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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.

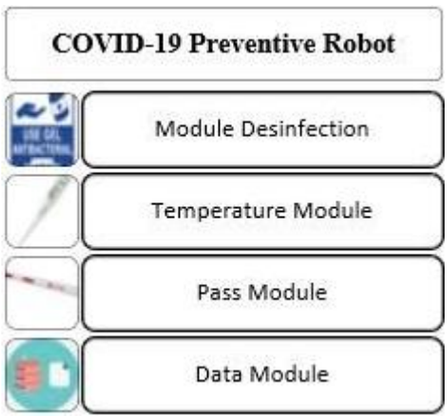

Figure 2 Functional modules that make up the "COVID-19 Preventive Robot" Project

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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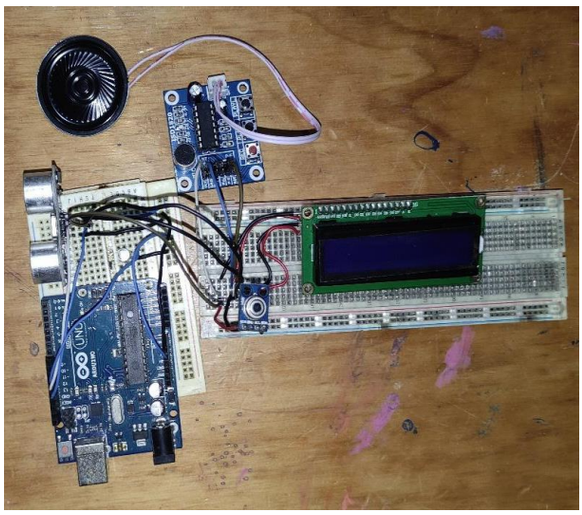

Figure 3 Prototype of the Temperature module of the "COVID-19 preventive robot" Project

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.

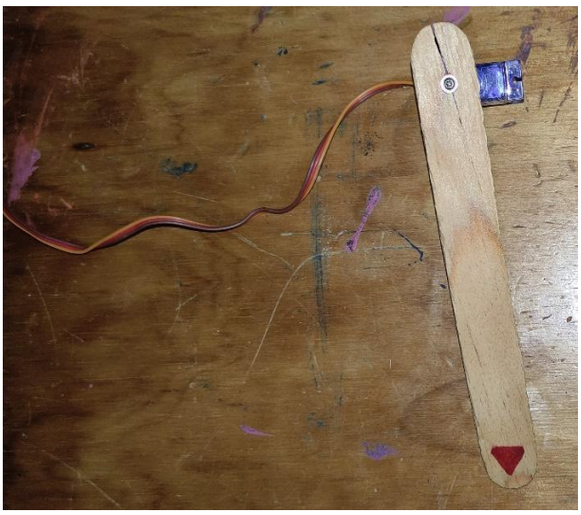

Figure 5 Prototype of the passage module of the Project "COVID-19 preventive robot"

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.

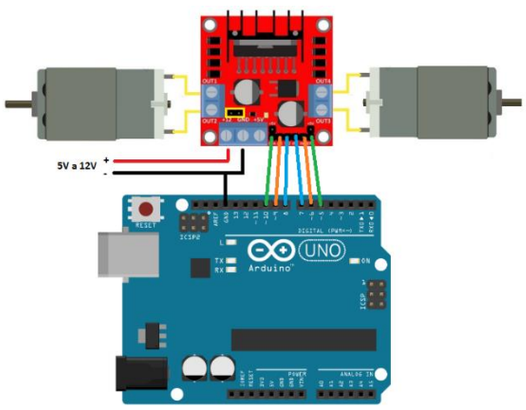

Figure 7 Functional integrated scheme of the disinfection module of the "COVID-19 preventive robot" Project

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

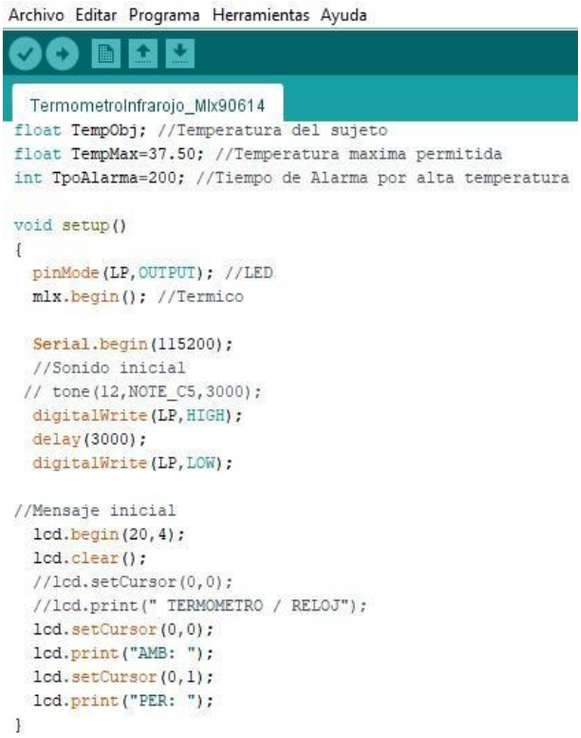

Figure 8 Code in Arduino IDE for the disinfection node of the Project"COVID-19 preventive robot"

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

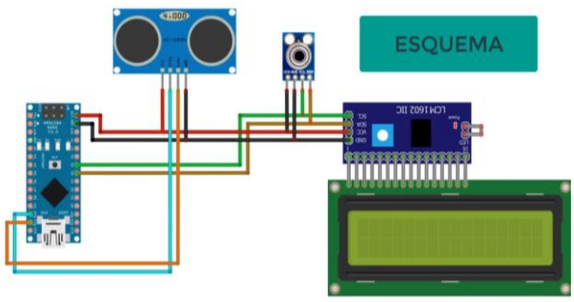

Figure 9 Functional integrated scheme of the temperature module of the "COVID-19 preventive robot" Project

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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.

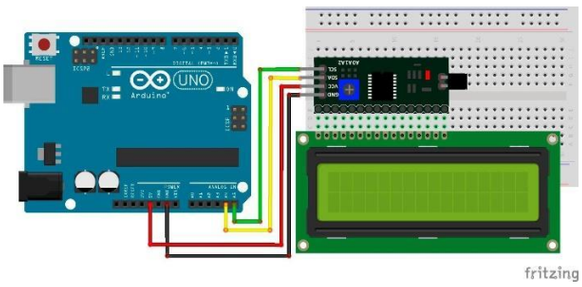

Figure 11 I2C Scanner to check the I2C address of the module

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.

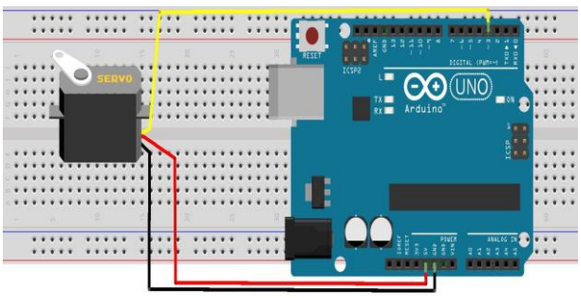

Figure 12 Functional integrated scheme of the passage module of the Project "COVID-19 preventive robot"

Servo

```
// Incluimos 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.

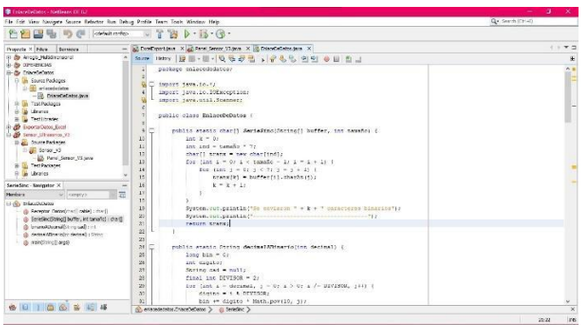

Figure 15 Code in Java for the data module of the Project "COVID-19 preventive robot"

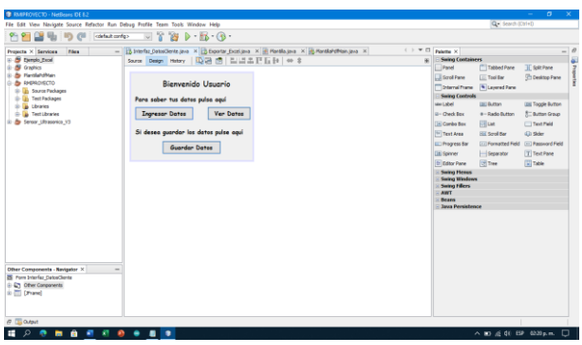

Figure 16 User Welcome *Interface of the data module of* the Project "COVID-19 preventive robot"

Gratitude

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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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