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Journal Computer Technology

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The works must be unpublished and refer to topics of Data Management, Establishment of Computer Networks, Design of Database Systems, Software Design, Computer Science, Software, Computer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

Presentation of content

In volume five, issue fourteen, as the first article we present, *Applying the use of technologies in preventive measures against the COVID-19*, by HERNÁNDEZ-CRUZ, Luz María, ALOR-MEDINA, Levi Daniel, MEX-ÁLVAREZ, Diana Concepción and CASTILLO-TÉLLEZ, Margarita, with secondment at the Universidad Autónoma de Campeche, as a second article we present, *Electronics engineering virtual laboratory for COVID-19 pandemic*, by ESQUEDA-ELIZONDO, José Jaime, JIMÉNEZ-BERISTÁIN, Laura, MARTÍNEZ-VERDÍN, Annette Sofia and SERRANO-TRUJILLO, Alejandra, with an appointment at Universidad Autónoma de Baja California, as a third article we present, *Virtual communications laboratory as a tool for the subject of selected telecommunications topics*, by VELASCO-CASTILLO, Miguel Ángel, ROJAS-SANDOVAL, Daniel, GIL-VELASCO, Alfredo and HERNÁNDEZ-BÁEZ, Irma Yazmín, with secondment at Universidad Politécnica del Estado de Morelos, as fourth article we present, *TIC applied to collection management. SOFIPA CORPORATION. Case study*, by ALTAMIRANO-CABRERA, Marisol, BENITEZ-QUECHA, Claribel, TORAL-ENRIQUEZ, Fernando and DIAZ-LARA, Carlos Alberto, with secondment Instituto Tecnológico de Oaxaca.

Content

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Applying the use of technologies in preventive measures against the COVID-19

Aplicando el uso de tecnologías en medidas preventivas ante el COVID-19

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Abstract

This article carries out applied research for the use and integration of Technologies in the implementation of an autonomous system, which allows to ensure compliance with preventive health measures when entering public places. This, in order to contribute to the reduction of infections in the face of the COVID-19 pandemic. The main objective of the study is to glimpse the application of technologies to provide effective and efficient mechanisms that favor the monitoring of health measures for the benefit of health. The "COVID-19 Preventive Robot" Project is presented, composed of four functional modules that allow temperature taking, the supply of anti-bacterial gel, the control of entry (passage) and the maximum capacity of people. Initially, the problem is exposed and the research study is proposed together with the prototypes of each module. The Technologies used throughout the project are briefly described below. Finally, as a result, the functional schemes are deployed using the Fritzing software and the source codes in Arduino IDE developed for the automation of the mechanism of each of the proposed modules. From the above, it is concluded that the Technologies used in the project "Preventive Robot of COVID-19" empower automation and autonomy to the process of preventive measures foreseen in the access to crowded physical places reducing the latent risk of contagion.

Prevention, Technology, Pandemic

Resumen

El presente artículo efectúa una investigación aplicada para el uso e integración de Tecnologías en la implementación de un sistema autónomo, que permita asegurar el cumplimiento de medidas preventivas sanitarias al ingresar en sitios públicos. Esto, con la finalidad de contribuir con la disminución de contagios ante la pandemia del COVID-19. El objetivo principal del estudio es entrever la aplicación de Tecnologías para brindar mecanismos eficaces y eficientes que favorezcan el seguimiento de medidas sanitarias en beneficio de la salud. Se presenta el Proyecto “Robot Preventivo del COVID-19” compuesto por cuatro módulos funcionales que permiten la toma de temperatura, el abasto de gel anti-bacterial, el control de entrada(paso) y el aforo máximo de personas. Inicialmente se expone la problemática y, se plantea el estudio de investigación junto con los prototipos de cada módulo. Enseguida, se describen brevemente las Tecnologías utilizadas en todo el proyecto. Finalmente, como resultado se despliegan los esquemas funcionales usando el software Fritzing y los códigos fuente en Arduino IDE desarrollados para la automatización del mecanismo de cada uno de los módulos propuestos. De lo anterior, se concluye que las Tecnologías empleadas en el proyecto “Robot Preventivo del COVID-19” facultan de automatización y autonomía al proceso de medidas preventivas previstas en el acceso a lugares físicos concurridos reduciendo el riesgo latente de contagio.

Prevención, Tecnología, Pandemia

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Introduction

The year 2020 changed the way of living in society, due to the arrival of COVID-19. The SARS-CoV-2 coronavirus causes a disease called COVID-19, which has spread around the world and was declared a global pandemic by the World Health Organization (WHO). Two countries, including Mexico, have put in place sanitary measures to contain the spread of contagion in the population. This disease has claimed the death of 222,232 as of May twenty-six, 2021. We can do something to mitigate and contain the spread of the disease. Sanitary filters are one of the most used preventive measures recommended by the health sector. However, in most cases, there are people assigned to monitor, control and follow up on compliance with the actions imposed by the sanitary filter. This, without a doubt, is an imminent risk, since that person becomes the focal point of interaction or closeness with a considerable number of people and can become the carrier of contagion.

This study analyzes the proposal of the project "Preventive robot of COVID-19", which ensures automation and autonomy through an integrated system of functional modules with the use of current technologies.

The development of the research details the implementation process and provides a viable solution for its implementation. As an added value, we can highlight the low cost for its production and the great scope for the application of its use as in schools, SMEs, health centers and, in general, any physical place.

The sections you find in the body of this article are:

- The problem: this section details the problems detected and the importance in which the research study lies.
- The research study: describes the research proposal, along with the study proposal to be carried out.
- Applied Technologies: exhibits the Technologies applied in the Project "COVID-19 Preventive Robot" and the main characteristics to consider in its integration and implementation.
- Results: Source code and implementation of the functional modules of the project "COVID-19 preventive robot".

The problem

Defining the coronavirus are known to be a large family of viruses that can cause disease in animals or humans. These different coronaviruses cause illnesses ranging from the common cold to more serious illnesses such as severe acute respiratory syndrome (SARS or SARS), Middle East respiratory syndrome (MERS), and COVID-19.

COVID-19 was identified in Wuhan, China, in December 2019. It is caused by the severe acute respiratory syndrome coronavirus type 2 (SARS-CoV-2), a new virus in humans that causes respiratory illness and can spread from person to person. (WHO, 2021)

COVID-19 is primarily transmitted from person to person to a group of respiratory droplets that are released when a person with the disease sneezes, coughs, or speaks. These infectious droplets can reach the mouth or nose of healthy people nearby and possibly enter their lungs when breathing. Another possibility of contagion lies in touching infected objects or surfaces and then touching your eyes, nose or mouth. (Mexico, 2021)

Short-range transmission is threatening, particularly in crowded medical units and in spaces not adequately ventilated. (Diseases, 2021)

According to the World Health Organization (WHO), the three main preventive measures to combat the spread and spread of COVID-19 are (Health, 2021):

- *Use Masks.* Masks can help prevent people who wear them from spreading the disease and spreading it to others. However, they do not protect against COVID-19 on their own, but must be combined with physical distancing and hand hygiene.

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- *Wash your hands.* This helps the prevention of cases, since, by disinfecting the hands with soap, the bacteria are eliminated and the spread of contagion to other people directly by greeting or touching is prevented; or indirectly by infecting things or surfaces.

- *Healthy Distance.* A good distance decreases the chance of infection. The World Health Organization (WHO)recommends maintaining a physical distance of at least 1 meter (3 feet) between people to avoid becoming infected, while the Centers for Disease Control and Prevention (CDC) recommends maintaining a physical distance of at least 1.8 meters (6 feet) between people.

The latest strain of COVID-19 known as B117 (or also VUI-202012/01), has caused an unprecedented increase in the number of cases in the country and has become the predominant variant in just three months.

Much remains to be discovered about this strain that has 23 mutations (17 of which appeared abruptly) with respect to the virus that appeared a year ago in the Chinese city of Wuhan, but what has become evident is that it is much more contagious and that it is displacing the older versions of the virus.

According to a study from Imperial College London, the new strain is about 50% more transmissible than others, and this raises the average number of people an infected person can with tag air. (NEWS, 2021)

The research studies

For all the above, the intention arises to contribute to the preventive measures imposed at the global, national and particular level of each federative entity. The present study focuses on reinforcing through the design of an automated robot, the assurance of compliance with sanitary control standards imposed to enter public establishments, to minimize collective contagion.

Figure 1 shows the preventive measures addressed by the COVID-19 Preventive Robot Project.

Figure 1 Preventive control measures addressed by the "COVID-19 Preventive Robot" Project

The COVID-19 Robot is a project that combines several technologies in a single integrative system that can perform preventive health tasks both individually and together. Figure 2 shows the set of functional modules that make up the "COVID-19 Preventive Robot" Project.

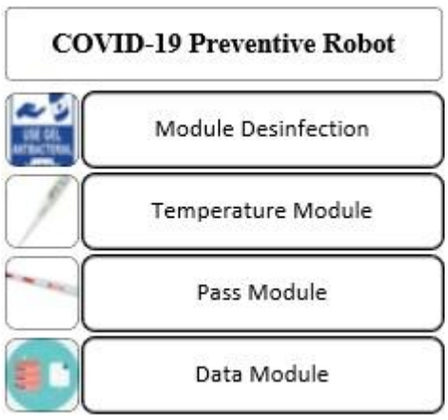

Figure 2 Functional modules that make up the "COVID-19 Preventive Robot" Project

The research study is carried out through the design of functional prototypes of each integrated module of the COVID-19 Preventive Robot.

It is worth mentioning that the module of disinfection consists of an autonomous mechanism that, by means of a set of sensors, detects the presence of the hand inside the Robot and expels the hand sanitizer with the help of motors, the disinfectant is based on antibacterial gel or sanitizers. Figure 3 shows the prototype designed for the disinfection module of the COVID-19 Preventive Robot Project.

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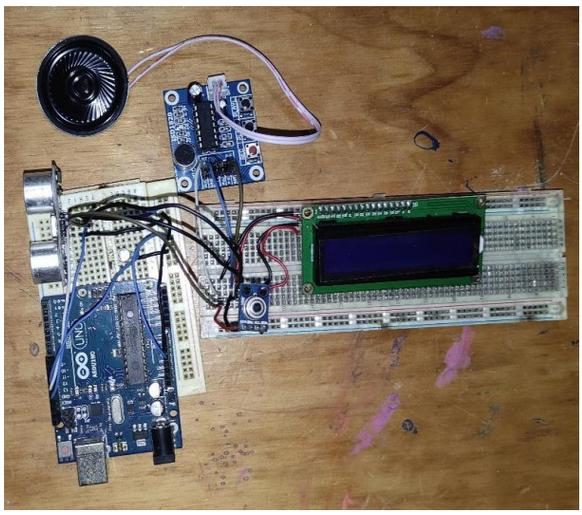

Figure 3 Prototype of the Temperature module of the "COVID-19 preventive robot" Project

With regard to the temperature particle, two main elements are available: a non-contact temperature sensor, for the measurement of the person's temperature; and an LCD screen (Liquid Crystal Display), where you can see the resulting value of the measurement. Figure 4 shows the prototype of the temperature measurement module of the “COVID-19 Preventive Robot" Project.

Figure 4 Prototype of the disinfection module of the "COVID-19 preventive robot" Project

The paso node, acts analogously to a mechanical boom in a parking lot, consists of a Servo Motor that will allow access to the person only when the temperature sensor takes a value between the range established as acceptable. Figure 5 shows the prototype of the passage module of the “COVID-19 Preventive Robot" Project.

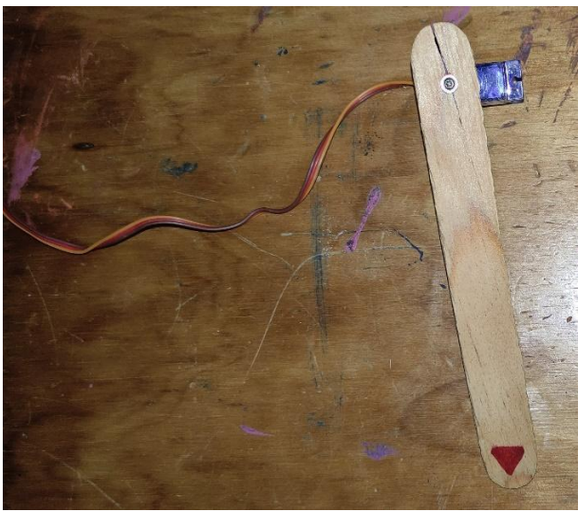

Figure 5 Prototype of the passage module of the Project "COVID-19 preventive robot"

Operation of the data module

Finally, the node of data. This module, unlike the previous ones, is a software. This program has been developed in Java programming language and has as its main objective to store and present the temperatures and distances that the Robot registers, in addition to including a people counter to keep a statistic of the people who come and control the maximum capacity. An added value of this module is that it has the option to export the data saved in an Excel spreadsheet. The graphical interface of the data module was made in NetBeans using the Java programming language, since this development environment allows the creation of interfaces for this language.

It is worth mentioning that the interface has the functions of observing the data of the sensors, as well as saving this data in an Excel workbook, in this way it is easier to make daily or weekly statistics of the possible states presented by customers or users of any place where the Robot is located. Figure 6 shows the prototype of the data module of the “COVID-19 Preventive Robot" Project.

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Figure 6 Main interface of the data module of the "COVID-19 preventive robot" Project

Applied technologies

As mentioned above, the integration of Technologies is one of the vital purposes of the study.

The following are the fundamental and specific characteristics of the Technologies applied in each proposed module of the "COVID-19 Preventive Robot" Project:

- *Temperature Module.* This module is the pillar of the project because the temperature is needed to be able to control an action based on the parameters desecrated in the Arduino program. Temperature is the determining value to estimate that people are healthy and with it, prevent the spread of COVID-19. Table 1 shows the physical components associated with this module.

Component	Description
Arduino Uno R3	It is an electronic board based on the Atmel ATmega328 chip. It has 14 digital input/output pins, the Arduino Pinout of which 6 can be used as PWM outputs, 6 analog inputs, a 16 MHz glass oscillator, a USB connection, a power connector, an ICSP wax fit and a reset button. The board's software includes a USB controller that can simulate a mouse, keyboard, and serial port (Arduino, Arduino Uno R3, s.f.)
Temperature Sensor MLX90614	The MLX90614 is a non-contact infrared temperature sensor manufactured by melexis. It is possible to connect these sensors with an automaton or processor such as Arduino to measure the temperature of an object at a distance. Communication is done through SMB us, a subset of I2C bus, so it is easy to read, and it is possible to connect more than one sensor simultaneously. MlX90614 thermometers are often found integrated into modules such as the GY-906 that incorporate the necessary electronics to connect it easily to an Arduino(Llamas, s.f.)
HC Ultrasonic Sensor – SR04	The HC-SR04 sensor is a low-cost distance sensor that uses ultrasound to determine the distance of an object in a range of 2 to 450 cm. It stands out for its small size, low energy consumption, good accuracy and excellent price. The HC-SR04 sensor is the most used within ultrasound-type sensors, mainly because of the amount of information and projects available on the web (Mechatronics, s. f.)
16x2 I2C LCD display	The LCD to I2C Adapter Module is based on the PCF8574 I2C controller, which is a digital Input and Output Expander controlled by I2C. Due to the design of the PCB this module is used specially to control an Alphanumeric LCD (Arduino A., s.f.)
Power Supply (from 5 to 12 volts)	A power eliminator from a laptop charger is used as the power supply.

Table 1 Physical components associated *with the* temperature module of *the Project* "Preventive robot COVID-19"
Source: Own source.

- *Disinfection Module.* The function of the module is basic, it receives as input the value of the sensor that is activated when detecting the hands of the people inside the Robot and returns as output the action of the motors that supply the disinfectant. Table 2 shows the physical components associated with the disinfection module.

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Component	Description
Sensor Ultrasonic HC – SR04	The HC-SR04 sensor is a low-cost distance sensor that uses ultrasound to determine the distance of an object in a range of 2 to 450 cm. It stands out for its small size, low energy consumption, good accuracy and excellent price. The HC-SR04 sensor is the most used within ultrasound-type sensors, mainly because of the amount of information and projects available on the web (Mechatronics, s.f.)
Motor reductor	It is a very compact machine that combines a speed reducer and a motor. These are joined in one piece and are used to reduce the speed of a computer automatically. (Roydisa, 2021)
Bridge H L293D	It is a Shield of motors with 4 complete bridge-H's, based on two L293D, can handle 4 inductive loads of 0.6 A per channel (4 relays, 4 solenoids, 4 DC motors or 2 unipolar or bipolar step motors), allows to control speed and direction of rotation in motors. Also provides connector for 2 servos of 5 V (Caldas, 2019)

Table 2 Physical components associated with the disinfection module of the Project "Preventive robot COVID-19"
Source: Own source

- *Step Module.* Entering a place is no longer irrelevant, the function of allowing or not allowing people to pass depends on complying with preventive health measures, including having an acceptable temperature within the normal. In this module, by means of temperature sensors, access is controlled by a physical mechanical pen device since if the maximum allowed temperature is exceeded, it will not be possible to lift and, therefore, the person will not have access to the place. Table 3 shows the essential physical component used in the step module.

Component	Description
Servo Motor	A servo motor is a device similar to a direct current motor that has the ability to be located in any position within its operating range, and remain stable in that position. (PanamaHitek, s.f.)

Table 3 Physical component associated with the passage *module of the Project* "Preventive robot COVID-19"
Source: Own source

- ***Module of Data.*** The function of this module is to store information. In this case, a java program was made in which you can obtain from the serial port the data from the sensors and in a GUI (User Interface) you can visualize these data, such as the Time, Date, Distance and Temperature of each person. Here, not use is made of physical components, the technological tools used are software. Table 4 shows the applications handled within the data module.

Component	Description
NetBeans 8.2	NetBeans is a free integrated development environment, mainly oriented to the development of Java applications. The NetBeans platform allows the development of structured applications through a set of components called "modules"(Oracle, s.f.)
Communication Libraries Serial	Serial communication is the most commonly used method in the Arduino environment. Also called UART by Universal Asynchronous Receiver/Transmitter, it is, as the name suggests, an asynchronous **Function:** (PanamaHiteck, Librerias Arduino, s.f.). **Libraries:** - Arduino.jar - PanamaHiteck_Arduino.jar - PanamaHiteck_Arduino_Sources.jar - RXTXComm.jar - Comunicación Serial-2.01.jar
Excel and PDF export libraries	Excel and comma-separated or CSV files are widely used as a format for exchanging data between applications or as a format for exporting large amounts of data from an application. (PanamaHiteck, Exportacion a Excel, s.f.) **Libraries:** - poi-3.9-20121203.jar - itextpdf-5.5.1
Arduino IDE	Open-source Arduino software (IDE) makes it easy to write code and upload it to the board. This software can be used with any Arduino board (Arduino, 2021).

Table 4 Software used in the data module of the Project "COVID-19 preventive robot"
Source: Own source

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Results

Next, it is shown how all the components and technologies pointed out in the previous section are integrated, to obtain as a result the implementation of each module of the "COVID-19 preventive robot". Table 5 shows the software tools for specific use for the design and implementation of the "COVID-19 Preventive Robot" Project.

Component	Description
Arduino IDE	Open-source Arduino software (IDE) makes it easy to write code and upload it to the board. This software can be used with any Arduino board (Arduino, Arduino IDE, 2021)
Solidworks	SolidWorks is a CAD software for mechanical modeling in 2D and 3D, currently developed by SolidWorks Corp., a subsidiary of Dassault Systemes, for the Microsoft Windows operating system (Solidworks, 2021)
Fritzing	Fritzing is a free electronic design automation program that seeks to help designers and artists move from prototypes to final products. (Fritzing, 2020)

Table 5 Software used for the design and implementation of the implementation of the Project "Covid-19 preventive robot"
Source: Own source

The disinfection module is graphically schematized using the Fritzing software. Figure 7 shows the functional scheme of the disinfection module.

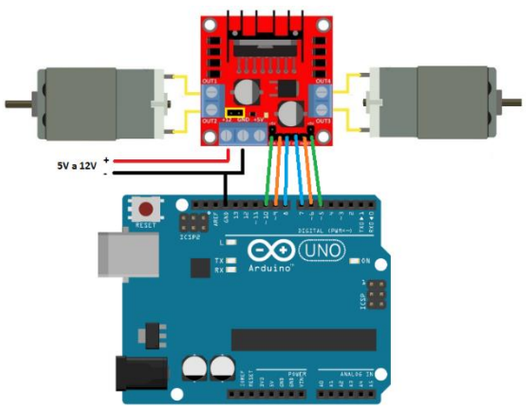

Figure 7 Functional integrated scheme of the disinfection module of the "COVID-19 preventive robot" Project

Figure 8 shows the code written in Arduino IDE to activate the delivery of antibacterial gel by recognizing the presence of the hands.

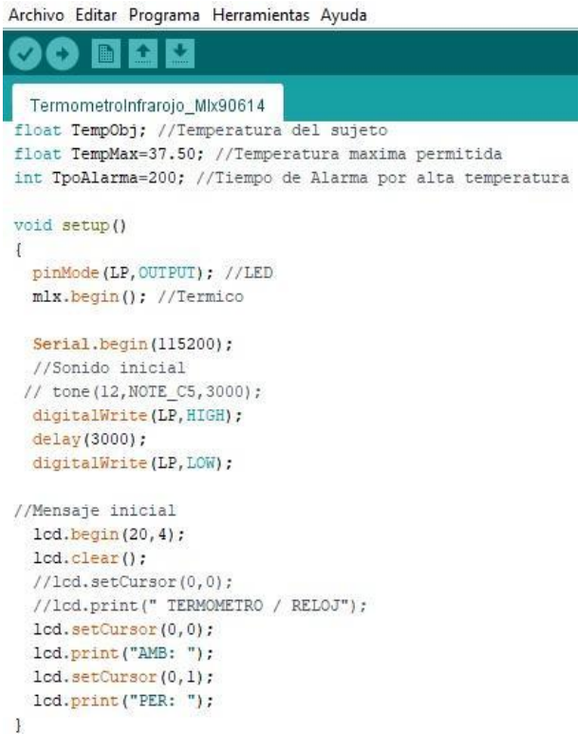

Figure 8 Code in Arduino IDE for the disinfection node of the Project"COVID-19 preventive robot"

Figure 9 shows the functional scheme of the temperature module and Figure 10 shows the code in Arduino IDE that supports temperature taking.

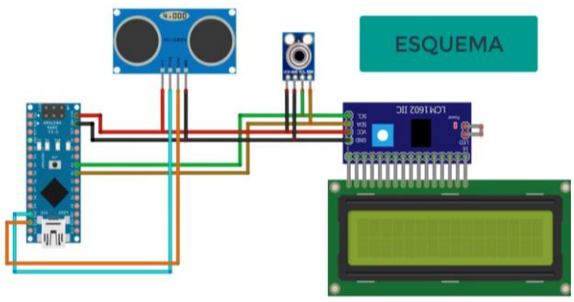

Figure 9 Functional integrated scheme of the temperature module of the "COVID-19 preventive robot" Project

Medidor_Temperatura

```
//Librerias
#include <Wire.h> //comms
#include <Adafruit_MLX90614.h> //Termico
#include <Adafruit_LiquidCrystal.h> //Pantalla
#include <SR04.h> //Ultrasonido

//Definicion de Pines
#define Echo 11 //Echo del Ultrasonido
#define Trig 10 //Trig del Ultrasonido
#define LP 9 //Salida LED

//Inicializar
int POSITIVE;

Adafruit_MLX90614 mlx = Adafruit_MLX90614(); //Sensor Termico
Adafruit_LiquidCrystal lcd(0x27, 2, 1, 0, 4, 5, 6, 7, 3, POSITIVE); // Pantalla LCD
SR04 sr04=SR04(Echo,Trig); //Ultrasonido

//Variables
int Esperal=300; //Espera en el loop

//Distancia
int Dist; //Distancia del ultrasonico
int DistMin=10; //Distancia minima para detectar al sujeto (mm)
int Presente=0; //Si hay alguien frente al Termometro
int Espera=500; //Tiempo de espera para verificar sujeto
unsigned long Tiempo=0; //Tiempo que lleva detectado para Millis
int Ahora=0; //Millis en el momento que se inicia
```

Figure 10 Code in Arduino IDE for the temperature module of the Project "COVID-19 preventive robot"

Particularly, in this module it is of utmost importance to consider that the default I2C address can be 0x3F or in other cases 0x27. This means that the I2C address of the module must be correctly identified, to avoid errors that may prevent the correct operation of the program. To check the specific address, a small test sketch called: I2C Scanner is used to obtain the I2C address of the device connected to the Arduino. Figure 11 shows the interface of I2C Scanner.

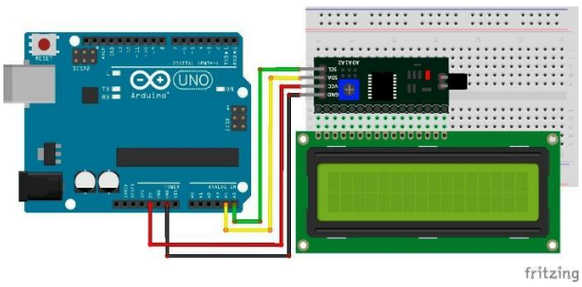

Figure 11 I2C Scanner to check the I2C address of the module

Figure 12 presents the functional scheme of the step module and Figure 13 shows the code in Arduino IDE that takes the temperature value and evaluates it, with the local signal of the ultrasonic sensor, to activate or not the access through the servomotor.

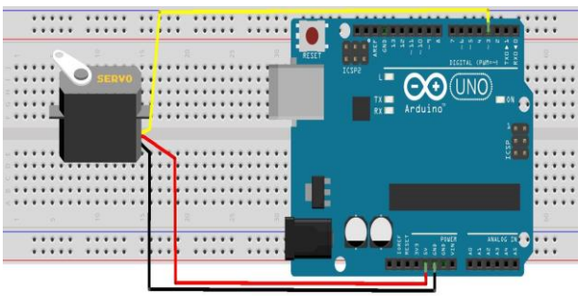

Figure 12 Functional integrated scheme of the passage module of the Project "COVID-19 preventive robot"

Servo

```
// Incluímos la librería para poder controlar el servo
#include <Servo.h>

// Declaramos la variable para controlar el servo
Servo servoMotor;
int led1 = 3;
int led2 = 4;

void setup() {
  // Iniciamos el monitor serie para mostrar el resultado
  Serial.begin(9600);

  // Iniciamos el servo para que empiece a trabajar con el pin 9
  servoMotor.attach(6);
  pinMode(led1, OUTPUT);
  pinMode(led2, OUTPUT);
}

void loop() {

  // Desplazamos a la posición 90°
  servoMotor.write(50);
  // Esperamos 1 segundo
  delay(4000);
  digitalWrite(led1,HIGH);
  digitalWrite(led2,LOW);
  // Desplazamos a la posición 180°
  servoMotor.write(135);
```

Figure 13 Code in Arduino IDE for the passage module of the Project "COVID-19 preventive robot"

Finally, the data module, which integrates two software components, one written in Arduino IDE and another in Java programming language.

Figure 14 shows the code in Arduino IDE where you can see the serial port that is used for communication between Arduino and Java, as well as the counter that will have the function of keeping track of people for the control of the maximum capacity.

```
SensorUltraLCD
#include <Wire.h>
#include <LiquidCrystal_I2C.h>

const int trigPin = 9;
const int echoPin = 10;
long duracion;
int distancia;
int ultimaDistancia = 0;
LiquidCrystal_I2C lcd(0x27,16,2);
void setup()
{
  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);
  Serial.begin(9600);
  lcd.init();
  lcd.backlight();
}
void loop()
{
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  duracion = pulseIn(echoPin, HIGH);
  distancia = (duracion * 0.034) / 2;
  Serial.println(distancia);
  if(distancia != ultimaDistancia)
  {
```

Figure 14 Code in Arduino IDE for the data module of the Project "COVID-19 preventive robot"

Figure 15 is part of the code written in Java where the classes responsible for performing certain functions such as displaying the data are specified, and Figure 16 shows the welcome user interface for the export of the stored information.

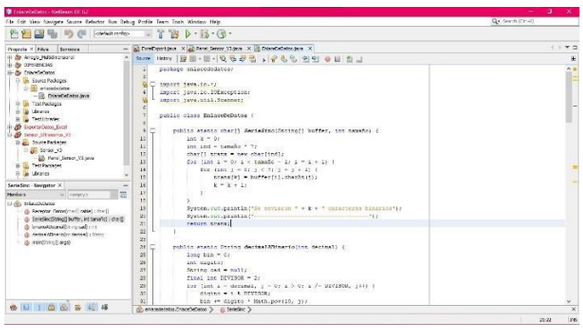

Figure 15 Code in Java for the data module of the Project "COVID-19 preventive robot"

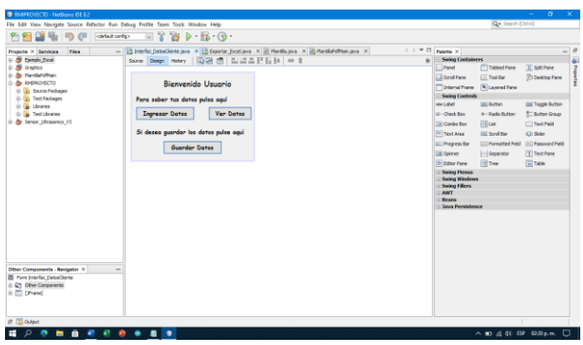

Figure 16 User Welcome *Interface of the data module of* the Project "COVID-19 preventive robot"

Gratitude

A broad thanks is extended to Mr. José Román Ruiz Carrillo, Rector of the Autonomous University of Campeche for the willingness and support provided for the publication of this article. In the same way, the recognition of the Mac. Francisco Javier Barrera Lao, Director of the Faculty of Engineering and Mrs. Nancy Georgina Ortiz Cuevas, Coordinator of the Educational Program Engineering in Computer Systems for Empathy for promoting research studies in the area of Computer Science.

Conclusions

The study concludes with the success of the research, the "COVID-19 preventive robot" project is a feasible solution for both the business and the technical field, since, by implementing the mechanisms provided, a control of the flow of people in closed places, stores and shops in general is carried out in an automated and autonomous way.

The hardware and software technologies integrated into the project provide stability and ensure the correct functioning of the COVID-19 Preventive Robot. Controlling and maintaining an autonomous mechanism mitigates the vulnerability of contagion spread in sanitary filters.

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Electronics engineering virtual laboratory for COVID-19 pandemic

Laboratorio virtual de ingeniería electrónica para la pandemia de COVID-19

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Abstract

Due to the COVID 19 pandemic, many aspects of everyday life change how Higher Education Institutions work. The teaching of subjects containing laboratory practices had to adapt to remote working conditions. As a response, we adopted the software Proteus to develop laboratory practices in electronics engineering. We present Some conventional face-to-face practices adapted to be developed remotely in Proteus during this contingency by COVID-19. We present examples of laboratory activities applied to the Control area of the Electronic Engineering study program of the School of Chemical Sciences and Engineering of the Universidad Autónoma de Baja California (UABC) in 2020 and 2021. To develop these laboratory practices, the Collaborate tool of the Blackboard platform, which is the institutional virtual classroom of the UABC, was used as a virtual classroom. These combined tools provide the student with most of the competencies obtained in the laboratory but are now under pandemic conditions. They also serve as a basis to continue applying them in distance education.

Virtual laboratory, Electronics, Proteus

Resumen

Debido a la pandemia de COVID 19, muchos aspectos cotidianos cambiaron, entre ellos, la forma de trabajar de las Instituciones de Educación Superior. La enseñanza de materias que contenían prácticas de laboratorio tuvo que adaptarse a las condiciones de trabajo remoto. Como respuesta, adoptamos el uso de la herramienta de software Proteus para desarrollar prácticas de laboratorio en el área de ingeniería electrónica. Se muestran algunas prácticas convencionales presenciales, que fueron adaptadas para ser desarrolladas de forma remota en Proteus durante esta contingencia por COVID-19. Se presentan ejemplos de actividades de laboratorio aplicadas al área de Control del programa de estudios Ingeniería Electrónica de la Facultad de Ciencias Químicas e Ingeniería de la Universidad Autónoma de Baja California (UABC), durante 2020 y 2021. La implementación de estas prácticas de laboratorio se lleva a cabo mediante la herramienta Collaborate de la plataforma Blackboard, la cual es el aula virtual institucional de la UABC. El uso de estas herramientas combinadas permite proporcionar al alumno la mayoría de las competencias que se obtienen en el laboratorio, pero bajo condiciones de pandemia. Asimismo, sirven de base para continuar aplicándolas en educación a distancia.

Laboratorio virtual, Electrónica, Proteu

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† Researcher contributing as first author.

Introduction

Due to the pandemic that we have experienced in recent months, different learning methods have been used, for example, virtual classes (Chang, 2020; Roatta & Tedini, 2021). Universities changed from traditional face-to-face learning to a virtual learning environment to continue working during the lockdown (Morales-Alarcón, 2021). Therefore, it was necessary to find alternative teaching methods, especially when dealing with practical subjects where it is necessary to use laboratory equipment and physical design prototypes (Gamage *et al*., 2020). In this case, circuit simulators offer an adequate solution.

Due to the quarantine, it has not been possible to carry out physical practices in laboratories. Therefore, several simulation programs and strategies can help carry out these practices (Gomes da Silva *et al*., 2021; Klein *et al*., 2021).

The simulators allow an approximation of how a circuit would behave if built, considering physical factors, representing a helpful tool for the student to practice and experiment with electronic circuits virtually, quickly, and safely. In addition, a simulator represents an easy-to-use and learning tool since the user can create any circuit as desired.

In the subsequent sections, we present the Proteus software and examples of laboratory practices designed.

Platforms used by the Universidad Autónoma de Baja California during pandemic

The Universidad Autónoma de Baja California institutional platform is Blackboard Ultra (Blackboard Inc., 2021; Roatta & Tedini, 2021; Universidad Autónoma de Baja California & Centro de Educación Abierta y a Distancia, 2020b) and the virtual classroom tool is Blackboard Collaborate (Universidad Autónoma de Baja California & Centro de Educación Abierta y a Distancia, 2020a). Also, UABC uses Google Classroom and Google Meet as a secondary online institutional platform.

Use of the laboratory practice during COVID-19 pandemic

To develop these laboratory practices with the Proteus software, we use the Collaborate conferencing tool, so the instructor organized teams during the session, and every team worked together and attended the simulation.

What is Proteus software?

Proteus, also known as Proteus Design Suite, is an electronic design automation software developed by Labcenter Electronics Ltd (Labcenter, 2021). This software is helpful to design, simulate and draw electronic circuits. Proteus is one of the most widely used engineering programs, especially electronics (Mandal, 2017).

Some of the advantages offered are:

- It allows instructors to perform virtual laboratories.
- It offers students a dynamic and fun learning tool.
- Electronic components are expensive, but in Proteus, we can use them for free, for example, the oscilloscope.

The main features of the Proteus software are:

- Virtual prototypes can be helpful to test the system before transferring it to the physical printed circuit board.
- Circuit design takes less time than practical construction of the circuit.
- There is no chance of any electronic components being burned or damaged in Proteus.

Proteus software

Proteus consists of two modules: ISIS (Intelligent Schematic Input System) and ARES (Advanced Routing & Editing Software).

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The ISIS application allows the user to create real circuits and test their operation on a PCB (printed circuit board). ISIS stands out for the quality of its schematics, total control over the appearance of drawings, templates to create custom schematics with its style, and easy creation of new components. Furthermore, with the help of the PAT tool (Property Assignment Tool), the user can program the option to perform repetitive tasks, e.g., assign, remove, rename, hide, show, or resize different objects.

The ARES application (Advanced Routing & Editing Software) is the component routing, placement, and editing tool. It is helpful for the manufacture of printed circuit boards.

Examples of laboratory practices of signals and systems on Proteus simulator

This section shows some examples of the laboratory practices adapted and developed during this pandemic.

Low-pass filter design and implementation

The function of this electronic circuit is to filter or eliminate various high-frequency signals, such as noise.

Virtual Materials:

- Three 1K resistors.
- One 560Ω resistor
- Two 10nF ceramic capacitors
- One TL081 op-amp
- Multimeter
- Function Generator
- Voltage Source
- Oscilloscope

The circuit implemented is the Sallen-Key voltage-controlled filter (Floyd, 2008), shown in figure 1.

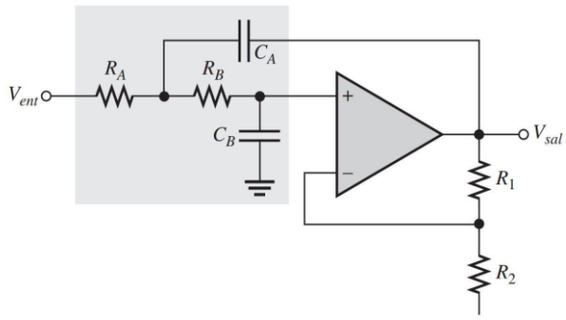

Figure 1 Sallen-Key filter
Source: (Floyd, 2008)

In order to create a fixed filter output, we need to obtain the relative damping factor (DF), which will establish the characteristics of the output signal from either a Butterworth, Chebyshev, or Bessel filter. The literature recommends using a Butterworth characteristic filter since it allows the frequencies within the bandpass to have the same gain, helping to visualize which signals will be inside easily and outside the filter.

To create a Butterworth characteristic, DF must be equal to 1.414. The formula for finding the damping factor is:

$$DF = 2 - \frac{R1}{R2} \quad (1)$$

Obtaining the damping factor, we proceed to calculate the critical frequency. The equation to find the critical frequency is:

$$fc \frac{1}{2\pi\sqrt{(R_A R_B C_A C_B)}} \quad (2)$$

The circuit needs a connection to a signal generator, starting from 3V to the TL081 operational amplifier. We use an oscilloscope to obtain the frequency and amplitude of the waveform. First, connect a probe to the generator output (v_i) and another to the TL081 output (v_o), as shown in figure 2. These measures allow the user to compare the input signal with the circuit output signal and helps the user visualize the difference between the two signals depending on the frequency used.

Simulate the circuit with the values mentioned above, as shown in figure 3.

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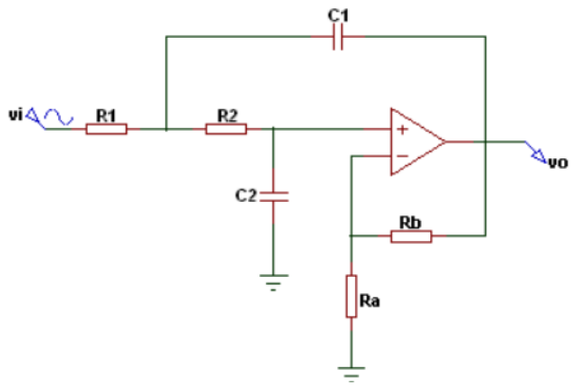

Figure 2 Introducing the signal to the circuit and input and output probe localization, made in Proteus
Source: Self-made

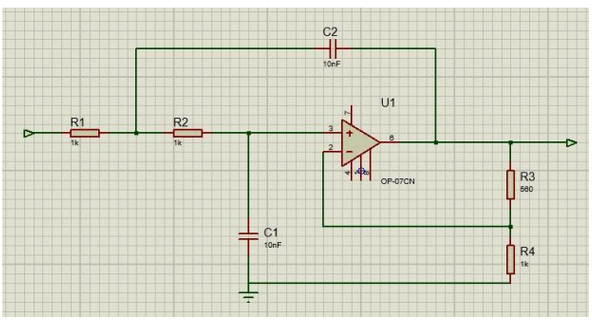

Figure 3 Circuit simulation in Proteus with the proposed values
Source: Self-made

By substituting different values for the circuit components, produce different amplitude output waveforms.

A common way to obtain the Bode Diagram is using the simulators from Matlab and Octave. The frequency response in the Bode Diagram is also available in Proteus. Figure 4 shows a Bode Diagram obtained in Proteus.

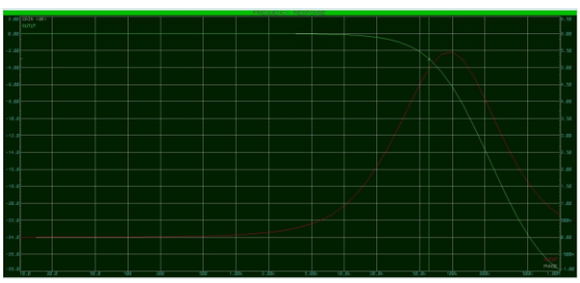

Figure 4 Bode Diagram answer in Proteus. Red: Magnitude and Green: Phase
Source: Self-made

Finally, obtain the amplitude and frequency using an oscilloscope.

Fourier analysis (spectrum)

Fourier analysis is helpful to analyze the frequency content of signals, and the harmonic behavior of a signal, converting a signal to the frequency domain. Fourier plots represent periodic functions, which are the infinite sum of harmonically related sinusoidal functions.

First, draw the electronic circuit to be analyzed to obtain a frequency analysis plot, as shown in Figure 5. Next, place a Fourier plot on the work area. Then, place the oscilloscope probes on the points of the circuit to be analyzed and pick up and drop them on the graph. Edit the chart properties to set the start time, end time, and resolution. Select the time interval and resolution that correspond to the signal to be analyzed. Figure 6 shows the Fourier plot or spectrum.

To obtain a Fourier plot, follow these steps:

- Draw the electronic circuit to be analyzed, as shown in figure 7.
- Place a Fourier plot on the work area.
- Place the oscilloscope probes on the points of the circuit to be analyzed and pick up and drop them on the graphic.
- Edit the chart properties to set the start time, end time, and resolution. Select the time interval and resolution that correspond to the signal to be analyzed. Figure 8 shows the Fourier plot or spectrum.

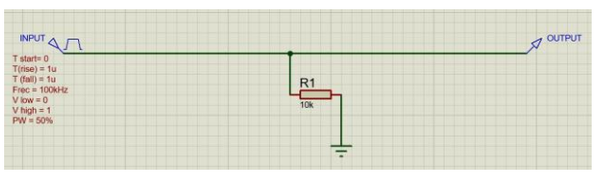

Figure 5 Fourier Analysis Example Circuit
Source: Self-made.

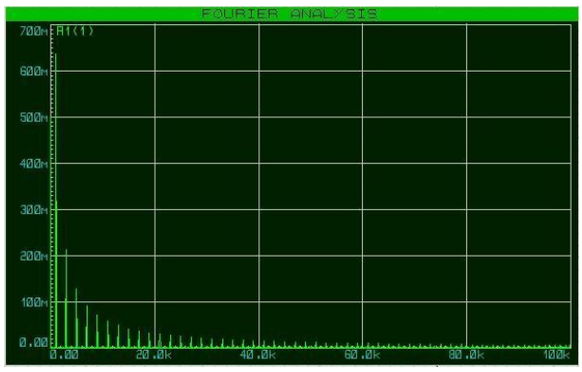

Figure 6 Fourier Analysis Graph or spectrum
Source: Self-made

Control laboratory

A mathematical model, expressed in time or frequency, can be represented, regardless of its order, as the integration of electrical circuits, which, in turn, forms a system that can respond to the input signal:

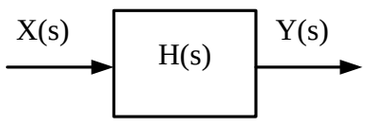

Figure 7 System representation
Source: Self-made

For the analysis of the transient response of a linear system, with a time-invariant input and output, it is convenient to have the representation through the transfer function (3), so that:

$$g(t) = \frac{y(t)}{x(t)} \qquad \mathbf{L} \qquad G(s) = \frac{Y(s)}{X(s)} \qquad (3)$$

It will also be helpful to use block diagram transformations to obtain the transfer function by part, for example, cascade systems, as is shown in figure 8.

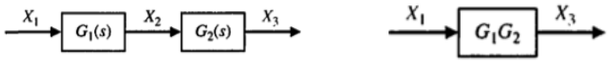

Figure 8 Transformations for obtaining transfer function
Source: Self-made

If we know the plant of the system, G(s), it will only require an input excitation to know the output.

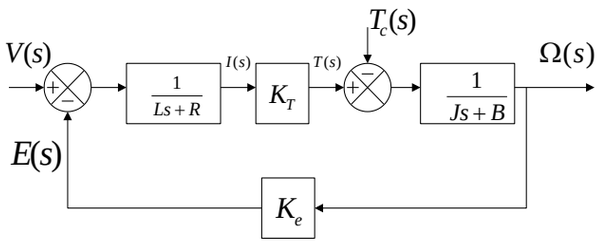

Figure 9 The transfer function for CD motor blocks

$$\frac{\Omega(s)}{V(s)} = \frac{K_T}{JL\,s^2 + (JR + BL)s + RB + K_T K_e}.$$

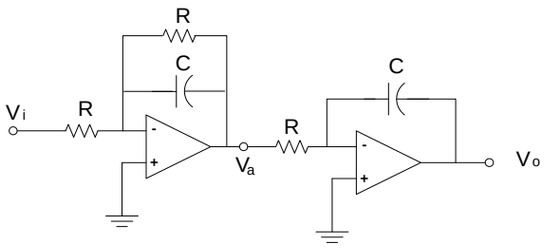

Figure 10 Circuit simulation for plant or process G(s)
Source: Self-made

Table 1 presents the DC motor parameter values used for the simulation.

R	Armor resistance (Ohms)	1.1648
L	Armor Inductance (Henrys)	0.0068
J	Equivalent moment of inertia $(Kg\ m^2)$	1.0271
J_m	Motor inertia moment $(Kg\ m^2)$	0.0271
J_c	Load inertia moment $(Kg\ m^2)$	1
B	Equivalent coefficient of viscous friction $(N\ m/(rad/seg))$	0,23646
B_m	Motor's coefficient of viscous friction $(N\ m/(rad/seg))$	0.00776
B_c	Load's coefficient of viscous friction $N\ m/(rad/seg.)$.	0.2287
K_T	Constant drive torque $(N\ m/Ampere)$	0.55
K_e	Constant counter-electromotive force $(V/(rad/seg.))$.	0.82
i	Current in the armor (Amperes)	I(s)
V	Voltage applied to the armor (Volts)	V(s)
ω	Angular speed motor (radians/seg)	$\Omega(s)$
T	Torque developed by the motor (Newton-meter)	T(s)
T_C	Perturbation or Disturbance (Newton-meter)	Tc(s)

Table 1 DC motor parameter values

Remember that it is possible to create a system G(s) from its transfer function, with the configurations presented in figures 11 and 12.

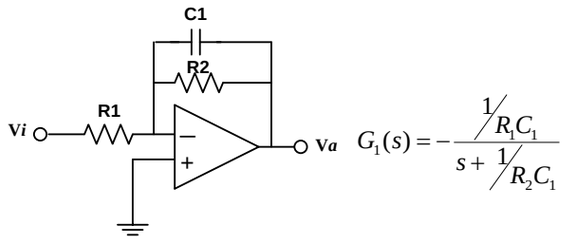

Figure 11 Circuit simulation for plant or process G(s)
Source: Self-made

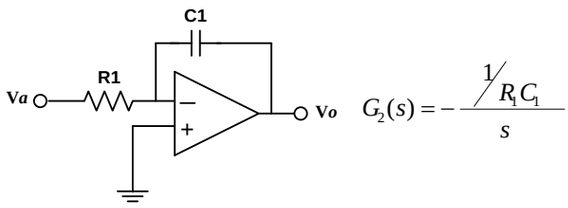

Figure 12 Circuit simulation for plant or process G(s)
Source: Self-made

For the next step, we have to obtain the closed-loop system to watch its behavior without compensation to notice what parameters need to be adequate to the requirements, as shown in figure 13.

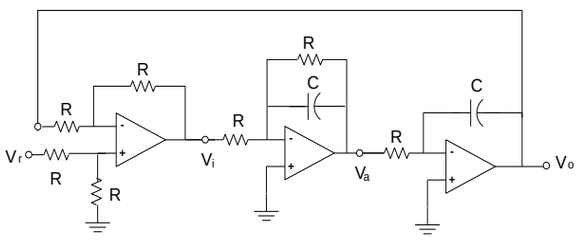

Figure 13 Plant G(s) in a closed-loop
Source: Self-made.

Compensators are added to the original system, either in direct path or in feedback, to improve its performance characteristics to meet the design specifications both in transient and steady-state.

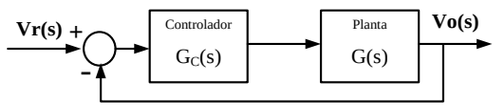

Figure 14 Closed-loop system with controller Gc(s)
Source: Self-made

The controllers will add zeros, poles, or a combination of both to the system, creating a leading or lagging or leading-trailing offset, as appropriate. Table 2 presents the formulas for calculating the elements of the lead-lag compensator.

Type	Compensator transfer function and conditions	Formulas for calculating resistances and capacitors:
Advance	$G_C(s) = K_C \frac{s+\rightleftarrows 1/T}{s \rightleftarrows +\rightleftarrows 1/\alpha T}$ $0.07 < \alpha < 1$	where: $T = R_1C_1$, $\alpha T = R_2C_2$, $K_c = \frac{R_4C_1}{R_3C_2}$

Table 2 Elements of the overrun compensator

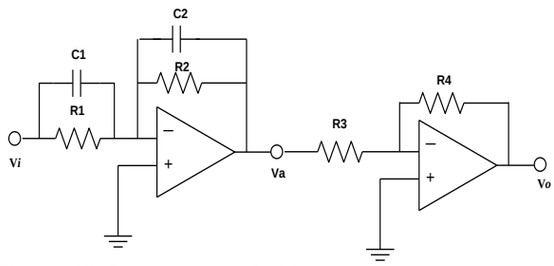

Figure 15 Compensator Gc(s)
Source: Self-made

Once the student finishes with all the connections, he can make measurements by connecting the function generator to the Vr input of the control loop, with a square signal from the generator with an amplitude from zero to one volt, and choosing an appropriate frequency until the transient response, and its steady-state are visible. At this point, we need measurements of the input and output signal of the control loop in each oscilloscope channel so that the student measures the transient, overshoot, and steady-state times.

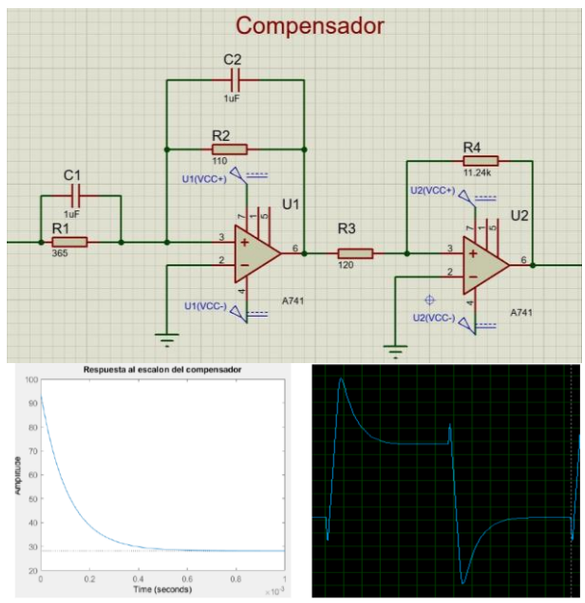

Figure 16 Compensator Gc(s) step response in open loop, obtained in Matlab (left) and Proteus (right)
Source: Self-made

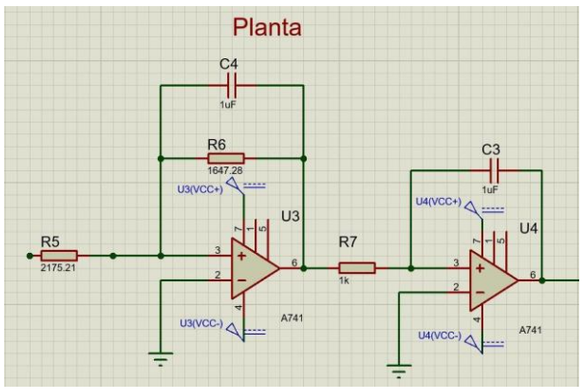

Figure 17 Proteus circuit representing the system G(s)
Source: Self-made

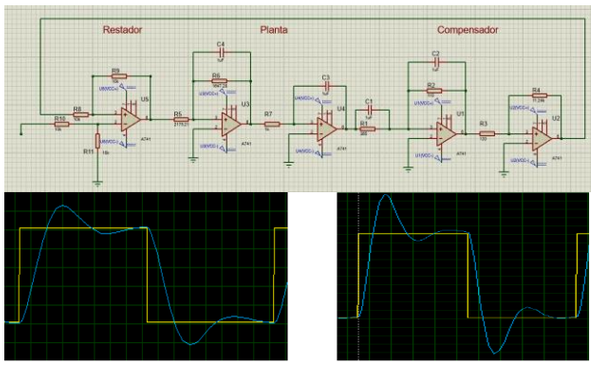

Figure 18 Closed-loop circuit with compensator and the step responses of the uncompensated (left) and compensated (right) feedback system, respectively
Source: Self-made

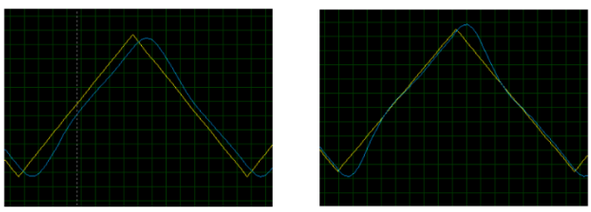

Figure 19 Uncompensated (left) and compensated (right) feedback system ramp response, respectively (Proteus)
Source: Self-made

In addition, this configuration appears in another practice where the input to the control loop is a sine wave, and the frequency compensator design methodology is applied; some of the requested readings are gain, phase relationship at specific frequencies, and the gain and phase margins.

Conclusions

As it is known, traditional students prefer face-to-face learning, but with the COVID-19 pandemic, everything changed, and the way students and instructors work is one of them.

The use of software simulators simplified the transition to online education. The use of Proteus lets the students obtain part of the knowledge they get in traditional learning. The students experiment the different stages of design, simulation and implementation using operational amplifiers that represent a position control loop by means of compensation for a DC motor model.

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Virtual communications laboratory as a tool for the subject of selected telecommunications topics

Laboratorio virtual de comunicaciones como herramienta para la asignatura de temas seleccionados de telecomunicaciones

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Abstract

The pandemic has forced to abandon classrooms, replacing them with virtual learning spaces, generating various problems due to not being able to interact physically. These problems increase even more in subjects with laboratory hours. This article addresses the proposal to create a virtual laboratory for subjects related to the telecommunications area, particularly those that include the topic of microwave network links. Radio Mobile software was used for the creation of the laboratory, which is freely accessible. The objective of this research is to obtain information that allows visualizing if the use of this web tool contributes to the learningof the students, allowing to simulate the main practices that can be carried out in a laboratory or in physical form. The software was used during the teaching of a course in the subject Selected Topics in Telecommunications, through the action-research method, obtaining favorable results, achieving a better academic performance in the matter.

Educational software, Virtual lab, Telecommunications

Resumen

La actual pandemia ha obligado al abandono de las aulas, sustituyéndolas por espacios virtuales de aprendizaje, generando diversas problemáticas al no poder tener interacción de manera física. Estas problemáticas se acrecientan aún más en asignaturas con horas de laboratorio. En el presente artículo se aborda la propuesta de creación de un laboratorio virtual para asignaturas relacionadas con el área de telecomunicaciones, particularmente, con aquellas que incluyen el tema de enlaces de redes de microondas. Para la creación del laboratorio se utilizó el software Radio Mobile, el cual es de acceso libre. El objetivo de la investigación es obtener información que permita visualizar si el empleo de esta herramienta web contribuye al aprendizaje de los alumnos, permitiendo simular las principales prácticas que comúnmente se realizan en el laboratorio o en forma física. El software se utilizó durante la impartición de un curso de la asignatura Tópicos Selectos de Telecomunicaciones, a través del método investigación-acción, obteniendo resultados favorables, logrando observar un mejor rendimiento académico en la materia.

Software educativo, Laboratorio virtual, Telecomunicaciones

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Introduction

Faced with the pandemic, there has been a change in the way of teaching-learning, from one day to the next; classrooms had to be abandoned, changing them for virtual classrooms, which brought with it several problems.

For example, (Rincón, 2008) mentions that the incorporation of Virtual Learning Environments (EVA) implies reversing the process of acquisition and transformation of knowledge; therefore, educational relevance, quality, and usefulness consists in knowing how to integrate meaningful learning activities and take advantage of the tools offered by these virtual environments. Therefore, it is relevant to redesign, adapt didactic planning to technological changes, through the construction of a pedagogical and methodological structure, which must be based on content, evaluation, and experiences.

On the other side, (Sánchez, 2003) mentions that Information and Communication Technologies (TIC), depending on their use, can be a source of innovation for teaching, contributing to the learning process, offering methodologies and resources for the 21st-century student.

In (Chaupart, 2002) is stated that "what is sought is not to create a technological dependence, since ICTs are a means to apply the new, more effective pedagogies for the student". Both the teacher and the student must incorporate the use of ICT as a didactic resource in the teaching-learning process, specifically in online classes.

Derived from the above, the need arises to pay special attention to those subjects related to laboratory work, since students do not have access to the facilities, equipment, and instruments that are essential tools for the correct development of skills and abilities. And it is here where TIC can be a solution for the creation of virtual laboratories that allow students to experiment, to build their learning. All of the above is not strange to one of the subjects of the Educational Program of Engineering in Electronics and Telecommunications: Selected Topics of Telecommunications, where one of the thematic units addresses the topic of link calculations in microwave networks.

The objective of this research is to obtain information that allows visualizing if the use of a web tool (online program) helps to generate learning when link calculations of microwave networks are carried out.

Based on the objective, the following research questions were proposed:

- What elements should be integrated into the planning of virtual laboratory activities for student learning?

- Will the use of the proposed virtual laboratory, through the use of the Radio Mobile tool, increase student motivation?

- What action process should be used to successfully include the use of a virtual Telecommunications laboratory in the teaching of content in the Communications area?

This work is pertinent given that the use of technology seeks to improve the performance of students when carrying out work inherent to the career they are studying and relying on their learning, having as a result that their learning has a better understanding of the topics reviewed in the courses they take and, consequently, an improvement in the knowledge and skills acquired during the subjects taken. This technology is also expected to improve the organization of tasks to be carried out during the development of a solution in the field of telecommunications.

This project was developed at the Universidad Politécnica del Estado de Morelos (UPEMOR), with a group of the ninth semester of Electronics and Telecommunications Engineering. The main contribution of this study is to providea strategy that allows seeing improvements in the teaching-learning process.

This research work contains a methodology, where the selection of the tool is explained, the description of the construction of the process to validate the online software as an option to generate learning, as well as the process of execution, of the instrument to evaluate through a survey and finally present the analysis carried out, as well as the results and conclusions.

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Before developing the methodology, it is briefly explained what needs to be done to carry out a link calculation in microwave networks:

a) Location of the site (latitude and longitude) and altitude of the sites.

b) Investigation of the type of soil.

c) Verify availability of power, according to the standards of the ITU (International Telecommunications Union), for transmission in the areas to be linked.

d) Investigate propagation conditions.

- Line of sight: Refers to an unobstructed path between the transmitting and receiving antennas. So that there is the best propagation of Radio Frequency signals.

- Feasibility of a link: Refers to the line of sight calculation whose probability of linking two sites is 99.65% (ITU Standards).

Methodology

According to (Álvarez & Álvarez, 2014) the action research method begins with a collective or group idea that some type of improvement or change in the process that is being participated is desirable, such is the case of the process of teaching-learning. According to (Pérez, 1989), action research requires the participation of groups, integrating both participants and observers in the process of inquiry and dialogue. Consisting of the following steps:

1. Delimitation of the problem to be investigated in action.

2. Planning the action process.

3. Execution of the action.

4. Evaluation of what is generated in the action.

This set of four steps can be repeated in successive spirals. It is this research method that is taken as a basis, to propose the project work methodology, which is shown in Figure 1.

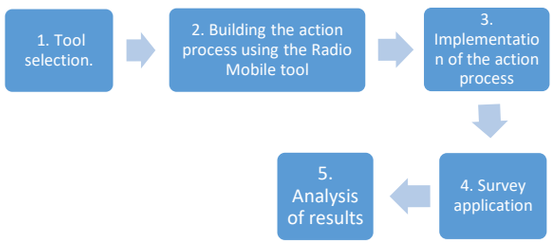

Figure 1 Work methodology
Source: Own elaboration

The methodology is made up of five stages:

1. *Selection of the tool*. In this stage, the problem to be investigated is delimited, in our particular case: deciding which platform could be the one that would promote greater learning in the student.

From information from previous courses, in which the cartography provided by INEGI was used, the students had to enter the position data and investigate the propagation conditions, indicating this in the cartography (see Figure 2). What involved doingpartial-time work, because of the lack of information for the link calculation process. To find out more in detail, they must go to the place where the microwave base is placed, something thatis not desirable in this pandemic.

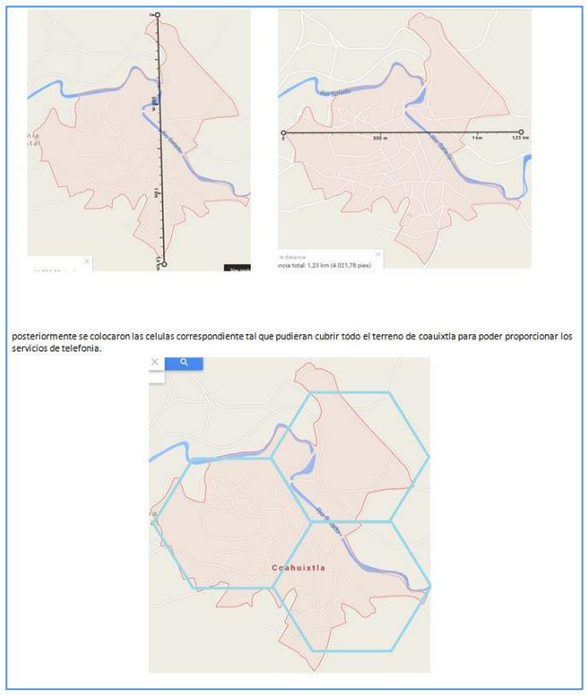

Figure 2 INEGI work on cartography
Source: Own elaboration

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Facing this situation, it was decided to look for an online program, preferably free, that had greater versatility displaying the maps and being able to put the elements for the calculation of the link. Finding Air Link software online, Figure 3.

The use of this software implied that the students did not have to travel to the site and spent less time as they no longer had to insert icons or images, but some problems were detected, the first of which is that it only uses the equipment of whom made the website, preventing the placement of other brands or models, the second problem is that it performed the calculation without the student interacting with the values to be considered and this generates a bias in learning. One last problem is that the values indicated by the ITU standards could not be counted on, since it does not consider the type of area (desert, forest, etc.), power level restrictions, etc. (Standards P.525, P.527, K.69, among others).

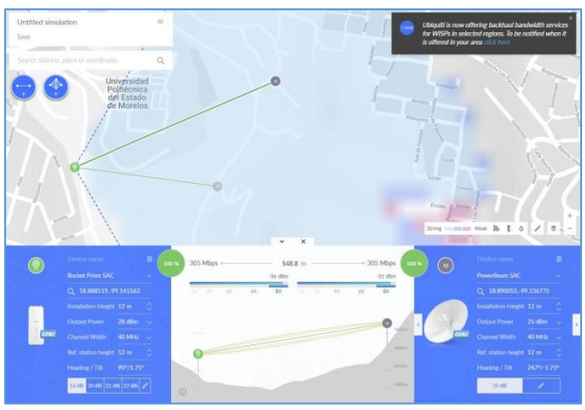

Figure 3 Software AirLink
Source: Own elaboration.

We continued looking for another alternative technological tool, finding the Radio Mobile software (also free), which would allow placing the maps and locations, to form the microwave networks (Figure 4), to generate the sites individually and based on values that the student had to calculate, link them and finally create the network that can contain up to 150 sites.

Figure 4 Menu to generate specifications of microwave sites
Source: *Own elaboration*

When creating the sites, the students are based on preliminary calculations of the selected link (Figure 5), so they must know the characteristics of the transmitter, the receiver, the ITU standards, etc. In other words, the student must know the behavior of the network that he is implementing, which leads him to achieve his learning, unlike support software.

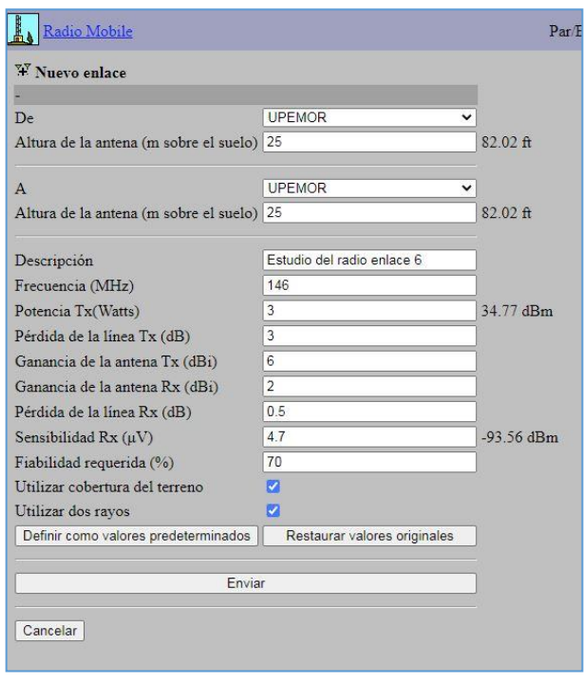

Figure 5 Data that must be entered after calculation by the student
Source: Own elaboration

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2. *Construction of the action process of the Radio Mobile software*. We proceeded to propose a methodology to be followed to make much more efficient the use of the software and that would imply a prior research process. This led to propose the construction of the process as a case study, which when requesting to generate a network of services of microwaves, leads the students to show a competence, from an integrative approach, that represents a dynamic combination of attributes that according to Heywood (1993), cited by Villa and Villa (2007), provides: a description of the action to the extent that the person seeks to perform it as a particular type of solution; performance in specific situations, incorporating the idea of judgment, to provide a service, for example, connectivity; interpretive capacity and consequent decision-making; integration and relationship in specific contexts and fundamental tasks that, as "intentional actions", are a central part of professional practice. Determine that the link is completed based on the calculations made and is operational in situations, such as adverse weather conditions. As well as any other type of disturbance when transmitting the signal.

Table 1 describes the steps of the action process used.

In Figure 6, the result that is obtained is observed, when carrying out the work as a development of the work environment to provide a solution, for example: to a connectivity problem between various points and that the very process of framing the idea of a case study, make it feasible.

#	Activity	Supervision	Duration
1	In a virtual environment, the learner was introduced to online educational software, explaining its function and main components. Demonstrative examples are shown in order to understand its use and scope.	The student is allowed to interact with the application freely, without proposing any exercises, with the aim of familiarising him/her, experimenting and asking questions to resolve doubts about the functions of the online programme. Information is collected through observation: student behaviour, interest in the software, questions and doubts raised.	1 hour
2	A series of sessions is scheduled where the learner is asked to solve a set (previously prepared) of exercises using the online software. Students are allowed to interact with each other and can work in teams if they wish.	Information is collected through observation: behaviour, interest, doubts. The exercises solved by the students are collected.	Several sessions of 3 hours each
3	An evaluation session is scheduled. Evidence of knowledge is designed, where the learner must use the tool to solve a series of exercises. The student is asked to work individually.	The results of the knowledge evidence are collected.	2 hours
4	A survey is applied to the students, using an ad hoc questionnaire. This was done in order to gather the students' impressions after participating in the experience.	The results of the survey are collected.	30 minutes

Table 1 Action process
Source: Own elaboration

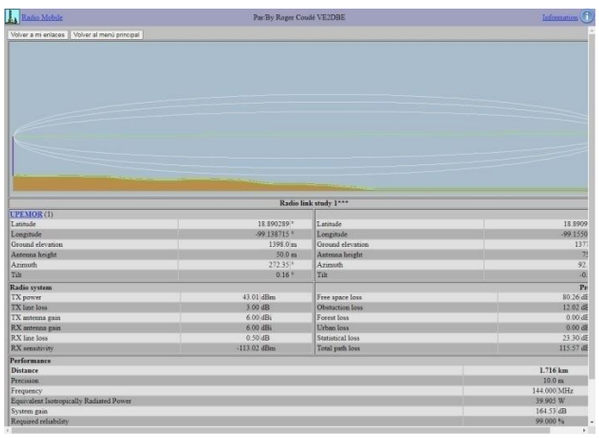

Figure 6 Line of sight and link feasibility calculations
Source: Own elaboration

3. *Execution of the action process.* At this stage of the research, the study group was defined, determining that the experimentation would be carried out with the group of the ninth semester of the Engineering in Electronics and Telecommunications career of the UPEMOR. The study group has the following characteristics:

Success in completing university studies in the area of electronics and telecommunications engineering depends a lot on personality characteristics, study habits, development of learning skills, and time management to fulfill the tasks assigned in each one of the subjects studied during a semester, semester, or school year. In this sense, the group of students from the third cycle of training of the electronics and telecommunications engineering study program (2018-2021 generation) will reach this point in the study plan.

Considering their performance in various subjects taught during different semesters of the study program, personality characteristics such as academic procrastination have been identified, which is a common problem in high school and upper secondary students (Barraza-Macías & Barraza-Navarez, 2019). This group of students has this personality trait, which leads them to undergo high levels of stress and on several occasions, they have generated inadequate results in the delivery of requested tasks and/or projects. There are multiple causes of procrastination, with the amount of work and proper management of your time being its main factors.

Likewise, these students base their learning on the use of computer information technologies (tutorials, web pages, learning forums, etc.), which today has become the most common way of the learning process (Martinez, Esmeralda, Cantu, & Patricia, 2018). However, the use of this type of learning strategies has generated that their performance is subject to the presence of a tutorial to develop the activities requested in the different subjects. This has led to their analysis capacity not being adequately developed, and they only develop the ability to reproduce what is described in tutorials.
Finally, even with inappropriate personality traits, it is noted that the group of the third cycle of electronics and telecommunications training has managed to be at this stage of their training due to their sense of responsibility, dedication, and perseverance, which are key elements for successful completion of the curriculum.

4. *Survey application*. Once the students' experience with the online software had concluded, a survey was applied, for which an ad hoc questionnaire was designed.

5. *Analysis of results*. In the last stage, a detailed analysis of the results obtained during this research process was carried out.

Results

As part of the analysis of results, a survey was applied to the students that consisted of five questions, of which three focused on the use of the tool and two on interactivity with the teacher. In Table 2, the statistics generated from the application of the instrument are presented.

From the questions asked, it is observed as a result: that the support of software has facilitated the students' learning and that it was easy and simple for them to use. The question asked about the interaction with the teacher gives an unexpected result, since they show little interaction between students and teacher.

In addition to the instrument, data was collected throughout the action process, through direct observation, highlighting the following:

1. The attitude of the group changed when Introducing the use of software in the dynamics of the class. The students showed greater participation with respect to the first sessions.

2. The use of the tool allowed to foster teamwork, interactions between group members could be observed to explain the sites that they had to link to.

3. The general average obtained in the evaluation of the first partial of the subject, improved with respect to groups that took the same subject in previous years.

4. In general, the students' comments have been very positive regarding the technique and tools used by the teacher.

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Question	N	Mean	Standard deviation	Standard error of the mean
Do you feel that the Radio Mobile programme provides the right elements for learning?	12	10	0	0
Does the interface of the Radio Mobile programme allow quick access to insert information and perform calculations?	12	8.75	2.26	0.65
Does the Radio Mobile software allow interaction with the teacher?	12	7.58	3.18	0.92
Does the Radio Mobile programme allow easy and simple access to the generated map and base station information, as well as to the line of sight?	12	8.75	2.26	0.65
Does using an online programme allow you to know and measure your progress in a course?	12	8.75	2.26	0.65

Table 2 Descriptive statistics
Source: Own elaboration

Conclusions

Motivation is a very important element in any work methodology and the educational field is no exception (Peinado & Navarro, 2014). Motivation turns out to be a condition that guarantees both effectiveness and efficiency in the use of technology in the teaching-learning process.

The use of technological tools as teaching tools has always been widely recommended, especially for digital natives, such as the case of our students today.

The improvement in the grades that are observed, taking into account the history of the first partial, of previous courses, indicate that the software tool used improved the performance and the interest of the student, since it allows them to observe the fieldwork environment, without having the problems of transfer to the different points to be linked in a real network, allowing better learning. As future work, it is necessary to implement other stages within the same subject to give training in other thematic units, since the results and comparisons only correspond to a first partial among the courses with which it has been evaluated.

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TIC applied to collection management. SOFIPA CORPORATION. Case study

Las TIC aplicadas a la gestión de cobros. CORPORACIÓN SOFIPA. Caso práctico

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Abstract

The developed project aims to automate and streamline the collection management processes of the SOFIPA CORPORATION Company through a web system and a mobile application that provides support to managers and the collection coordinator. The system has modules for portfolio recovery, managers, agreements, settlements, visit scheduling and the option to print reports of the activities carried out by managers. The mobile application is installed on 2 types of devices: mobile point of sale (mPOS) or smart phones, both must be permanently connected to the Internet. With them, the managers who visit the clients assigned by route and register their payments; once updated in the system, they will be able to print receipts on portable USB printers. This project contributes to streamline and automate processes and increase response capacity, mainly in the recovery of portfolio of delinquent clients. The Web system was based on the SCRUM agile development methodology, the SPRING framework was used for the development, the mobile development ide was Eclipse and as a MySQL database manager. The purpose is to guarantee efficient work.

Web system, Debt recovery, Payment reconciliation

Resumen

El proyecto desarrollado tiene como objetivo automatizar y agilizar los procesos de gestión de cobranza de la empresa SOFIPA CORPORATION a través de un sistema web y una aplicación móvil que da soporte a los gestores y al coordinador de cobranza. El sistema cuenta con módulos de recuperación de cartera, gestores, convenios, liquidaciones, programación de visitas y la opción de imprimir reportes de las actividades realizadas por los gestores. La aplicación móvil se instala en 2 tipos de dispositivos: punto de venta móvil (mPOS) o teléfonos inteligentes, ambos deben estar permanentemente conectados a Internet. Con ellos, los gestores que visitan a los clientes asignados por ruta y registran sus pagos; una vez actualizados en el sistema, podrán imprimir recibos en impresoras USB portátiles. Este proyecto contribuye a agilizar y automatizar los procesos y a aumentar la capacidad de respuesta, principalmente en la recuperación de la cartera de clientes morosos. El sistema web se basó en la metodología de desarrollo ágil SCRUM, se utilizó el framework SPRING para el desarrollo, el ide de desarrollo móvil fue Eclipse y como gestor de base de datos MySQL. El objetivo es garantizar un trabajo eficiente.

Sistema web, Recuperación de deudas, Conciliación de pagos

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Introduction

One of the main benefits that is obtained in the school-company link of the students of Computer Systems Engineering, enrolled in the Technological Institute of Oaxaca and who carry out the professional residency, by signing a framework agreement: it is the experience acquired that validates the skills strengthened throughout their training process. The role of organizations in the formation of the resident's social responsibility is very important, because the responsibility for complying with the requirements of the study plan is shared.

In this sense, during the period August 2020- January 2021, it was developed at the facilities of the company SOFIPA CORPORATION S.A.P.I DE C.V SOFOM E.N.R, a financial company that offers loans preferably to groups of women whether or not they are engaged in formal and established commerce at the national level. The document presented is organized integrating: the theoretical foundation and the activities carried out during the phases defined by the software development methodology used (SCRUM), in figure 1 the life cycle by interactions is shown, validating the stages of: Start, Execution, Testing and Launch. (Turley, 2019) Always looking to satisfy the demands and needs raised by project leaders in the sprints; in the delivery times of the project in general.

In the initial stage, the project requirements were collected and defined, interviews and questionnaires were conducted to finally analyze the needs. The execution was organized through four sprint's, which include the following phases: Sprint plaining, Daily Scrum, Desing, Build, Testing, Sprint Review y Retrospective.

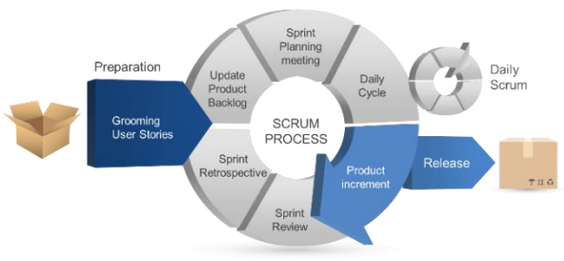

Figure 1 Process SCRUM
Source: Turley, Nader K. RadFrank, (2019)

The reason for doing it by sprint is because, as it is an agile methodology, priorities must be aligned between the company and project development and the contributions indicated in the User stories, modeling, interface design, databases. and performance tests were run and validated by the collection management area and overdue portfolio of the company SOFIPA.

The tools used in the different stages of figure 1 are those suggested by the company, because there are other applications developed under the framework of infrastructure support at the application level with the Spring and Angular development framework for the design of the interfaces, such as Eclipse mobile development IDE and Visual Studio Code for creating and debugging web and cloud applications, and a GNU GP license of MySQL as a database manager.

Finally, the results obtained are shown, through the interfaces, system tests, the conclusions obtained with the implementation of the system and the impact on the automated processes that contribute to the achievement of the general objective by developing a web system and mobile application to manage the system. collection of the company SOFIPA CORPORATION SAPI DE CV SOFOM ENR, the thanks given to the National Technological Institute of Mexico, the Technological Institute of Oaxaca and Sofipa Corporation SAPI de CV Sofom ENR for trusting our students and the references consulted in the preparation the article.

Problem statement

The SOFIPA company is a financial company that offers loans to groups of women who have a business (not necessarily established). When these loans are granted, they take into account the credit capacity, the economic situation of the applicants and the period chosen to pay the resource borrowed plus the corresponding interest. For the management of these loans, the company hires the credit managers to act as recuperators of the resource granted in the event that the client, regardless of the situation they go through; no longer go to the branches to continue paying and resort to a legal agreement.

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Due to the fact that a manager is assigned several delinquent portfolio clients on a daily basis and by not having this automated process and with the daily report, sometimes it is not possible to make correct decisions regarding the client, in addition to the fact that the entire process described above is manual and are captured in spreadsheets. The execution of the procedure is asynchronous, which in most cases hurts the clients since if the record is not kept on time, the total interest continues to increase and affects the managers in the collection of their commission, as well as inconsistency in data, duplication or loss thereof.

Developing

The Collection Management System aims to automate and streamline processes in accordance with the problem statement and the scope is included in the following modules:

- Clients: list of portfolio clients to recover.
- Managers: customer assignment, visit scheduling.
- Payments: scheduled, settlements and release.
- Payment Agreements: Various periods.
- •Commissions: calculation of commissions per manager.
- Reports: activities of managers, client account statements, managerial decision making.
- Trading parameters.

The mobile application described above also records the customer's visit, notifies payment dates, shows the total commission achieved during the week, and shows the information on the agreements made.

Methodology

On the software development methodology, the use of the agile Scrum methodology was established because technical and management processes are used emphasizing the fast and functional delivery of the product.

(Peñalvo, 2019) using its main tools: User History, stacks of products, list of tasks and estimates of time and activities, the above organized in four sprints with the following phases: Planning, Design, Coding and Testing and that are nothing more than the execution of the tasks of the user stories to achieve a requirement.

Below is table 1 corresponding to the master list of user history planned for the project.

Master list of user histories			
Requirement	**Estimated points**	**Priority**	**Risk**
ITERACIÓN I			
LOGIN	1	HIGT	HIGT
CLIENTES	1	LOW	LOW
GESTORES	2	LOW	LOW
ITERACION II			
PAGOS	2	HIGT	HIGT
CONVENIO	4	HIGT	HIGT
ITERACION III			
COMISIONES	4	HIGT	HIGT
ITERACION IV			
REPORTES	3	LOW	LOW
PARAMETROS	2	LOW	HALF

Table 1 Master List of User stories and
Source: Own creation

User stories encompass a series of specific properties that must be met for their execution, once all have been defined.

A- Planning

In this first stage of the methodology, all the roles of the team (Team Scrum) that intervene in the project are defined, focusing on the Scrum Master who in this project was assigned to the ISC Mariela Pérez Lagunas Responsible for User Service at SOFIPA CORPORATION SAPI DE CV SOFOM ENR, Julissa Concepción Luis Lorenzo as developer, and Marisol Altamirano Cabrera, Claribel Benítez Quecha, Fernando Toral Enríquez and Carlos Alberto Díaz Lara as advisers.

B- User histories

Once the roles are defined, the processes that need to be automated are analyzed and they are reflected in stories known as users, these stories will help with the resolution of the functionalities of the system and the mobile application. Below is an example of two user stories (one per sprint).

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Table 2 reflects the authentication of the managing user to enter the application and thus shows the list of clients that have been assigned for recovery and their details, and the different options to pay or settle the loan granted.

While table 3, validates the access of the administrator user to enter the application, and allows once the customer has been contacted, to reconcile the debit balance through a legal agreement, with fixed deadlines for its settlement.

User history	
Number: 2	**Users:** administrator and users
Story name: clients.	
Business priory: low	**Development risk: low**
Estimated points: 1.5 weeks.	**Assigned iteratión:** 1
Resposible programer: luis lorenzo julissa concepción.	
Description: Need a web module where the clients and their details are shown, can be settled and assigned to the managers and a mobile module for the managers that only lists the clients assigned to them	
Observations:	

Table 2 User History Customers
Source: Own creation

User history	
Number: 4	**User:** Administrator and Users
Story Name: CONVENIOS	
Business priory: High	**Development risk: medium**
Estimated points: 2.5 semanaseeks.	**Assigned Iteratión:** 2
Resposible Programer: Luis Lorenzo Julissa Concepción.	
Descriptión: Clients agree to settle their account, the agreements that are in a single payment or in several are managed, the dates that the payment will be given must be saved, the frequency that will be applied may vary.	
Observations:	

Table 3 User history agreements
Source: Own creation

The work team developed the rest of the user stories identified for the web system and the mobile application, taking into account priority and development risk.

C- Design

In this phase, alternatives we generated for the design of the product based on the requirements to developed, including user orientation criteria, ensuring that it continues with the line drawn in the later phases.

The use of creativity is a strength at this point, since by modeling some processes and the database, the other members of the team and clients will be able to understand the analysis made, and that it may undergo changes due to the opinions expressed in this phase.

In figure 2, an example of a sequence diagram of the managing actor is shown, at moment in which a client is assigned for its follow-up and its interrelation with the system and figure 3, is the interface generated for such process, that is to say the screen that interacts with the end user when the project is completed.

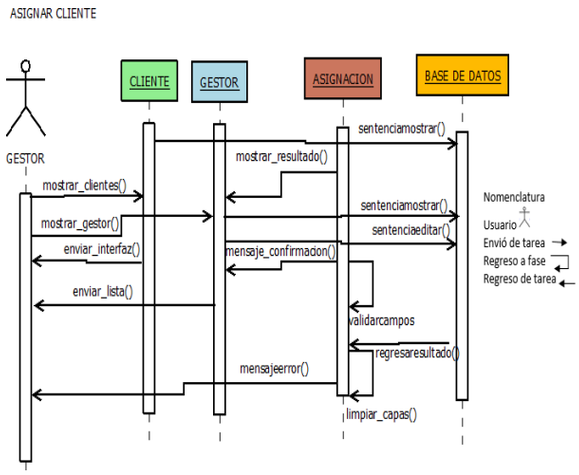

Figure 2 Assign customer diagram
Source: Own creation

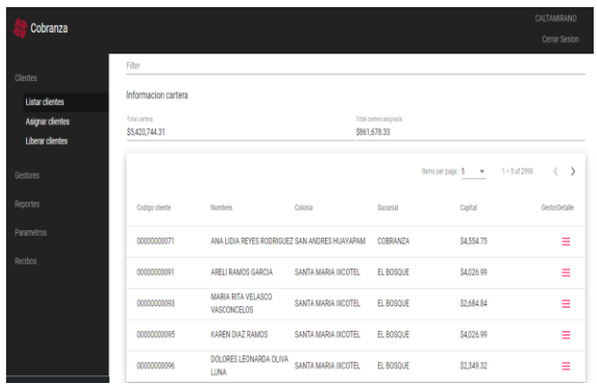

Figure 3 Customer list interface
Source: Own creation

In the design, the allocation of time and resources is prioritized, in addition to defining the technology with which the final product will be developed, it is usually suggested to make a comparative table of which are the programming languages, database managers, and other resources technological that serve to translate ideas to solve the needs of customers.

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C- Development and production

In this phase, the activities defined above are carried out and the way in which it will be deployed is evaluated, starting from the initial requirements; The SCRUM team holds meetings with customers seeking, on the one hand, to deliver a simple product that, when built, meets the requirements of the requested by evaluating the functionalities shown and on the other, so that it can be corrected and iterated immediately. until a clearly defined product is obtained. In this phase where the effectiveness of the strategies and definitions proposed, we verified.

Based on the requirements discussed in the meetings, figure 4 shows the UML (Unified Modeling Language) diagram of the commission process, which describes the process of calculating the commissions generated by the total portfolio recovered by each manager on a weekly basis.

This process complies with some restrictions based on the commission table according to the days of delay, the assigned percentage, the days and the customer's credit type.

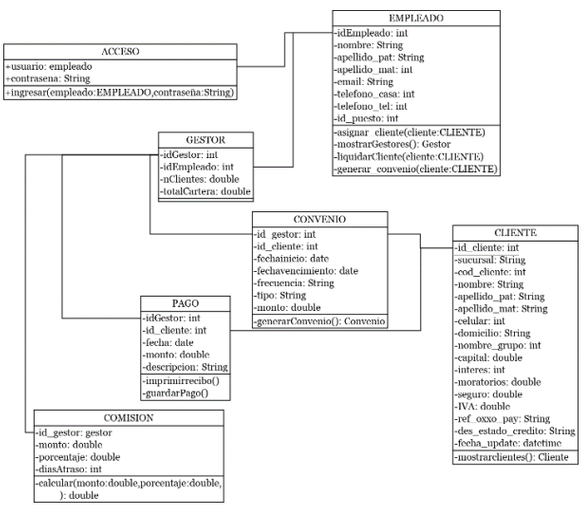

Figure 4 UML Iteration 3
Source: Own creation

Regarding the Web Collection Management System of the SOFIPA CORPORATION company and its mobile application, this process is reflected in the following interfaces (see figure 5), in which the administrator user will be able to carry out the collection assignments and general the corresponding payments.

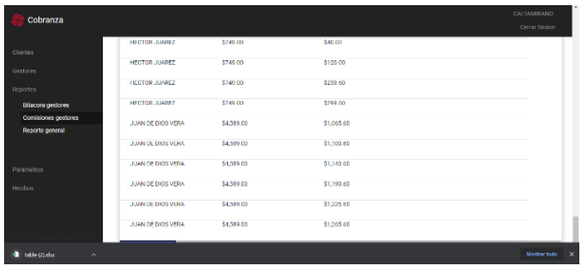

Figure 5 Commissions generated Interface
Source: Own creation

Results

According to the Scrum methodology, at the end of each sprint, the product obtained evaluated, endorsing its functionality; from that moment on, it recommended that the client use it once it has been configured and validated.

The results obtained here are nothing more than the conclusion of the planned activities are integrated in each sprint or iteration. In this work, two applications we obtained as result of the requirements posed by the client: The Web System and Collection Management mobile application of the SOFIPA CORPORATION Co. They have the requested modules, as well as the incorporation of the established business rules, in friendly and intuitive interfaces (figure 6).

By bringing together very efficient characteristics that ensure the fulfillment of its goals and objectives, the possibility of the project being profitable is very high, because it is efficient, safe, and practical and portable. The system and its structure respond to a strategy that seeks to facilitate activities of employees in the SOFIPA Co., streamlining internal processes during judicial collection.

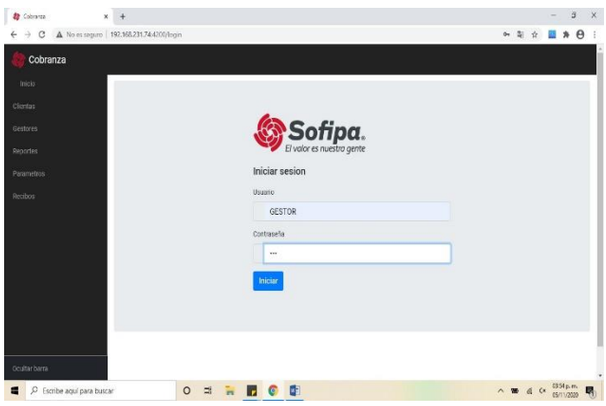

Figure 6 Web system access
Source: Own creation

The system intends to increase the organization to collect payments from delinquent clients, as well as the productivity of collaborators by having the mobile application installed (Figure 7) for printing payment receipts on portable thermal printers.

Figure 7 Movil aplication system SOFIPA
Source: Intellectual property SOFIPA

Conclusions

With this project, it we concluded that it is very beneficial for any educational institution to allow its final semester students to link with companies to develop their capacities and abilities to solve real problems in companies that require it, as well as skills for verbal and written communication.

This project not only provides a solution to a persistent problem in the SOFIPA company, but it is also confirmed that the use of an agile design methodology in web projects such as Scrum, allows systematic planning that includes the coordinated work of a multidisciplinary team. Led by experts in the area and that enrich the student's experience as the project progresses.

The great challenge presented is the current situation generated by the confinement due to the pandemic and the provisions in Mexico, coming from the World Health Organization, for which it we decided to work remotely and go to the physical facilities if necessary and specifically for managerial presentations.

The Web and Mobile applications are already in production, fully incorporated into the company's integral platform, in the first phase for the state of Oaxaca, considering that with the results obtained it can be replicated in other entities in which SOFIPA has a presence.

Gratitude

We thank the Technologic National de México campus Institute Technologic of Oaxaca and the company SOFIPA, for the facilities granted to carry out the project, mainly to Luis Lorenzo Julissa Concepción, student of Computer Systems Engineering, with his experience and time when carrying out the project in the course of your professional residence.

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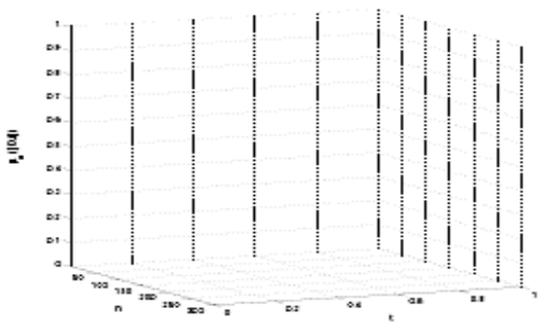

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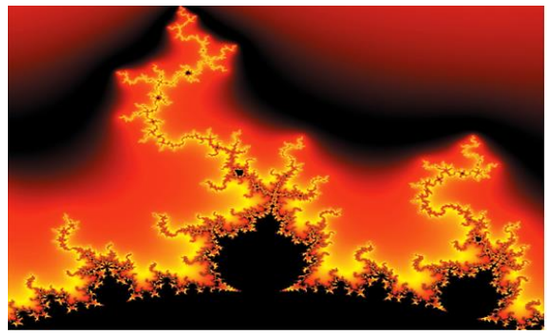

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