educational innovation. "The differentiation of the successive stages that the teacher goes through before the integration of ICT, can be useful, both for diagnosing the situations in which we find ourselves, and for designing training strategies" (García Valcárcel, 2013) .

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The present study aims to present an applied investigation of problem-based learning (PBL) as a strategy in the teaching-learning process. The research covers a specific applied case that follows the seven-step methodology and includes as a technique the didactic sequence integrating technological tools for the development of meaningful knowledge in higher education in the area of computer science. Figure 1 shows the structure of the study.

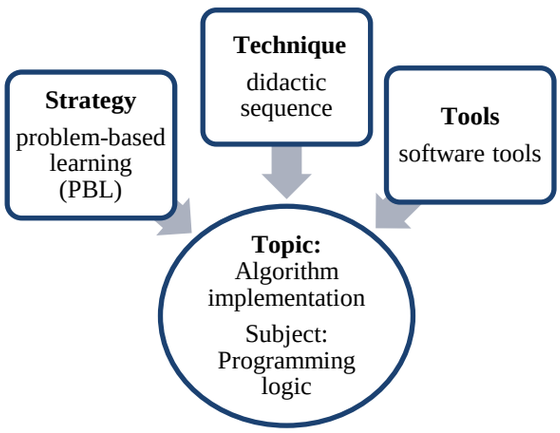

Figure 1 Problem-Based Learning Process
Source: Own Source

Methodology

Problem-based learning begins with the presentation of the problem to which students have to find an answer, continues with the identification of the learning needs that arouses the search for the answer to the problem, and ends with the access to the necessary information and the back to the problem. The process is conventionally developed according to what has been called the "seven steps" and is known as the Maastricht Model (Ortiz Cárdenas, Calderón Ariosa, & Travieso Valdés, 2016).

In the version used by the University of Maastricht, students follow a seven-step process to solve the problem (Moust, Bouhuijs and Schmidt, 2007; Schmidt, 1983), which will be the methodology used in the applied case of the present research:

1. Clarify concepts and terms: It is about clarifying possible terms in the text of the problem that are difficult (technical) or vague, so that the whole group shares their meaning.

2. Define the problem: It is a first attempt to identify the problem that the text raises. Later, after steps 3 and 4, you can go back to this first definition if necessary.

3. Analyze the problem: In this phase, students contribute all the knowledge they have about the problem as it has been formulated, as well as possible connections that could be plausible.

4. Carry out a systematic summary with several explanations to the analysis of the previous step: Once the greatest number of ideas about the problem have been generated, the group tries to systematize and organize them, highlighting the relationships that exist between them.

5. Formulate learning objectives: At this point, students decide which aspects of the problem need to be investigated and better understood, which will constitute the learning objectives that will guide the next phase.

6. Seek additional information outside of group or individual study: With group learning objectives, students seek out and study missing information. The learning objectives can be distributed or they can all be worked on, depending on what has been agreed with the tutor.

7. Synthesis of the information collected and preparation of the report on the knowledge acquired: The information provided by the different members of the group is discussed, contrasted and, finally, the pertinent conclusions for the problem are drawn.

These steps are reflected in Figure 2. The Problem-Based Learning Process (PBL).

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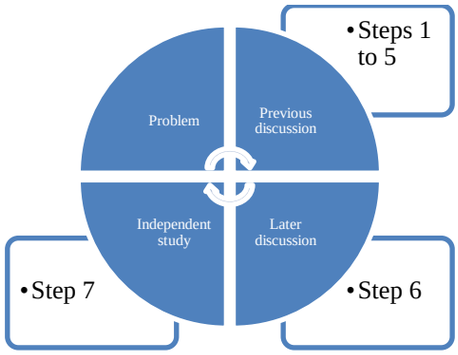

Figure 2 Problem-Based Learning Process
Source: (Vizcarro & Juárez, 2008)

Approach

The research is carried out using an applied case that is developed with the achievement of the methodology indicated in the ABP, applying in turn the construction of a didactic sequence for the topic Implementation of algorithms of the Logic subject of the programming of the educational program Engineer in Computer Systems from the Autonomous University of Campeche, from a qualitative perspective.

Within the didactic sequence, use of technological tools is made:

– Google Classroom. Classroom is part of the set of applications that Google offers under the name of Google Apps for Education (GAFE), an integrated communication and collaboration solution that Google offers to educational centers and that includes its traditional tools, such as email, calendar and chat; It also has the possibility of adding more Google services to adapt it to particular needs (Allueva Pinilla & Alejandre Marco, 2018).
– Google Forms. A Google form (Google Forms) is a web page that allows you to send questions of various types to the target population of students. The responses to the form are collected as a Google spreadsheet. This data can be visualized using automatically generated graphs (collective or individual responses), or you can simply use it (Rebiere & Rebiere, 2020).
– Padlet. It is a board that allows you to invite students to leave their opinions, answer instructions or share images and documents in a simple way. It is widely used to generate virtual interaction. It has a free version (Podestá, 2020).
– MindMeister. It is an application that has a very different and specific purpose that can serve as support when viewing the structure of processes, sections or any other type of element. MindMeister allows the creation of mind maps quickly and efficiently, being able to share and modify them at any time. It has a free basic plan (Corredor Lanas, 2017).
– PSeInt. It is a tool to assist a student in their first steps in programming. Using a simple and intuitive pseudo-language in Spanish (complemented with a flowchart editor), it allows you to focus your attention on the fundamental concepts of computational algorithms, minimizing the difficulties of a language and providing a work environment with numerous aids and didactic resources (SOURCEFORGE, 2021).
– Flipgrid. It is an application belonging to Microsoft where students record videos of variable duration, from 15 seconds to 5 minutes. The main objective is to empower the voice of the student, listening to her voice. The videos are linked to a theme, or topic that the teacher determines within a Grid, which we could equate to a class, or a project to be developed. One of the strengths is the possibilities of sharing a topic, since with our students we can share it with a QR that we project in class, and that our students can enter if we have the application downloaded on the mobile, but also through a link or inserting it into other applications (Microsoft, 2021).

Results

Within the applied case, the didactic sequence proposed by Ángel Díaz Barriga of the National Autonomous University of Mexico is used. The elements included in the didactic sequence are (Díaz Barriga, 2021):

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1. Course,
2. General theme,
3. Contents,
4. Duration of the sequence and number of sessions planned,
5. Name of the teacher who created the sequence,
6. Purpose, purposes or objectives,
7. If the teacher considers it, choice of a problem, case or project,
8. General guidelines for evaluation,
9. Line of didactic sequences (opening activities, development activities, closing activities),
10. Line of evidence for learning assessment and,
11. Means.

Table 1 shows the first part of the didactic sequence for the applied case (it covers elements 1 to 8 of the format).

Teaching sequence
Learning Unit: Programming Logic Responsible professor: ISC Luz María Hernández Cruz, MGTI.
Subject: Programming logic
General theme:
Algorithm implementation
Duration of the sequence and number of sessions foreseen:
2hrs, 2 sessions
Purpose, purposes or objectives:
Construct flow diagrams or pseudocodes to solve problems by selecting the control structure, rules, techniques and analytical criteria to express the algorithms.
If the teacher considers it, choosing a problem, case or project:
Problem: showing if a number is positive, negative, or zero.
General guidelines for evaluation:
The activities established for the evaluation of the subject are detailed below and correspond to 20% of the weighting of the first part of the learning unit.

Table 1 Didactic sequence for the applied case (first part)
Source: (Díaz Barriga, 2021)

It is important to emphasize that the data provided in the didactic sequence come from the institutional format of the learning unit program (PUA) of the Logic of Programming subject and, in addition, the Problem is raised for the present applied case (UAC, 2021).

Next, each step of the adopted Methodology is described.

STEP 1: Clarify concepts and terms

Prior to the class session, establish in the didactic sequence as part of the opening activities of the topic "Implementation of algorithms" didactic materials corresponding to:

– Steps for troubleshooting using a computer.
– The definition of algorithm.
– The characteristics of the algorithms.
– Techniques for the representation of algorithms (pseudocodes and flow diagrams).

Define at least one individual activity for the student where they consult various scientific sources and integrate relevant data on the subject. Table 2 shows the opening activities defined for the applied case exposed in the didactic sequence.

Teaching sequence
Teaching sequence line Opening activities The opening activities to the topic, prior to the class session, carry out the following activities:
Activity 1: Consult different sources of scientific information for the definition of algorithm and identify its characteristics. Share the information you collect on Padlet (https://padlet.com/) and you will add a comment to at least three colleagues. It is important to register with your institutional email and add your full name and registration.
Activity 2: Read the teaching material provided in Google Classroom within Resources - Topic: algorithm implementation and design a Concept Map that encompasses all the information reviewed. Didactic material: Topic: implementation of algorithms. • CHAPTER 2 Methodology of programming and software development. P. 45-53. • Algorithmic: Design and analysis of functional and imperative algorithms / Javier Galve Frances, Juan Carlos González Moreno, Ángel Sánchez Calle and J. Ángel Velázquez Iturbide. Editorial Wilmington: Addison-Wesley Iberoamericana, 1993. CHAPTER 1 Introduction to Programming. P. 1-23. •Programming Fundamentals. Algorithms, data structure and objects. 4th. Edition. Luis Joyanes Aguilar. Mc GraW Hill Publishing House. CHAPTER 2 Methodology of programming and software development. P. 63-81.

Table 2 Didactic sequence for the applied case. Didactic sequence line - opening activities
Source: Own Source

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STEP 2: Define the problem

During the class session, the teacher presents the thematic content highlighting the main concepts and terms of the topic "algorithm implementation". It is important to interact with students to stimulate their motivation and interest. Clarify doubts and identify the main elements of the problem to reaffirm your understanding.

The questions What are the input data? What processes are required to perform to solve the problem? What is the output data to be obtained? They will define the problem. Each student will contribute concrete ideas to be able to recognize elements that provide a solution to the problem.

STEP 3: Analyze the problem

The didactic sequence contains the development activities.

Table 3 shows the development activities defined for the applied case exposed in the didactic sequence.

Teaching sequence
Teaching sequence line Development activities At the end of the teacher's presentation. The development activities of the topic, during the class session to be carried out are the following:
During the virtual session, the solution of the problem with the design of the algorithm will be carried out using the specific use software tool PSeInt. The latter can be downloaded from Google Classroom under Resources - Software tools.
Activity 3: Design the algorithm of the problem posed PROBLEM: Show if a number is positive, negative, or zero. – Join teams of 4 members – Read carefully the problem posed and Identify the data of the problem (analysis and definition of the problem - Input (s), Process (s) and Output (s)). – Using a round table or working table, design the algorithm to solve each of them defining the sequence of finite, concrete, and concise steps. – Use the specific use software tool PSeInt to implement the designed algorithm.

Table 3 Didactic sequence for the applied case. Didactic sequence line - development activities. Source: Own source.

Table 4 shows the characteristics of the Workbench.

Work table
Work Table Guidelines
1. The moderator is the team leader or the member designated by the work team for that role. 2. Do not initiate, do not intervene, do not respond to the dialogue until the moderator indicates ("name" intervention) 3. Participants must wait for the moderator to give them the floor and be specific when presenting their contributions. 4. Each participant presents their points of view, comments and / or contributions with their own language and respecting the points of view of the other participants. 5. End the participant's intervention by writing (or saying) "I give the floor" 6. The moderator is responsible for making his annotations for the delivery of the Report.
Workbench process
1. Opening – The moderator provides the welcome, the purpose and the introduction of the participants 2. Dialogue – The moderator gives the floor to the first participant to speak – The participant presents their comments, contributions, criticisms, etc. – Once the intervention is over, the moderator gives the floor to another participant. So hereafter. 3. Closing – The moderator has concluded with the questions of the Topic to be discussed. – The moderator ends the round table, makes a summary or synthesis of the interventions. – Appreciates participation and assistance.

Table 4 Round table or working table of Activity 3 of the development activities in the didactic sequence
Source: Own Source

STEP 4: Carry out a systematic summary

The development activity is summarized in the Workbench report. Figure 3 shows the report format for the Workbench of the applied case. The algorithm resulting from the activity is added in the Conclusions part of the format.

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Round table:	
Course:	
Theme:	
Moderator:	
Objective:	
Topics:	
Participants:	
Process:	
Opening **Dialogue** **Closing**	
Conclusions	

Figure 3 Didactic sequence for the applied case Line of didactic sequence - development activities - Work table report
Source: Own Source

STEP 5: Formulate learning objectives

Once the problem has been analyzed and with the design of the proposed algorithm, the result of the previous step. The work team sets itself the objective of implementing the algorithm by applying the pseudo-code managing the specific use software PSeInt.

STEP 6: Find additional information outside the group

Consult various sources to guide you in pseudocode design using the PSeInt software tool. Later implement the pseudocode that solves the applied case. Figure 4 shows the case pseudocode applied in the PSeInt software tool.

```
Algoritmo positivo_negativo_cero
    Definir num como entero

    Escribir "Ingrese un número"
    Leer num
    Si num>0 Entonces
        Escribir "El número es positivo"
    SiNo
        Si num <0 Entonces
            Escribir "El número es negativo"
        SiNo
            Escribir "El número es cero"
        Fin Si
    Fin Si
FinAlgoritmo
```

Figure 4 Didactic sequence for the applied case Line of didactic sequence - development activities - implementation of the algorithm using PSeInt
Source: Own Source

STEP 7: Synthesis of the information collected and preparation of the report on the knowledge acquired

Run, test, and document the generated pseudo-code. In order to summarize the main concepts and elements of the algorithm, students are required to document the algorithm. Figure 5 shows the documented algorithm implemented in PSeInt.

```
Algoritmo positivo_negativo_cero
    //definición de variable
    Definir num como entero
    //variable num de tipo de dato entero

    Escribir "Ingrese un número"
    Leer num
    //instrucción de entrada, guarda el valor de la variable num

    Si num>0 Entonces //validar si la variable num es positiva
        Escribir "El número es positivo" //instrucción de salida
        Si num <0 Entonces //validar si la variable num es negativa
            Escribir "El número es negativo" //instrucción de salida
        SiNo //validar si la variable num es cero
            Escribir "El número es cero" //instrucción de salida
        Fin Si
    Fin Si
FinAlgoritmo
```

Figure 5 Didactic sequence for the applied case Didactic sequence line - development activities - implementation of the documented algorithm using PSeInt
Source: Own Source

Consecutively, the closing activities are established in order to demonstrate the knowledge acquired in the application case. Table 5 shows the closing activities of the didactic sequence of the applied case.

Teaching Sequence
Teaching sequence line Closing activities The closing activities of the topic, after the class session, do the following extra-class activities.
Activity 4: In this activity you will present through a video explain the algorithm designed to solve the PROBLEM: Show if a number is positive, negative or zero. – Using the Flipgrid software tool. – When accessing the link, you will be asked to register, to access it, you will do so with your institutional email. Once on that page, it will be shown as topic Topic: Implementing an Algorithm. – Click the Add an answer button. This will take you to the video recording interface. Explain in detail the algorithm designed for the applied case and its main elements. – Once completed, you must send it and give feedback to at least three of your colleagues**.**

Table 5 Didactic sequence for the applied case Line of didactic sequence - closing activities
Source: Own Source

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Finally, as part of the didactic sequence and for the benefit of the knowledge acquired, the line of evidence for the evaluation of learning is established, specifying the evidence, percentages and evaluation instruments of the applied case. Table 6 shows the last sections of the didactic sequence proposed by Díaz Barriga (the line of evidence and resources) for the applied case of the investigation.

Teaching Sequence
Learning assessment line
– Activity 1. Evidence: contribution in Padlet. Weighting 15%. Assessment instrument: checklist. – Activity 2. Evidence: Concept Map in MindMeister. Weighting 15%. Assessment instrument: Rubric. – Activity 3. Evidence: pseudocode in PSeInt. Weighting 50%. Assessment instrument: Rubric. – Activity 4. Evidence: video on Flipgrid. Weighting 20% Assessment instrument: Rubric.
Means
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Table 6 Didactic sequence for the applied case Line of evidence of evaluation of learning and resources
Source: Own Source

Conclusions

The integration of a learning strategy in the educational process contributes to the achievement of learning. In this study, it is concluded that applying the problem-based learning strategy specifically on the subject of algorithm implementation was satisfactory, achieving the development of the following generic competencies: collaborative work, teamwork, cognitive skills and use of ICTs in the professional field. In addition, collaborating with the competence of the logical learning unit of programming "Design computational algorithms for the expression of elementary problems of various disciplines through the formal use of basic techniques".

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Article **ECORFAN Journal-Democratic Republic of Congo**
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Proposal of a computer security scheme for a Comprehensive Planning System

Propuesta de un esquema de seguridad informática para un Sistema Integral de Planeación

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Abstrac

At present, Comprehensive Planning Systems are a fundamental part of any organization, since they function as a tool in the scheduling of activities as well as their Budgeting, Control, and Monitoring. The improvement and continuous updating of said systems are necessary to provide reliability in any context, that is why this research proposes to design and implement a computer security scheme focused on the entire administrative system, benefiting users who interact operating in the various related processes. In addition to this, the methodology used will be divided into two phases constituted by activities and tasks that will allow to satisfactorily find critical, severe, and moderate vulnerabilities in the server. Consequently, by obtaining a comprehensive diagnosis of the server, a security scheme is implemented to solve the problems detected and improve the organization.

Comprehensive Planning Systems, IT Security, Vulnerabilities

Resumen

En la actualidad, los Sistemas Integrales de Planeación son parte fundamental para cualquier organización, ya que funcionan como una herramienta en la programación de actividades así como su Presupuestación, Control y Seguimiento. El mejoramiento y la actualización continua de dichos sistemas son necesarios para brindar confiablidad ante cualquier contexto, es por eso que la presente investigación propone diseñar e implementar un esquema de seguridad informática enfocada a todo el sistema administrativo, beneficiando a los usuarios que interactúan operando en los diversos procesos relacionados. Aunado a esto, la metodología empleada se dividirá en dos fases constituidas por actividades y tareas que permitirá encontrar de manera satisfactoria vulnerabilidades críticas, severas y moderadas en el servidor. Consecuentemente, con la obtención del diagnóstico integral del servidor, se procede a la implementación de un esquema de seguridad para solucionar las problemáticas detectadas y mejorar la organización.

Sistemas Integrales de Planeación, Seguridad informática, Vulnerabilidades

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Introduction

Currently, the Comprehensive Planning System (SIPlan), has solved the problems related to the annual programming of activities, as well as the Budgeting, Control, and Monitoring of these.

This system is hosted on a server of the National Technological Institute of Mexico (TecNM) with the name of Administration System (SISAD) under a free license from SIPlan, developed at the Technological Institute of Cancun (IT Cancun), the Institute that has coined the project.

The aforementioned system has benefited 132 Federal Institutions of the TecNM, of which 2,865 areas carry their budgetary control in this system, as well as the 4,528 users who interact daily for the operation of their different activities in which the following are carried out processes:

- Annual Work Program
- Annual Operating Program
- Sub-budgets
- Budget Transfers
- Budget adequacy
- Programmatic Budget Evaluation
- Requisitions
- Travel expenses
- Purchase Orders
- Simultaneous Warehouse Entry and Exit
- Service Request
- Payment request
- Payment Registration
- Educational Structure

Currently, in the Technological Institutes, Planning, Programming and Budgeting is systematized in the SIPlan, which has solved the problem of keeping strict control of the budget exercise in general of the Institution.

The Comprehensive Planning System until 2019 was hosted on a server at IT Cancun. Since 2015, this server was tuned and made ready for the operation of the SIPlan, sufficient vulnerability tests were carried out to avoid intrusion both to the server and to the Database. This server has the Red Hat Linux Operating System installed which is installed with a graphical environment called Anaconda.

Today, the Management System is hosted on a Microsoft Azure platform server, with the Free BSD Operating System which is a free and open-source derivative of BSD (Berkeley Software Distribution) with a focus on speed, stability, security, and consistency, among other characteristics.

However, the aforementioned is a new server that has not been tuned, so it is necessary to carry out the necessary vulnerability and attack tests to be able to do the corresponding tuning and generate confidence in the stability and security of the information. Due to the above, it is important to develop this proposal for a computer security scheme for the TecNM Administration System.

Thematic scheme

The emergence of the idea

The present investigation has been delimited with the purpose of guiding the study with a systematic order. Next, figure 1 shows a diagram where this delimitation is observed:

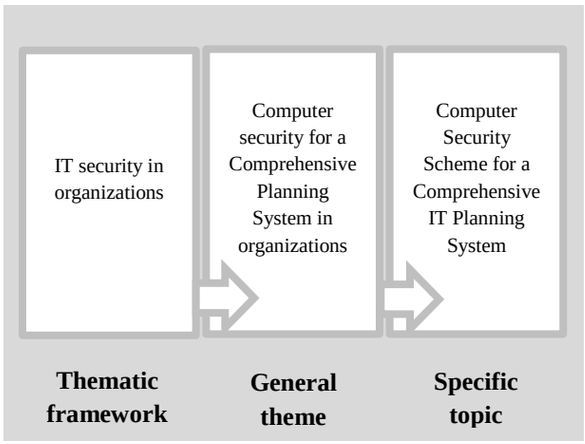

Figure 1 General scheme for the delimitation of the subject
Source: Author's perception

In phase one, IT security in organizations forms the thematic framework, thus providing a starting point for this study. The general research topic has been called Computer Security for a Comprehensive Planning System in organizations, consolidating the research.

Phase three is called Information Security Scheme for a Comprehensive Planning System in IT, delimiting the investigation towards a specific sector.

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Identification of experts

This project is developed with personnel from the Information and Communication Technologies Directorate and personnel from the Cancun Technological Institute, both belonging to the National Technological Institute of Mexico. The staff is interviewed by the researcher, sectioning the process by rounds, addressing important points on the subject of study. The researcher subjectively determines the knowledge of the personnel regarding the Comprehensive Planning System. The selected personnel is called Experts.

Methodology

The methodology used in the development of this study is "Methodology for the Detection of Vulnerabilities in Data Networks". (Franco, D., Perea J. and Puello, P., 2012).

Which consists of three phases:

– Recognition
– Port scanning and service enumeration
– Vulnerability scanning

Each of the phases is supported by software tools. The results of each phase provide data necessary for the execution of the following stages. (Franco, D., Perea J. and Puello, P., 2012).

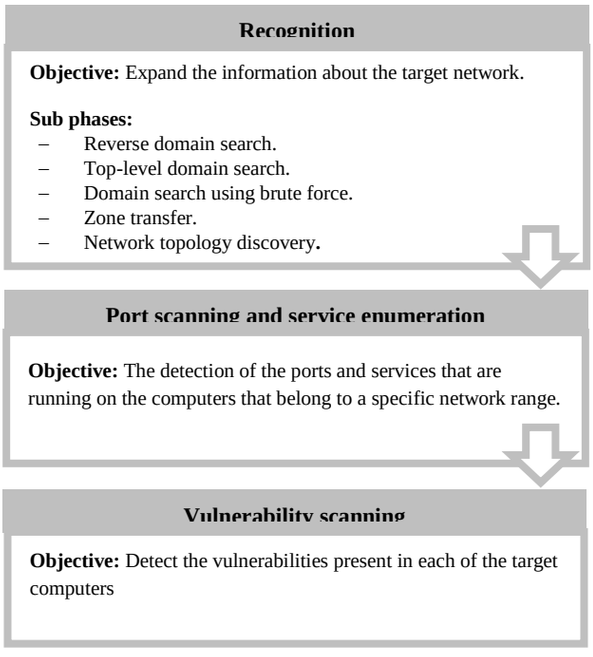

Figure 2 Scheme of the methodology for the detection of vulnerabilities in data networks
Source: Methodology for Detecting Vulnerabilities in Data Networks (2012)

Additionally, for this study, two separate phases were implemented for the operation of the Application, which are:

– Preparation
– Implementation

Activities

The activities are developed according to the phases of the Methodology used:

1. Preparation
1.1. Installation
2. Recognition
2.1. Diagnosis of security schemes
3. Port scanning and service enumeration
3.1. Scan with port tools
4. Vulnerability scanning
4.1. Vulnerability detection
5. Implementation
5.1. Determination of threats

Chores

The Tasks are developed according to the phases of the Methodology used and the proposed activities:

1. Preparation
1.1. Installation
1.1.1. Server Installation
1.1.2. Application Installation
2. Recognition
2.1. Diagnosis of security schemes
2.1.1. User Identification
2.1.2. Information Identification
2.1.3. Infrastructure Identification
3. Port scanning and service enumeration
3.1. Scan with port tools
3.1.1. Analysis application with the Nmap tool
3.1.2. Scan report analysis
4. Vulnerability scanning
4.1. Vulnerability detection
4.1.1. Analysis application with the ZAP tool
4.1.2. Analysis application with the Nessus tool
5. Implementation
5.1. Determination of threats
5.1.1. Server Tuning
5.1.2. Application Tuning

Diagnosis of security schemes

SIPlan security is carried out from the following three parts:

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– Users: Here there is an Entry Verification system (Login) where the Session Name and Password are verified, once this filter has been passed through there are 23 Types of Users to which the Menu Options are assigned , as well as their respective privileges.

– Information: In this aspect, the information is housed in a Relational Database, the verification of the information that enters has two filters, one from the code itself where the validations are made so that what we want to happen and from the code itself Database Model as it has restrictions to save integrated information.

– Infrastructure: The system is hosted on the Azure platform of TecNM in the cloud, as for the server there is a Dell PowerEdge R320 Server - Xeon E5-2407V2 - 2.4GHz - 8GB - 2 x 1TB - Raid 1 - Free Dos.

The System is developed in the PHP Programming Language that runs on the Server side, interacting with JavaScript that runs on the client-side, the views are developed in HTML and the Database Manager is MySQL.

As preventive mechanisms, the backup of the database is done through a process programmed in the TecNM Server which is launched at two in the morning to a remote server which is located in the ITCancún, this backup is done in the SQL.

It is worth mentioning that the system is in the general implementation stage at the National Level, so it is necessary to be updating the system modules.

Vulnerability detection

At the launch of the project at the national level, a vulnerability analysis was carried out and Development Vulnerabilities were detected, especially in possible SQL injections due to the use of the GET method in the passing of parameters between PHP files, this was detected through scans that were they did with the ZAP Scanning tool and Nessus.

The problem was that when making a hyperlink with an HTML <a> tag embedded in a PHP file, the URL of the address where the tag refers as well as the variables are displayed in the status bar of the browser which is passing to the other PHP file where it is directed, this generated a high vulnerability since if that URL was copied and the values were changed, it was prone to logical SQL injections for the system and for the base engine data, then the solution was immediately made as shown in Figure 3.

Figure 3 Parameter passing by PHP's GET method
Source: Author's perception

As mentioned in the Diagnosis, the System is hosted on Microsoft's Azure platform, and it is known that in this type of platform the tools are provided to implement the most convenient server, and therefore the security of this server is totally low. responsibility of the platform administrator.

In this case, the Information and Communication Technologies (ICT) staff of TecNM, when scanning the server, detected that the Server Security was not well implemented since it was possible to access the servers and view the contents of the Directories and Files in such a way that by having the code it was susceptible to intrusion into the database by means of some SQL injection, so all this type of privilege was closed for users who visited or browsed the server.

Reviewing the requestlog file on the server where SISAD was hosted at that time, the following vulnerabilities were found:

– The server instance was not new, it had not been created for the SISAD implementation.

– It was detected that the server was very compromised, since March.

– There was a clear sign that they had already had an Apache service there and had already hit it previously.

– The detail was to know if they had left a shell on the server.

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- This indicates that they did not enter through your app, since the server was already compromised long before.

- According to the log, it indicates that March 27 was the first time that SISAD was installed on that server, but it had already installed things before and they had already gotten into them.

- In line 9912 it indicates that it is the first time that they sent a request for administracion2 with http: //5.188.210.101/echo.php, from there it is detected that the server is open without protection.

- On the server is the phpmyadmin application, which is super vulnerable for SQL injections.
- From line 9750 they put the nmap to scan that server overnight and the next day with a program called ZmEu that is to attack phpmyadmin.

- Already here you can detect that they entered.

- From here almost daily they hit the server and from the same IP 129.211.50.227.

- Similarly, it was detected that the SQL queries had vulnerabilities.

Proposal

Having already had a diagnosis and having detected the vulnerabilities, a security scheme was implemented to solve the problems encountered in the detected vulnerabilities.

As a first point was the solution of the server issue for which the following actions were carried out:

- Users were advised that SISAD would be out of service for maintenance.

- A new instance was created on the Azure platform for the creation of a new server.

- Security rules were already applied to this new server so that it was not a completely open server but a completely closed one. Only the services that were necessary for the SISAD Application were opened and it was duly controlled.

- A fresh installation of the required software was made: Apache, MySQL, PHP.

- phpmyadmin is no longer installed, for security reasons.

- The System load was made as new from the original scripts, a copy of the previous server was not made.

- The database was loaded.

- SQL injection is a danger to data integrity and it is known that attacks must protect data. For this, the .htaccess file of our server was reconfigured to protect against this type of attack, and it was added to the .htaccess file with the following lines:

```
RewriteCond %{QUERY_STRING} (;|<|>|'|"|\)|%0A|%0D|%22|%27|%3C|%3E|%00).*(/\*|union|select|insert|cast|set|declare|drop|update|md5|benchmark) [NC,OR]

RewriteCond %{QUERY_STRING} \.\./\.\. [OR]

RewriteCond %{QUERY_STRING} (localhost|loopback|127\.0\.0\.1) [NC,OR]
RewriteCond %{QUERY_STRING} \.[a-z0-9] [NC,OR]

RewriteCond %{QUERY_STRING} (<|>|'|%0A|%0D|%27|%3C|%3E|%00) [NC]

RewriteRule .* - [F]
```

It is important to remember that you need to have the server configured so that .htaccess is active and allows URL filtering. This helps to improve the security of the System.

As a second point was the solution to the issue of passing parameters between PHP files and SQL queries, for which the following actions were carried out:

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To solve the problem of the visibility of the <a> tag, all the calls to other files with buttons of the Input type were changed, with this you no longer saw the references to where the hyperlink was pointing, but thinking wrong and that If someone could have already obtained those references, the whole process for passing parameters was changed.

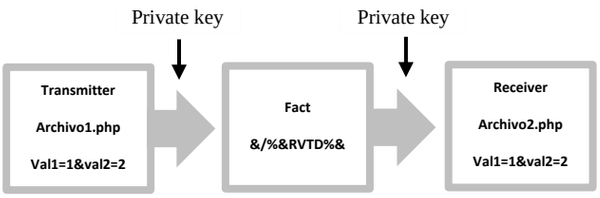

Figure 4 Solution to passing parameters in PHP with POST method
Source: Author's perception

The first thing that was done is that the data after "?" in file1.php, but a function called "encode" is called to which all the parameters to be protected are passed, upon receiving this function the chain assigns a control key before and after the chain, encoded with md5, the resulting string is encoded in PHP base64, the resulting string is passed to another function called "encrypt_one", which upon receipt of the string is applied another PHP encryption method "encrypt" and applies a word key encoded in md5 base 64, the resulting string is encoded in PHP base64 and this is the one that is passed through the URL with POST method.

As a second step, upon receiving the string in the file2.php, it calls a function called "decode" which does the reverse process of "encoding", thereby ensuring that even if the data sent by the URL is intercepted, they will not be able to be decrypted and thus ensuring that no SQL injections are made through these processes. To solve the SQL queries, we proceed to add the function "mysql_real_escape_string" before making a query to the Database, since it escapes special characters in a string for use in an SQL statement.

The function operates as follows:

– Escapes special characters in the string given by unescaped_string, taking into account the character set in the use of the connection, so that it is safe to use in mysql_query (). If binary data is to be inserted, use this function.

– Calls the mysql_real_escape_string function from the MySQL library, which prepends backslashes to the following characters: \ x00, \ n, \ r, \, ', "and \ x1a.

– This function should always be used (with few exceptions) to make data safe before sending a query to MySQL.

– The character set must be set either at the server level or with the mysql_set_charset () API function to affect mysql_real_escape_string ().

– Returns the escaped string or FALSE on error.

– Running this function without a MySQL connection present will also throw PHP E_WARNING level errors. It should only be run with a valid MySQL connection present.

An example SQL injection attack:

```
<? php
// We haven't checked $ _POST ['password'], it could be anything the user wanted! For instance:
$ _POST ['username'] = 'aidan';
$ _POST ['password'] = '"OR' '="";// Consultar la base de datos para comprobar si existe algún usuario que coincida
$consulta = "SELECT * FROM users WHERE user='{$_POST['username']}' AND password='{$_POST['password']}'";
mysql_query($consulta);

// This means that the query sent to MySQL would be:
echo $ query;
?>
```

The query sent to MySQL:

```
SELECT * FROM users WHERE user = 'Aidan AND password = " OR " = "
```

This would allow someone to access a session without a valid password.

How to solve it:

```
<? php

// We haven't checked $ _POST ['password'], it could be anything the user wanted! For instance:
$ _POST ['username'] = 'aidan';
$ _POST ['password'] = '"OR' '="";
```

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```
// Query the database to check if there is a matching user
$ query = "SELECT * FROM users WHERE user = '{mysql_real_escape_string ($ _POST [' username '])}' AND password = '{mysql_real_escape_string ($ _ POST [' password '])}'";
mysql_query ($ query);

// This means that the query sent to MySQL would be:
echo $ query;
?>
```

The query sent to MySQL:

```
SELECT * FROM users WHERE user = 'aidan' AND password = '\' OR \ '\' = \ "
```

This would prevent someone from being able to access a session without a valid password.

Conclusions

Given the study carried out, it is evident that the topic of Security in Systems is very delicate.

The level and security schemes to be implemented will depend on the type of information that is handled.

For the present work, both the vulnerability detection systems and the implemented schemes are free of charge, while for more sensitive information it is necessary to take into account the investment of software for both detection and implementation of security schemes.

Among the types of sensitive information, we can mention bank data were the situation, investments, and savings of users are found. Other types of national security, among which can be mentioned, are data on state secrets, information on weapons (from basic to nuclear), and data on secret missions to name a few.

Computer Security systems are of utmost importance in an organization, since the more sensitive the data, the greater the security schemes used.

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Integration and programming of delta-type parallel robot prototype

Integración y programación de prototipo de robot paralelo tipo delta

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Abstract

The development of the present study focuses on the exploration of the parallel robot in delta configuration, highly applied in the industrial environment, in order to integrate a prototype that concentrates the basic characteristics of its function. The constitution of the exposed implement implied the use of materials and devices of easy acquisition and low cost. Likewise, a detailed analysis of the respective mechanical structure and its operation was necessary, in reference to both the way and the medium through which the movement generated by the actuators is managed, to be transmitted to the end effector. The incorporation of the Arduino electronic board as the robot controller is reported, which contains the established programming to ensure its correct operation, given the instructions entered by the user from a computer. The results observed during the performance tests confirm the effective adoption of the joint values assigned by the user, within the mobility limits imposed; even at the level of a prototype.

Parallel robot in delta configuration, Prototype integration and programming, Joint position

Resumen

El desarrollo del presente estudio se enfoca en la exploración del robot paralelo en configuración delta, altamente difundo en el medio industrial, con la finalidad de integrar un prototipo que concentre las características básicas de su función. La constitución del implemento expuesto implicó el uso de materiales y dispositivos de fácil adquisición y bajo costo. Asimismo, fue necesario el análisis minucioso de la estructura mecánica respectiva, y de su operación, en referencia tanto al modo como al medio a través del cual es gestionado el movimiento generado por los actuadores, para ser trasmitido hacia el efector final. Se reporta la incorporación de la tarjeta electrónica Arduino como controlador del robot, la cual contiene la programación establecida para asegurar la correcta operación del mismo, dadas las consignas ingresadas por el usuario, desde una computadora. Los resultados observados durante las pruebas de desempeño, constatan la adopción efectiva de los valores articulares asignados por el usuario, dentro de los límites de movilidad impuestos; aun al nivel de un prototipo.

Robot paralelo en configuración delta, Integración y programación de prototipo, Posición articular

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Introduction

The integration of robotic mechanisms within multiple industrial systems has allowed the manipulation of materials in environments where the direct intervention of the human being used to be limited, implying a risk for their integrity (Bilyea, Seth, Nesathurai, & Abdullah, 2017). Thus, the incorporation of such equipment provides efficiency in the execution of operations with high repeatability, in long periods of time, increasing the productivity and profitability of production processes (Fong, Deb, & Chaudhary, 2015) (Valente, 2016). For more than half a century, industrial robotics focused its interest on the development of manipulators based on open kinematic chains (Szűcs & Galambos, 2020). These are implements made up of a set of links joined, one to another, from their ends; and in whose final portion a tool is located, which enables the execution of a specific task (Mann, Damti, Tirosh, & Zarrouk, 2018). Originally, the function of these articulated mechanisms was limited to parts handling, positioning or welding operations (Birglen & Schlicht, 2018).

However, the reduction of maneuvering spaces in the plant and the need to reach higher speeds, ensuring high precision in the movements described, would soon lead academics and, later, manufacturers to consider other design options (Gasparetto & Scalera, 2019) . Research fields were constituted around the conceptualization, analysis and design of other types of robotic configurations that differed from the conventional ones, which did not take long to become a reality (Borchert, Battistelli, Runge, & Raatz, 2015) (Wu , Bai, & Hjørnet, 2016).

One option to solve the emerging challenges of industrial robotics was the proposal of parallel robots; implements made up of closed kinematic chains or extremities (Altuzarra, Şandru, Pinto, & Petuya, 2011). In this type of mechanism, each end is assembled at one end to a fixed base, while the end effector is supported at the opposite end (Brinker, Funk, Ingenlath, Takeda, & Corves, 2017). Some of the notable attributes in this configuration are the rigidity of its mechanical structure and the stability in the transmission of movement from the actuators to the end effector (Bellakehal, Andreff, Mezouar, & Tadjine, 2011).

Among an infinity of proposals generated from the 1980s to the present day, the parallel robot in delta configuration constitutes the most representative and widely disseminated unconventional variant in the industry (Avizzano, Filippeschi, Villegas, & Ruffaldi, 2015).

Motivation

From the academic aspect with a technological orientation, owning and putting into operation a delta-type parallel robot would imply access to an analysis and programming model based on a highly dynamic and highly useful unconventional robotic configuration today. It is worth mentioning that the application of this type of robot in the industrial environment has determined a positive impact on the performance of selection and positioning processes of parts at high speeds, with excellent levels of precision; which encourages its growing implementation.

However, owning such equipment means a strong investment for any institution of higher education, particularly if it is public. Therefore, a valid option to have a mechanism with the characteristics described is the integration of a prototype based on low-cost technology and devices. Thus, the mechanical structure to be used could be manufactured by printing by adhesion of material or 3D, in addition to acquiring the commercial elements necessary for its assembly, which do not imply a considerable expense.

On the other hand, the electronic system required for the manipulation of the prototype could be formed from a board with adequate performance features, and economically accessible. In addition, to resort to a specialized, high-level, open source programming language. As well as being used other multiple devices of easy acquisition, that make possible the communication and interaction between the integrated delta parallel robot and a computer interface, through which its manipulation is carried out. In this way, once the proposed parallel robot in delta configuration has been formed, and through the variation of parameters that establish its operation, initially position, behaviors can be established that lead to the understanding of its use in the industry and the optimality of its operation.

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Also promoting, having a test equipement that provides another perspective of the application of Industrial Robotics to students of the Engineering areas of the Universidad Tecnológica del Norte de Aguascalientes, through the subjects related to this field.

Delta robot characterization

The delta configuration was proposed in the 1980s by Professor Reymond Clavel from the École Polytechnique Fédérale de Lausanne, in Switzerland. Originally, this robot had three translational degrees of freedom, one per limb, and one rotational in its end effector (Clavel, 1991). Figure 1 show how, in each extremity, the input links are arranged as rotating levers, actuated by electric motors at a first end; while at their opposite end, they are joined to the respective output links, using joints of revolution. The latter transmit the movement from the base to the mobile platform, where the end effector is located (Huang, Chiba, Arai, Ueyama, & Ota, 2015).

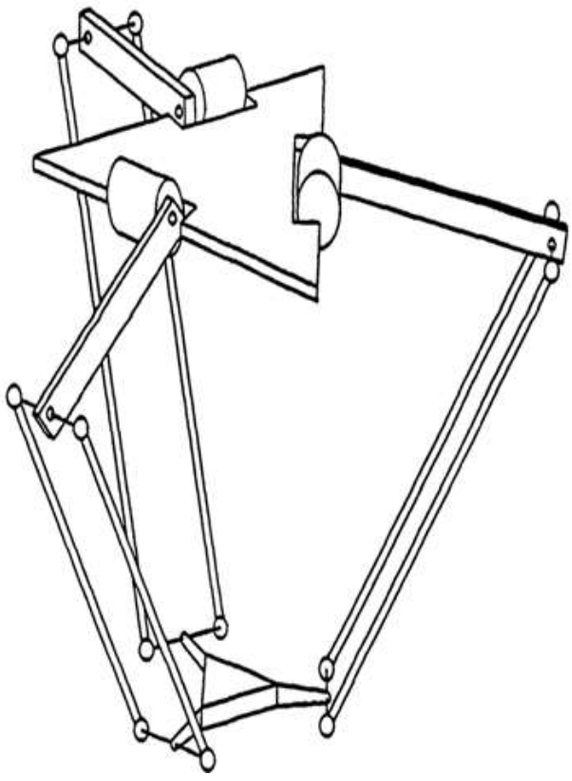

Figure 1 Delta parallel robot proposed by Clavel
Source: Clavel, 1991

The organization of the elements that make up the delta-type robot, allow the execution of tasks in which the performance of the serial robots would be limited.

However, on the contrary, its workspace is usually limited (Bellakehal, Andreff, Mezouar, & Tadjine, 2011). For its part, the arrangement of the actuators on the base and the use of low-weight links, allow the mobile platform to reach high accelerations (Staicu & Carp-Ciocardia, 2003), making the delta robot the ideal elementpick and place tasks of light objects, in consumer goods, food and electronics industries (Pedraza, Cárdenas, Rodríguez, & Yime, 2015).

Thus, the geometric parameters of the parallel delta robot, shown in Figure 2, are: the length of the actuated link (L_A), the length of the driven link (L_B), the radius of the fixed platform or base (R), the radius of the mobile platform or end effector (r), as well as the angles of the radii of the fixed platform q_i (i = 1, 2, 3), which affect the active and passive joint angles that determine the configuration of each limb (Laribi, Romdhane, & Zeghloul, 2007) (Sánchez-Alonso, Castillo-Castañeda, González-Barbosa, & Balmaceda-Santamaría, 2015).

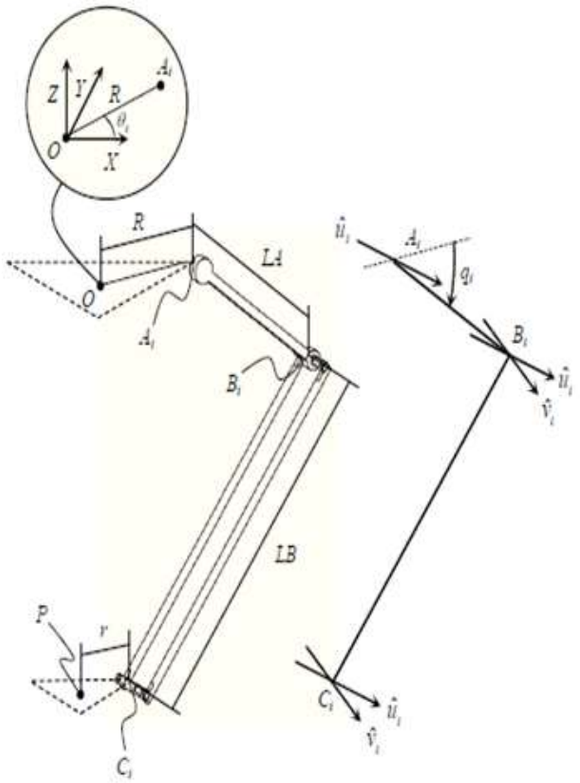

Figure 2 Geometric parameters of Delta parallel robot
Source: Sánchez-Alonso, Castillo-Castañeda, González-Barbosa, & Balmaceda-Santamaría, 2015

Description of the prototype used

The prototype of a parallel robot in delta configuration implemented, consists of three limbs in a closed mechanical chain configuration. Such chains are joined at their upper end by means of the fixed platform, which contains the motors that provide the movement for each one.

In its lower portion, the junction of the extremities is defined by the mobile platform, smaller than the previous one, and which supports the end effector, a pair of pliers that will hold the pieces. It should be noted that the design used for the development of the prototype is for public use, under a Creative Commons license (Franciscone, 2016).

The fixed platform is made up of three folds screwed together, with an upper hexagonal finish, which support the motors used. Both the pleats and the finish were manufactured using 3D printing.

In turn, the hexagonal element allows the insertion of three PVC half inch diameter plastic pipes diameter, to provide support to the physical structure of the robot itself from the union, at its other end, with directly coupled vertical supports on the mounting surface.

Each of the robot's limbs is made up of two links (Figure 3). The actuated link, also made by 3D printing, is coupled at one of its ends to the shaft of the respective motor, by means of screws. At its opposite end, such arm is attached to the driven link by means of copper joints, also screwed; which provide freedom for the axial and semi-torsional positioning of one element with respect to the other.

The driven link was manufactured from stainless steel threaded rod. The mobile platform, also printed, is attached to the opposite end of the driven link, in the same way that both arms are joined.

Figure 3 Delta parallel robot prototype used
Source: Own elaboration, 2021

It is worth mentioning that the copper joints used both for the assembly of both links, which integrate each extremity, and for the union between the driven link and the mobile platform, provide freedom so that the latter can vary not only its position but also also its orientation, with a certain limit. In this way, each chain can adopt a different angle, established by the independent movement of each motor. Whereas, if such joints are not used, a movement of equal magnitude could only be promoted for each motor, given the impossibility of modifying the orientation of the mobile platform.

Selection of actuators

In order to ensure the movement of each extremity of the robot, in order to fulfill the proposed function, it was necessary to select actuators that could support not only the weight of their own mechanical structure, but also the load that the part will add by handle. On the other hand, it was also a priority to guarantee the execution of a simple process by varying the position that the same actuators can acquire during the request, by the user or the system that manages the robot, of some specific joint movement; or, of the location of an assigned point, given certain coordinates in a Cartesian reference space.

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Thus, both the motors used to transmit movement to each of the robot's chains, as well as to drive the gripper used, are servomotors. Such type of electric motor provides an angular movement in integer values, which vary in a range between 0 and 180 °; In addition, they can be controlled by pulse width modulation (PWM). Usually, the operating frequency of the servomotors is 50 Hz, which implies an activation time or presence of an electrical signal of 0.5 ms to reach the 0 ° position and 2.5 ms to achieve 180 °; this during each cycle of the supplied control signal.

The servomotor used for the movement of each limb of the implemented parallel delta robot is of the Tower Pro brand, model MG995, high speed, shown in Figure 4. This actuator has a load capacity of 15 kilograms force per centimeter and a mechanical transmission made up of steel gears. Other operating specifications of this servomotor are presented in table 1.

Figure 4 Tower Pro MG995 servomotor
Source: https://www.alldatasheet.com, 2021

Characteristic	Specification
Input voltage	3.5 to 8.4 V (Recommended 5 V)
Dimensions	40 x 20 x 36.5 mm
Weight	48 to 55 gr
Operating speed (4.8V no load)	0.17 seconds / 60 degrees
Operating speed (6.0V no load)	0.13 seconds / 60 degrees
Stopping torque (4.8V no load)	13 kg / cm
Stopping torque (6.0V no load)	15 kg / cm
Operating temperature	-30 a 60°C

Table 1 Tower Pro MG995 servomotor technical data
Source: https://www.alldatasheet.com, 2021

It is worth mentioning that a Tower Pro brand servomotor is also used to drive the gripper, only in this case it corresponds to the MG90S model; same that is visualized in Figure 5. Unlike the previous servomotor, this one has a load capacity of up to 2.2 kilograms force per centimeter and a mechanical transmission made up of plastic gears; among other characteristics specified in Table 2.

Figure 5 Tower Pro MG90S servomoto
Source: https://www.alldatasheet.com, 2021

Characteristic	Specification
Input voltage	4.8 to 6.0 V (Recommended 5 V)
Dimensions	22.5 x 12 x 35.5 mm
Weight	13.4 gr
Operating speed (4.8V no load)	0.1 sec / 60 degrees
Operating speed (6.0V no load)	0.08 sec / 60 degrees
Stopping torque (4.8V no load)	1.8 kg / cm
Stopping torque (6.0V no load)	2.2 kg / cm
Operating temperature	-30 a 60°C

Table 2 Tower Pro MG995 servomotor technical data
Source: https://www.alldatasheet.com, 2021

Given the commercial variety of servomotors, the selection of the proposed elements was made from the material with which their transmission is manufactured. In this way, it was determined that for the execution of the movement of each limb of the robot, the transmission made of steel would provide greater durability, unlike its simile in plastic. Thus, even operating under the specification recommended by the manufacturer, the resistance of the steel transmission is considerably higher than the corresponding one made of plastic, whose teeth tend to present fatigue and premature wear in load applications.

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On the other hand, for the gripper, it was decided to use a lower capacity servomotor than those that mobilize the robot's extremities. This decision is based on the fact that the actuator, arranged in the end effector, does not directly support the weight of the transported part, but only opens or closes the pair of pliers to hold it; ensuring such condition during its transfer between the designated points. Therefore, the weight of the piece is supported by the aforementioned servomotors, this being part of the set that is attached in its lower portion to each arm of the robot.

Analysis of geometric parameters

The geometric parameters of the parallel robot in delta configuration prescribe particular characteristics that allow the physical differentiation of its mechanical structure with respect to other existing arrangements. Thus, for the establishment of the geometric parameters of the robot used, it was initially required to identify each of the main mechanical components that constitute it, as well as to establish the associated function within the robot mechanism, as a whole. Such elements are shown in Figure 6 and their respective characteristics are shown below:

1. *Fixed platform or base.* Provides support to the robot actuators and an equal arrangement of 120 ° to each other, with respect to the center of the robot. Each actuator will allow the direct conduction of the rotational movement generated, towards the first link of the respective limb, as they are both joined, through the axis of the first.

2. *Actuated link.* This element transmits the movement generated by each actuator, towards the end effector of the robot, through its mechanical connection with a second link. Together, these two elements make up each limb of the robot.

3. *Driven link.* This implement is attached to the respective actuated link, by means of a type of universal joint, to transmit the movement directly affected by itself, and direct it to the end effector.

4. *Mobile platform or end effector.* It is the device that contains the tool to be used by the robot. Therefore, this element will have to acquire a specified position through the movement executed by each of the actuators used, which will be transmitted up to this point, through the respective joints at each extremity.

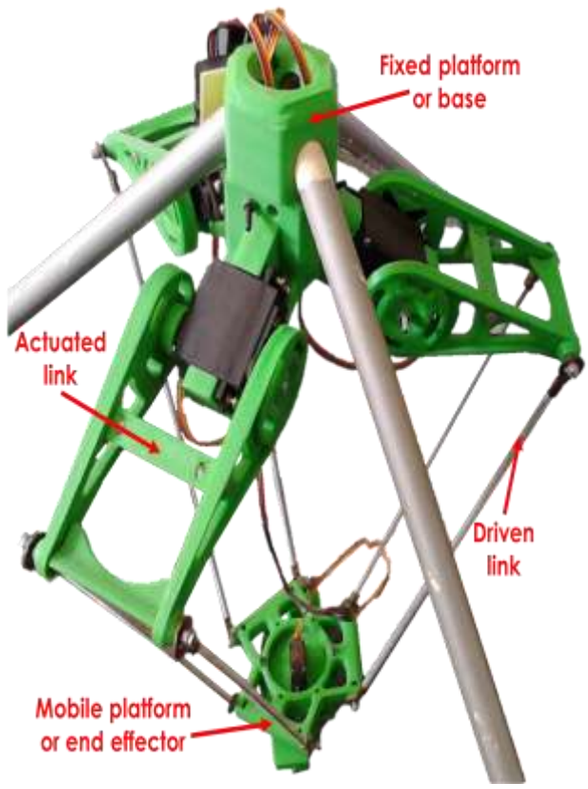

Figure 6 Mechanical elements of the parallel robot in delta configuration used
Source: Own Elaboration, 2021

Thus, from the identification of each of the elements described, it was possible to establish the value associated with the geometric parameters of the parallel robot in delta configuration used, and concentrate such information in Table 3.

Geometric parameter	Specification
Base radius (R)	7.5 cm
End effector radius (r)	4.5 cm
Actuated link length (L_A)	9.5 cm
Driven Link Length (L_B)	32 cm

Table 3 Definition of geometric parameters of the robot used
Source: Own Elaboration, 2021

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Controller programming

A controller determines the energy required for the execution of a specified task, by the user, on a given system. Therefore, for the present study, it was necessary to select a device capable of adequately managing the energy that would be required by each robot servomotor, while ensuring the correct positioning of its shaft, as required. The function of the controller used is set out in the joint control and data communication scheme in Figure 7; in which, given the designation of a positional value by the user, through a computer application, it is translated into the respective electrical signal and destined for the corresponding actuator.

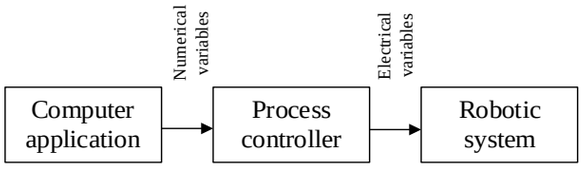

Figure 7 Relationship between application, controller and robot
Source: Own Elaboration, 2021

Thus, given the need to relate the numerical values emitted from the computer with the electrical signals that would directly and independently manipulate each limb of the implemented robot, the use of a programmable controller was considered that would allow transcription between both representations, in a simple, agile and reliable way. Therefore, after the validation of the characteristics provided by various control devices, it was decided to incorporate the Arduino UNO electronic board, shown in Figure 8 and whose specifications are shown in Table 4, as the controller of the delta robot available.

Figure 8 Arduino UNO board
Source: https://arduino.cl, 2021

Characteristic	Specification
Microcontroller	ATmega328
Supply voltage (recommended)	7 a 12 V
Supply voltage (limit)	6 a 20 V
Digital input / output pins	14
PWM output pins	6
Analog input pins	6
Current demanded by digital terminal	40 mA
Flash memory	32 kb
SRAM	2 kb
EEPROM	1kb
Clock frequency	16 MHz

Table 4 Arduino UNO board technical data
Source: https://arduino.cl, 2021

For its part, for the development of the algorithm in charge of managing each limb of the robot used, a proposal was made of an operation sequence triggered by the communication between the respective cybernetic and physical systems. In this way, the control instructions were exchanged from the computer to the robot or, by default, the feedback of the values acquired from each joint system and their presentation in the computer application used. Such functions, in the proposed order of execution, can be seen in the flow diagram of Figure 9; while a more detailed description of the interaction between the computer, the process controller and the robot is presented below.

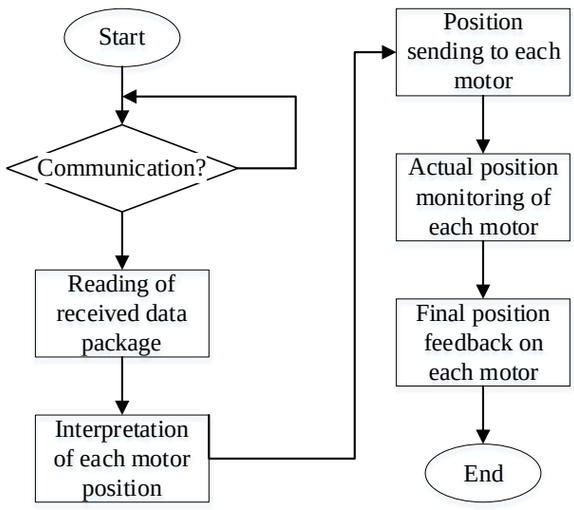

Figure 9 Algorithm for the process controller
Source: Own Elaboration, 2021

1. Through serial communication via USB, the respective data is transmitted to the movement to be executed by each of the servomotors integrated to the robot, according to the values emitted from the computer to the Arduino board used as the implement controller.

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2. The controller receives the data packet, interprets it and separates it, and then effectively allocates it to the corresponding actuator.

3. After a specified period of time has elapsed, the controller monitors the actual position adopted by each servomotor under management.

4. Via serial communication, the controller feeds back the data that allow the user to know the position of each robot actuator, during the execution of a movement and at the end of such action.

After finishing the edition of the respective programming code, it was downloaded into the microcontroller of the Arduino board used, through the COM port to which it was connected. Subsequently, it was needed to validate the effectiveness of such code, once applied to the motion control of each limb of the implemented robot.

Robot operation results

By enabling the Monitor Serial utility, integrated into the Arduino development software, it was possible to interact with the electronic system that executes the manipulation of the robot used. Thus, through the tool described, it is possible to manage communication, through a specific USB port on the computer, to another device that supports the serial standard, in this case the Arduino board used, both for reading and for write data to it.

To verify the adequate performance of the algorithm programmed in the controller board, the three servomotors that enable each robot arm were connected to it. However, given the need to handle a variable voltage, to ensure the operation of each actuator, the use of PWM outputs from the board itself was established, which were designated in the respective code. Thus, starting from the sending of a data packet, from the computer, with the angular position for each servomotor, the board manages on these the value requested by the user, by means of the serial monitor; at the same time that it emits the positional value reached by each actuator.

Before proceeding with the transfer of data to the servomotors, it was necessary to perform the physical calibration of the zero joint position, relative to each of these. Such position is defined by the fully horizontal alignment of the actuated link, by assigning a zero value to the respective joint. Figure 10 shows the arrangement of the actuated links, by assigning a zero joint value to the three joints of the robot used. In this way, a coherent relationship is established between the value proposed by the user towards each joint of the robot and the real position that both the servomotor and the respective actuated link must adopt.

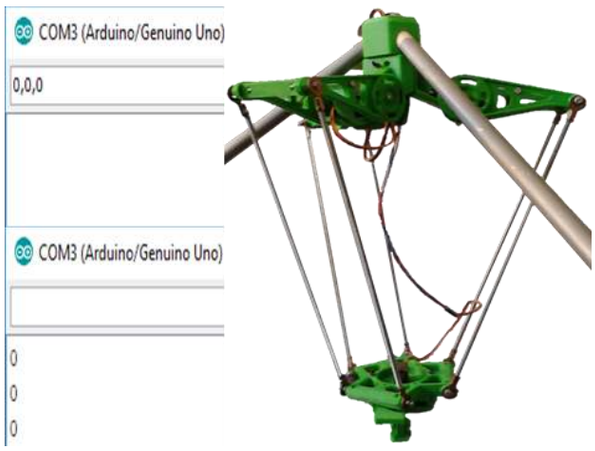

Figure 10 Zero position at the robot joints
Source: Own Elaboration, 2021

In the previous Figure, it can be seen that by assigning the same value to the three joints of the robot, the movement made by the end effector is described on a central vertical line, with respect to the fixed platform, establishing the specific height as a function of the value proposed. However, given the nature of the joint variables qi of the delta-type parallel robot, as the value assigned is higher, the end effector will tend to go down, or by default, it will go up. Therefore, it was essential to impose both the maximum and minimum value that each joint could adopt, without the mechanical structure itself adopting a seizure condition.

Likewise, since it was necessary to adopt both positive and negative joint values, to increase the range of positions to be reached by the end effector of the robot, the freedom of rotation of the servomotor was modified, from 0 ° to 180 °, to values between -90 ° and 90 °.

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In this way, the description of joint values, required by the user, was enabled, without their polarity with respect to the horizontal affecting the process. Figure 11 shows the assignment and adoption of three different joint values, one for each limb, thereby restricting the specific location of the mobile platform, outside of the previously analyzed vertical arrangement, thereby increasing the space of robot task.

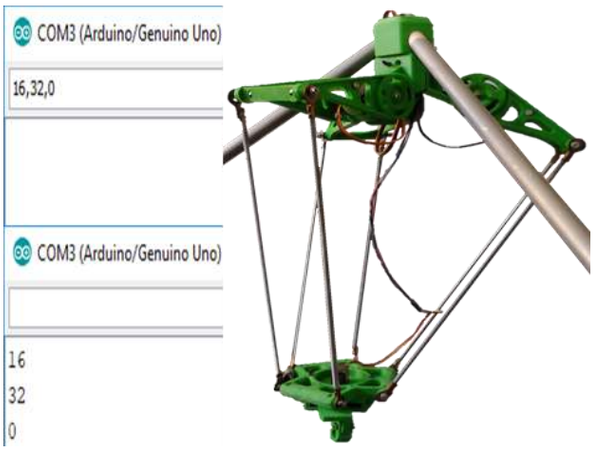

Figure 11 Emission of different joint values to the robot
Source: Own Elaboration, 2021

Conclusions

The integration of a test prototype from the use of a parallel robot in delta configuration, implied a precise analysis of the respective mechanical structure and the transmission of the movement provided by each actuator, through the pertinent limb, so that the effector final was set in a specific location. Although the Cartesian position of the point reached is not yet reported, the proper operation of each servomotor is guaranteed, based on the joint value entered by the user, from the computer. A detailed study to determine the specific location of the end effector may imply the continuity of the present work.

The analysis of two ways to influence movement towards the extremities of the robot used is highlighted: the assignment of the same joint value to its actuators and the sending of different values to each of them. The adequate performance of the robot is reported, by fully describing the behavior requested by the user, during the execution of the tests for both cases.

Likewise, both the calibration carried out on the operation of the actuators, as well as the interpretation that the programming of the controller exerted on the designated values, to emit the respective electrical signal to each actuator, as appropriate, were essential.

The use of the Arduino board for the implementation of the exposed prototype is exhibited, given its easy acquisition and low cost; highly valued qualities for its replacement, when causing a mishap that damages it. The performance of this board is acceptable and comparable to that offered by specialized and higher-cost controllers; in addition to being feasible its application in didactic projects. Emphasis is placed on simplicity to communicate the board used with a computer, program it and connect it to peripherals that are managed by the same.

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Design and implementation of a fuzzy control of temperature for a plastic aging chamber

Diseño e implementación de un control difuso de temperatura para una cámara de envejecimiento de plástico

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Abstract

Plastic is a versatile material found in virtually any type of product, however, due to its long-life cycle it has become an environmental problem. Therefore it is necessary to determine this cycle using an aging chamber, although previous research has already focused on this equipment, most implement ON-OFF or PID controllers, so it is proposed to design and implement a fuzzy controller using a microcontroller and Python, based on the ASTMD-4329 standard and simulating different sequences (sunrise, midday, sunset and night), In addition a preheating cycle is proposed, to verify the correct behavior the controller is compared with a simulation performed in Matlab giving a similarity of 96% for the sequence of half day to obtain this value is used the criterion of the Integral of time and Absolute Error (ITAE), finally all the sequences are implemented where the parameters established by the standard are met..

Fuzzy Control, Thermal Systems, ITAE criterion and Aging Chamber

Resumen

El plástico es un material versátil que se encuentra en prácticamente cualquier tipo de productos, sin embargo, por su amplio ciclo útil de vida se ha convertido en un problema ambiental. Por lo que es necesario determinar el este ciclo utilizando una cámara de envejecimiento, si bien investigaciones previas se han centrado ya en estos equipos, la mayoría implementan controladores ON-OFF o PID, por lo que se propone diseñar e implementar un controlador difuso utilizando un microcontrolador y Python, basado en la norma ASTMD-4329 y simulando diferentes secuencias (amanecer, medio día, atardecer y noche), además se propone un ciclo de precalentamiento, para verificar el correcto comportamiento se compara el controlador con una simulación realizada en Matlab dando una similitud del 96% para la secuencia del medio día para obtener este valor se utiliza el criterio de la Integral del tiempo y Error Absoluto (ITAE), finalmente se implementan todas las secuencias en donde se cumplen los parámetros establecidos por la norma.

Control difuso, Sistemas Térmicos, criterio ITAE y Cámara de Envejecimiento

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Introduction

Plastics are a set of materials artificially created from chemical reactions that use oil as the main raw material, this type of material is currently found in almost everything we occupy in our daily life, offering qualities and characteristics so competitive that they are suitable as essential components in clothing, technological components and food and beverage containers (Fernández & Jiménez, 2017). Due to this wide versatility, in 2019 according to data from the Plastics Europe association, the production of plastics reached 368 million tons, with the Asian continent being the main producer in the world (51%), in this region China is the country responsible for 31 % of world production, while in the American continent Canada, the United States and Mexico contribute 19% and the rest of Latin America only 4% (Plastics Europe, 2020). This production increases exponentially every year and given its long life cycle, most of the plastic can still be found in the environment, it is estimated that about 7.8 billion tons have been produced, which would mean the presence of one ton of plastic for each person in the world (Buteler, 2019).

Due to the great supply and demand of plastic, leaders of several countries have chosen to create agreements to correctly manage the life cycle of plastics worldwide, an example of this has been the fourth UN environmental assembly held in Nairobi Kenya, with the participation of more than 200 countries that have committed to reducing the use of plastics by 2030 (IISD, 2019).

However, agreements and laws are not enough, the development of new processes and technologies is a path that must be studied, for this reason, from the scientific and technological approach, various areas of science join in the search for new technologies for understanding of how certain environmental factors contribute to the degradation of plastic and not only that, today they focus on artificially simulating the environment in which the plastic will be exposed in order to accelerate its aging and guarantee the useful life of the material. To achieve a rapid degradation of the plastic material, aging chambers are commonly used where some of the physical variables such as temperature, humidity and ultraviolet radiation can be manipulated (Cai *et al*., 2018; Celestine *et al*., 2020; Chamas *et al*., 2020; Vohlídal, 2021).

Currently, research seeks to adequately control physical variables to optimize aging processes, so this article shows the process to control and optimize temperature using fuzzy control, where it is not necessary to know how the temperature behaves within a aging chamber.

Fuzzy control is based on the concept of fuzzy sets which lays the foundations of fuzzy logic. This method was proposed by the mathematician Lofti Ali Asker Zade at the University of California in an attempt to formalize or mechanize two human capacities. It seeks in the first place to generalize the ability to converse, reason and make rational decisions about imprecision, uncertainty, incomplete information, contradictory information, partiality of truth and partiality of possibility in an environment of imperfect information, secondly, it seeks be able to perform a wide variety of physical and mental tasks without measurements or calculations (Siddique, 2014).

For the part of the works related to aging chambers Orozco, (2010) carried out the design and construction of an aging chamber accelerated by temperature for polymers, this team worked in a temperature range of 100 to 50 ° C, additionally in the The design considered the interaction of construction materials with temperature and the ASTM E-95-1990 standard, five years later Uribe et al. (2015) made a design in which I modify the kp and ki values of a PI controller in an environment chamber by means of a fuzzy controller from the error and the derivative of the error that increases the robustness and efficiency of a control system of temperature to achieve this objective used MATLAB for the generation of the fuzzy control and the implementation was carried out with LabVIEW, while Ruiz (2016) implemented an ON-OFF controller in aging chambers from the construction materials, using LabVIEW and a data acquisition board.

Ezike *et al*. (2018) developed a low-cost controlled temperature chamber for testing materials where he used Arduino and an ON-OFF controller to control the temperature in the chamber.

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In that same year Muñoz (2018) designed a climate-controlled chamber with the ability to recreate temperatures between 2 and 5°C and a relative humidity between 50% and 98% to perform quality and energy efficiency tests on refrigerators, in this design I use a programmable logic controller that is connected to the internet to be able to monitor the temperature behavior across the network, just one year later Bahena (2019) carries out the design and manufacture of an accelerated aging chamber for plastics using an Arduino microcontroller and an ON-OFF controller to control temperature, ultraviolet light and humidity all in accordance with the ASTM D-4329 standard.

According to the history of work on the development of aging chambers, it is observed that the temperature controller is designed based on the construction materials, and using an ON-OFF controller, even when designing the diffuse controller they are based on MATLAB and for its implementation in Labview, so it is proposed to design and implement a Mamdami fuzzy temperature controller that is capable of adapting to the temperature control of an aging chamber without the need to know the construction materials, using a microcontroller and Python.

Method

An accelerated aging chamber consists of a thermally insulated container of stainless steel sheets, in the central part are the test tubes that are the material to be aged and at the ends there are two infrared lights with the purpose of increasing the temperature in the container, In addition, there is a temperature sensor in order to monitor and control the temperature as shown in Figure 1. Therefore, the operating parameters of the aging chamber and the temperature to work in the fuzzy controller must be determined.

Figure 1 Plastic aging chamber with two infrared luminaires
Source: Self Made

To control the temperature, the ASTM D-4329 standard is used, which establishes a complete aging cycle consisting of 12 hours, on the other hand, Bahena proposes dividing a cycle into microcycles which is divided into 4 sequences with different: cycles of ignition of the lamps, temperatures and minutes of operation (Bahena, 2019), as shown in Table 1.

Sequence	Temperature	Weather	L1	L2
Dawn	60±3 ℃	20 min.	On	Off
Midday	60±3 ℃	20 min.	On	On
Sunset	60±3 ℃	20 min.	Off	On
To become night	50±3 ℃.	30 min.	Off	Off

Table 1 Characteristics of a chamber cycle
Source: Own Elaboration

In addition to the proposed microcycles, a preheating sequence is integrated into the first aging cycle, where the half-day sequence is activated, which lasts 40 minutes.

On the part of the fuzzy controller, it is divided into four main parts: fuzzification, knowledge base, decision logic (inferences) and defuzzification as shown in Figure 2.

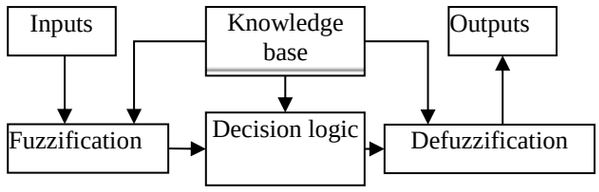

Figure 2 Structure of a fuzzy controller
Source: (Ponce, 2010)

Fuzzification converts the input data (numerical values) into linguistic variables in order to classify the input variable into fuzzy sets within the universe of discourse (Castaño et al., 2013), the input data correspond to the error and the derivative of the error, the linguistic variables determine the sets composed of each membership function defined by the expert for this investigation, the triangular function is used as shown in Figure 3, Eq. (1) (Singh & Lone, 2020) and they are used 7 linguistic variables as shown in Table 2.

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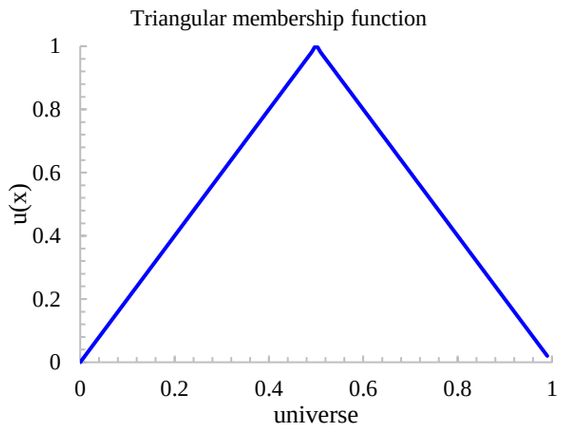

Figure 3 Triangular membership function
Source: Own Elaboration

$$f(x;a,b,c)=\max\left(\min\left(\frac{x-a}{b-a},\frac{c-x}{c-b}\right),0\right) \quad (1)$$

Where:
a is the lower limit
b is the center
c is the upper limit
x is the numeric value of the fuzzy controller input or output.

Error	Derived from the error	Output	Definition
eNG	deNG	uNG	Negative Large
eNM	deNM	uNM	Medium Negative
eNP	deNP	uNP	Small negative
eZ	deZ	uZ	Zero
ePP	dePP	uPP	Small Positive
ePM	dePM	uPM	Positive Medium
ePG	dePG	uPG	Positive Large

Table 2 Linguistic variables of the fuzzy controller
Source: (Castaño et al., 2013; Ponce, 2010)

The knowledge base contains all the information of the application to be controlled, as well as the goals of the controller, it consists of a database and a linguistic rule base to control the variable where the data provides the definitions for the establishment of rules and the manipulation of fuzzy data, on the part of the rules express the experience of the expert in a process of a combination of premises and consequents are carried out using prepositions for this case the prepositions "IF Input 1 and Input 2 Then Consequence ". From the aforementioned, the inference matrix is generated as shown in Table 3 and using Eq. (2) for this case, Rule 1 (R1) is used as an example.

	deNG	deNM	deNP	deZ	dePP	dePM	dePG
eNG	R1	R2	R3	R4	R5	R6	R7
eNM	R8	R9	R10	R11	R12	R13	R14
eNP	R15	R16	R17	R18	R19	R20	R21
eZ	R22	R23	R24	R25	R26	R27	R28
ePP	R29	R30	R31	R32	R33	R34	R35
ePM	R36	R37	R38	R39	R40	R41	R42
ePG	R43	R44	R45	R46	R47	R48	R49

Table 3 Inference matrix
Source: Self Made

If Input 1 and Input 2 then
R1= min (Input 1, Input 2) (2)

The decision logic is in charge of determining which rules of the knowledge base have been activated in the operation of the control and in turn a membership value is assigned to the output, obtaining the degree of truth or weight of each of the rules It is being activated so it depends on the Fuzzy Association Matrix (FAM) rules as shown in Table 4.

	deNG	deNM	deNP	deZ	dePP	dePM	dePG
eNG	uNG	uNG	uNG	uNG	uNM	uNP	uZ
eNM	uNG	uNG	uNG	uNM	uNP	uZ	uPP
eNP	uNG	uNG	uNM	uNP	uZ	uPP	uPM
eZ	uNG	uNM	uNP	uZ	uPP	uPM	uPG
ePP	uNM	uNP	uZ	uPP	uPM	uPG	uPG
ePM	uNP	uZ	uPP	uPM	uPG	uPG	uPG
ePG	uZ	uPP	uPM	uPG	UPG	uPG	uPG

Table 4 Fuzzy Association Matrix (FAM)
Source: (Castaño et al., 2013; Ponce, 2010)

From Table 3 and 4 we proceed to obtain the aggregation stage that represents the union of the activated fuzzy rules, so the max implication is used. As shown in Eq. (3), this equation shows the implication process of the uNG output, this must be done for each of the fuzzy sets of the output.

uNG=max(R1,R2,R3,R4,R8,R9,
R10, R15, R16,R22) (3)

Defuzzification is the process that converts the results obtained through the inference mechanism to a signal that can be interpreted by an actuator. To calculate this output, the centroid method for discrete values is used, which is defined in Eq. (4).

$$z^* = \frac{\sum_{i=1}^{n} A_i * x_i}{\sum_{i=1}^{n} A_i} \quad (4)$$

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Where Ai represents the subareas of the centroid and xi represents the centroid (Singh & Lone, 2020). Finally, the fuzzy controller is shown in Figure 4 where the setpoint is the desired temperature r (t), the error is the difference from the reference and the process output y (t), the controller output must be integrated to enter the process u (t), finally the system must be in closed loop.

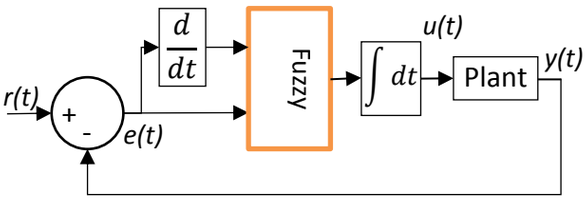


Figure 3 Fuzzy controller in block diagram
Source: Self Made

To obtain the error that is going to enter the controller, it must be considered when the controller reference is 60 ° C and the temperature inside the aging chamber is ambient temperature, for this case 0 ° C is taken as ambient temperature, therefore that the error is 60 ° C, otherwise the error is -60 ° C. Regarding the derivative of the error, it is necessary to know how the temperature behaves inside the aging chamber.

For this case, the noon sequence is used as shown in Fig. 5 where the microcontroller is in charge of sending a signal to the actuator that transforms electrical energy into heat by means of the luminaires, the change in temperature inside the aging chamber is measured by a temperature sensor that is connected to a 16-bit resolution analog-digital converter with a time of 4-second sampling, which is in charge of discretizing the analog to digital signal, the result obtained is sent to the microcontroller by I2C communication and finally the data is stored in the computer to determine the derivative of the error.

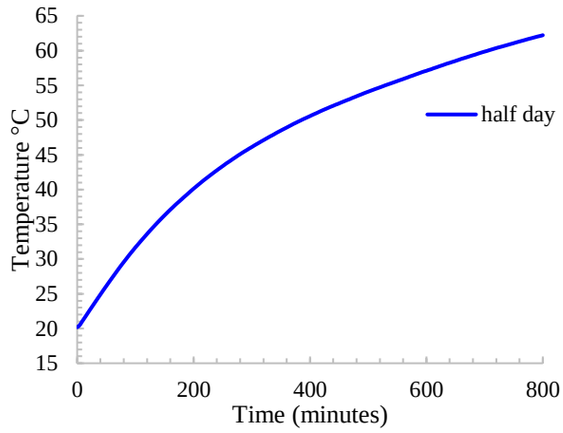


Figure 4 Temperature response in the aging chamber
Source: Self Made

The data obtained is shown in Table 5 and the temperature behavior is shown in Figure 6 where the derivative of the error is the difference between the current error and the previous error between the sampling time, so the maximum value of the derived from the error is 0.1277 from this value it is determined to work in a range of -0.2 to 0.2, for the output part u (t) is the resolution of the PWM controller that goes from 0 to 255 bits where the value of The integral can be defined as u (t) + u (t) above, so u (t) has to be a proportional part of the PWM for this work, the range of -35 to 35 was chosen (Castaño et al., 2013).

Weather	Temperature ° C
0	20.185
4	20.4453
8	20.9481
12	21.4441
….	…..
796	62.1191
800	62.2125

Table 5 Obtaining the data of the derivative of the error
Source: self made

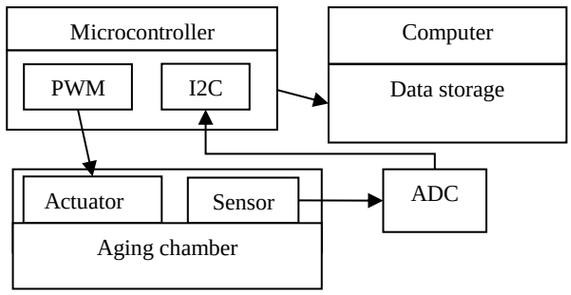


Figure 5 Block diagram to obtain the derivative of the error
Source: Self Made

With the data obtained, the transfer function of the aging chamber can be obtained using Matlab in order to compare the result obtained from the fuzzy controller with a simulation carried out in Simulink, the result obtained is shown in Eq. (5).

$$\frac{0.2625}{379.12s+1} \quad (5)$$

For the part of the simulation in Matlab, the Fuzzy toolbox is executed where the fuzzy controller is designed, where the first step is to add the control signals and the output as shown in Figure 7.

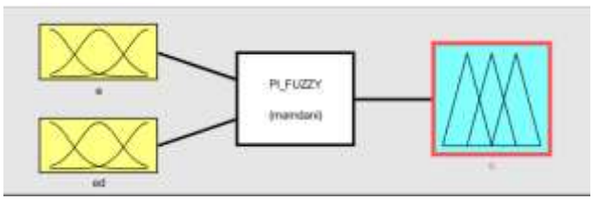
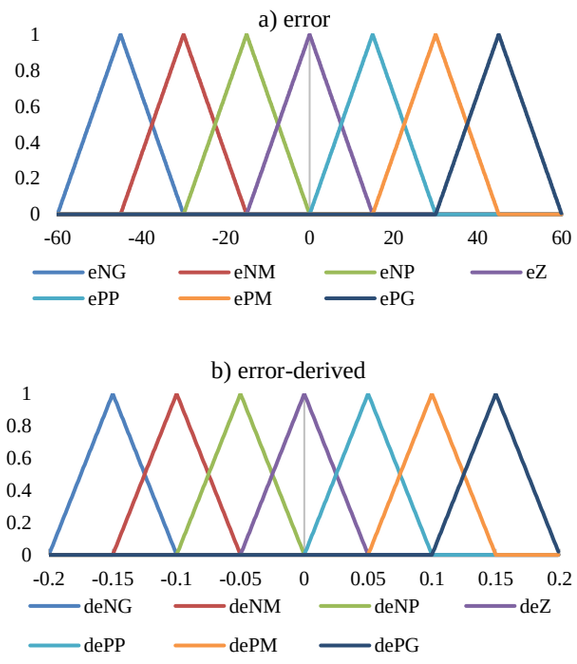


Figure 6 Fuzzy controller in Matlab
Source: Self Made

Subsequently, the linguistic variables are added to the inputs and the output shown in Table 2. In the case of all the input and output variables, a triangular membership function is used that have the same spacing depending on the domain established for the case of the error is from -60 to 60, for the derivative of the error is from -0.2 to 0.2 and u is from -35 to 35, as shown in Figure 8.



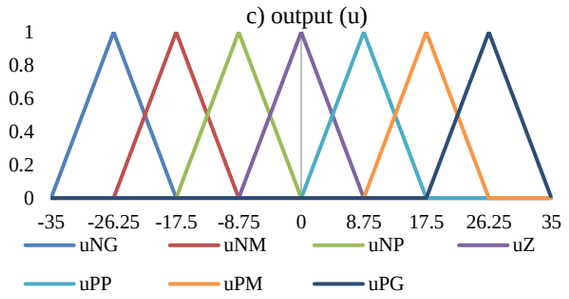


Figure 7 Integration of membership functions a) error, b) derived from error, c) u with their respective linguistic variables
Source: Self Made

The rules governing the fuzzy controller are added (Table 3 and 4). Finally, the series of steps that must be developed for the implementation of the fuzzy controller in Python is added.

1. Fuzzify the input by applying Eq. 1.
2. Obtain the value of each of the rules by means of Eq. 2, Table 3 and 4
3. Apply the aggregation method applying Eq. 3
4. Defuzzify by applying Eq. 4

Once the fuzzy control implementation steps have been completed, we proceed to obtain the controller results.

Results

To check the operation of the fuzzy controller, a simulation is performed using Matlab's Simulink, in which the fuzzy controller is exported as shown in Figure 9, where the fuzzy controller is simulated for the preheating cycle by the process part is The transfer function obtained by Eq. 5, in the case of the fuzzy controller implemented in the aging chamber is shown in Figure 9.

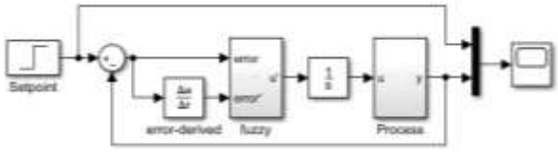


Figure 8 Simulator of a fuzzy controller in Matlab
Source: Self Made

The simulation is compared in a time of 0 to 30 minutes for the noon sequence with a setpoint of 60 ° C and the fuzzy controller with a sampling time of 4 seconds.

The results obtained are shown in Figure 10 where it presents a similarity of 96% this result was obtained by the Integral of Time and Absolute Error (ITAE) (Arrieta & Alfaro, 2011) which is described in Eq. 6.

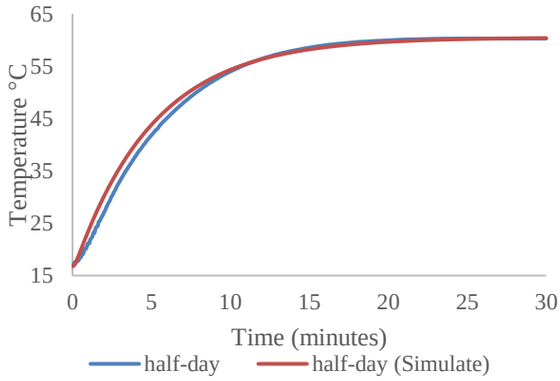


Figure 9 comparison of real and simulated fuzzy controller
Source: Self Made

$$\text{ITAE}= \int_0^{\infty} t|e(t)|dt= \sum_{k=0}^{n} t_k * |e_k| * \Delta x \quad (5)$$

$$Similarity = \frac{ITAE\ simulated}{ITAE\ real} * 100\%$$

Where:

- tk is the time occurred at the sampling instant
- $|\ e_k\ |$ is the absolute value of the error.
- Δx is the sampling time.
  - ITAE simulated is the error obtained in the Matlab simulation
  - ITAE real is the error obtained in the aging chamber

Finally, a microcycle described in Table 1 is carried out plus the preheating time as shown in Figure 11, for the preheating part (0 to 40 minutes) the temperature is set at approximately 15 minutes with a maximum value from 60.33 ° C, the sunrise sequence (40 to 60 minutes) the temperature decreases to a minimum value of 57.22 ° C, the half-day sequence (60 to 80 minutes) reaches a maximum peak of 62.83 ° C, the sunset sequence (80 at 100 minutes) has a minimum value of 59.29 ° C, lastly the nightfall sequence (100-130 minutes) maintains the temperature at 49.78 ° C, so it can be observed that the microcycles meet the parameters established by the ASTMD-4329 standard.

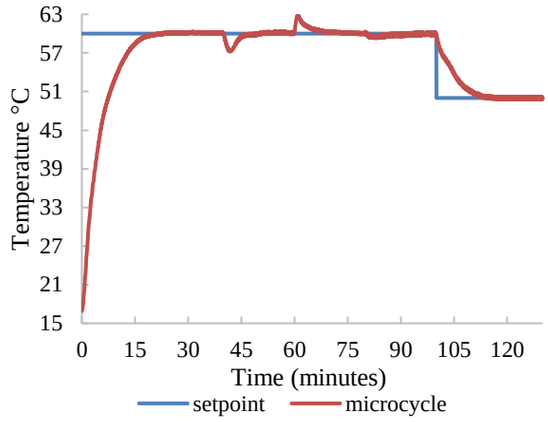


Figure 10 Result of preheating and microcycles of the aging chamber with diffuse control
Source: Self Made

Conclusions and future work

This research work shows that it is feasible to control the temperature using a fuzzy controller without knowing the mathematical model of how the temperature behaves internally in the aging chamber. However, it is important to bear in mind that to obtain satisfactory results it depends entirely on the expert and his knowledge in the process, for example, it is necessary to know how the temperature changes during the process, the input signals that will be input to the controller and their respective outputs, the membership function that best adapts to the process, the number of linguistic variables that will be used, the more linguistic variables are handled in the fuzzy controller, the rules in the knowledge base will increase, finally once the This controller can be implemented in other processes that need to control the temperature or another physical variable. For future work, the fuzzy controller will be optimized using genetic algorithms.

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Objectives
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Citation: Surname (IN UPPERCASE), Name 1st Author, Surname (IN UPPERCASE), Name 1st Coauthor, Surname (IN UPPERCASE), Name 2nd Coauthor and Surname (IN UPPERCASE), Name 3rd Coauthor. Paper Title. ECORFAN Journal-Democratic Republic of Congo. Year 1-1: 1-11 [Times New Roman No.10]

* Correspondence to Author (example@example.org)
† Researcher contributing as first author.

Introduction

Text in Times New Roman No.12, single space.

General explanation of the subject and explain why it is important.

What is your added value with respect to other techniques?

Clearly focus each of its features

Clearly explain the problem to be solved and the central hypothesis.

Explanation of sections Article.

Development of headings and subheadings of the article with subsequent numbers

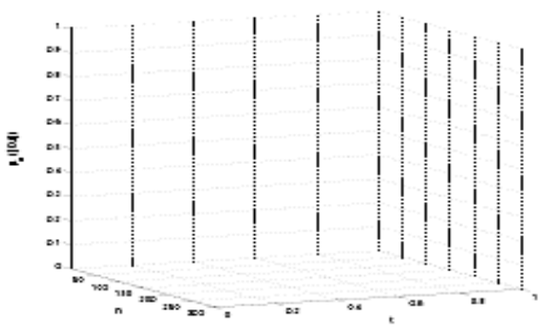
[Title No.12 in Times New Roman, single spaced and bold]

Products in development No.12 Times New Roman, single spaced.

Including graphs, figures and tables-Editable

In the article content any graphic, table and figure should be editable formats that can change size, type and number of letter, for the purposes of edition, these must be high quality, not pixelated and should be noticeable even reducing image scale.

[Indicating the title at the bottom with No.10 and Times New Roman Bold]



Graphic 1 Title and *Source (in italics)*

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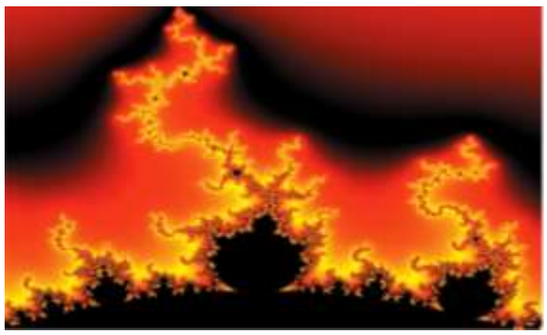

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Table 1 Title and *Source (in italics)*

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Each article shall present separately in **3 folders**: a) Figures, b) Charts and c) Tables in .JPG format, indicating the number and sequential Bold Title.

For the use of equations, noted as follows:

$$Y_{ij} = \alpha + \sum_{h=1}^{r} \beta_h X_{hij} + u_j + e_{ij} \quad (1)$$

Must be editable and number aligned on the right side.

Methodology

Develop give the meaning of the variables in linear writing and important is the comparison of the used criteria.

Results

The results shall be by section of the article.

Annexes

Tables and adequate sources

Thanks

Indicate if they were financed by any institution, University or company.

Conclusions

Explain clearly the results and possibilities of improvement.

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References

Use APA system. Should not be numbered, nor with bullets, however if necessary numbering will be because reference or mention is made somewhere in the Article.

Use Roman Alphabet, all references you have used must be in the Roman Alphabet, even if you have quoted an Article, book in any of the official languages of the United Nations (English, French, German, Chinese, Russian, Portuguese, Italian, Spanish, Arabic), you must write the reference in Roman script and not in any of the official languages.

Technical Specifications

Each article must submit your dates into a Word document (.docx):

Journal Name
Article title
Abstract
Keywords
Article sections, for example:

1. *Introduction*
2. *Description of the method*
3. *Analysis from the regression demand curve*
4. *Results*
5. *Thanks*
6. *Conclusions*
7. *References*

Author Name (s)
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