DESIGN OF AN AFFORDABLE MODULE FOR BODY TEMPERATURE MEASUREMENT AND CAPACITY CONTROL IN COMMERCIAL ESTABLISHMENTS TO AVOID THE INCREASE OF CONTAGES BY SARS-COV2

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ABSTRACT

This research presents a solution to increase the protection and security in health control in supermarkets and other places where lots of people make different activities. The design of the module includes body's temperature measurement and control of the capacity that a commercial place can have with the restrictions given by current state of pandemic. Also, this project provides an affordable approach by using through low-cost electronic components.

KEYWORDS: Security control, Pandemic, Affordable & Low-cost electronic components

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INTRODUCCIÓN

Currently, some of the main problems in the peruvian state and the rest of the countries of the world are the ravages of the pandemic that affect millions of people due to the SARS-CoV2 virus. According to the WHO, World Health Organization (OMS in Spanish), to date, there are 72,851,747 million of cases and more than 1,643,339 million of deaths worldwide [1].

Figure N°1: World Situation of Infections by Covid-19 as of December, 2020
Source: News web portal www.elpais.com [2]

Preventive measures in order to avoid the spread of the virus are presented as an increasingly efficient way to reduce the increase of infected people. Since the beginning of pandemic, protocols were established during the state of health emergency to avoid overcrowding in places of high urban concentration, places such as work centers, hospitals, supply centers, etc. According to the "Plan for the surveillance, prevention and control of Covid-19 in the Congress of the Republic", in numeral 7.4 of section VII, one of the main protocols to follow is the control of temperature for people who enter the mentioned places [3].

In June 2020, the Peruvian government, through Supreme Decree No. 110-2020-PCM, reactivated the commerce sector in public and private establishments belonging to phase 2 in order to keep the country's economy stable [4]. However, in the month of December 2020, according to the MINSA through its statement No. 353 on the Peruvian government website, it reported that the number of infected amount increased to 983 045 cases registered due to the possible second wave of contagions. [5]

Figure N°2: Current situation in Peru of infections by Covid-19 as of December, 2020
Source: Net Lab INS and SICOVID [6]

The modus operandi of commercial establishments is based in measurement of temperature for personnel and clients at the entrance ways of the commercial centers using hand thermometers operated by security personnel, but the problem of this protocol is the risk of exposure from the worker or bystanders. In the cases of work personnel, there is an infringement of 50% of 1 IUT (Equivalent to 2150 Peruvian soles or 597 USD) for lack of measurement. [7].

Given this, the present project proposes an alternative to reduce the interaction between people by having low-cost investment technologies capable of temperature measurements and regulating the control capacity of an establishment, a control that up to date is very inefficient and causal of conglomeration in crowded places, for which the following processes are considered:

- People counting stage.
- Validation stage for sensor activation.
- Temperature measurement stage.
- Increase in capacity.

- Repeat process for each user.
- Stage of comparison of capacity and maximum capacity.

METHODS AND MATERIALS

To power of the module of the body temperature and capacity control, a 12v DC source was used and a voltage regulator circuit was designed with the integrated LM7805, which gives us a fixed output voltage of 5 volts and which are suitable for applications that require supply current up to 1A, which is sufficient to power both the Atmega328P microcontroller as the infrared and temperature sensors. Condensers were added to the input and output of the integrated, this is, to stabilize the power supply avoiding peaks or noise. In addition to having a thermal overload shutdown protection. [8]

Figure N°3: Voltage Regulator Circuit with LM7805

For the programming stage, the Atmega328P microcontroller was used, this microcontroller is widely used in electronics projects, which is based on the development board better known as Arduino. This microcontroller has a 32KB memory program, in addition to providing 20 MIPS, a SRAM of 2048 KB, it has the most used communication protocols (UART, SPI and I2C), in addition to working in very wide temperature ranges from - 40 ° C to 85 ° C. [9]

Figure N°4: Atmega328P Microcontroller

Its flexibility of use allowed to develop the project minimizing the implementation costs. In addition, it has the communication protocols used by our sensors, I2C, this protocol is used to control different devices using the same

communication line, in this case the MLX90614 temperature sensor and the LM016L LCD screen were used with the I2C protocols.

The programming interface used was Arduino, the bootloader of the Arduino UNO in the ATmega328P was burned, this to reduce space and take advantage of the ease of use of the Arduino IDE. For the capacity control stage, the E18 D80NK infrared sensor was used, which is a photoelectric proximity sensor that allows the detection of objects without the need of contact. The sensor output is NPN type, it means normally open, so its output in rest state will be Vcc, and when detecting an object its output will be GND. These sensors work to detect intensity of light changes, that is to say the emitter and receiver of light are incorporated inside the sensor. Therefore, it does not emit a signal with distance but only shows on/off states. Also, this sensor can detect materials like cardboard, metal, wood, glass. It works with a voltage of 5V DC and a current of up to 20 mA with a detection range of 3cm to 80 cm which is regulated by a potentiometer. [10]

Figura N°5: Conexiones de los Sensores E18 D80NK

This sensor allows the counting of people using a Boolean programming logic, that is, when passing a person it will count as 1, otherwise, it will remain at 0. Added the other sensor for when people leave the commercial establishment, it will subtract the amount of people of the capacity to avoid the agglomeration.

In the temperature measurement stage, the MLX90614 sensor was used, this sensor does high precision measurements without having contact with the object. The temperature range that it measures goes from the range -40°C to 170°C , the reading accuracies oscillate with 0.02°C in addition to being used for medical applications and it can be supplied with voltages of + 3V and + 5V. [11]

Figure N°6: E18 D80NK Operating Mode
Source: E18D80NK Datasheet

This sensor communicates with the ATmega 328P through I2C, this device was used due to the high reading precision compared to another sensors, with the possibility of not having direct contact with the person to whom the measurement of temperature is measured.

Figure N°7: MLX90614 Sensor Connection Circuit

For the comparison stage, it was handled with external interruptions that are activated when a person leaves the establishment, this is because when the person leaves the establishment there is no temperature reading process for the same person, only for when they enter.

The final stage of the system consists of an alarm that allows knowing if there is some irregularity in the process of entering to the establishment, this can occur, when the person enters accompanied by another person at his side or

exceeds the maximum temperature required of 38 ° C.

The ATmega 328P microcontroller cannot handle high current or voltage loads, it only delivers maximum voltages of 5 V, for this we use a circuit with a transistor to be able to handle the load of the buzzer of 12V not to damage the microcontroller. The transistor used was the TIP122, which handles loads up to 5 amps. The configuration used is shown below. [12]

Figure N°8: Voltage Regulation Stage

PROGRAMMING

Programming in C language was developed in the Arduino IDE.

```
#include <Wire.h>

#include <LCD.h>

#include <Adafruit_MLX90614.h>

#include <LiquidCrystal_I2C.h>

#define sensorUp 2

#define sensorDown 4

#define buzzer 5

Adafruit_MLX90614 sensorTEMP = Adafruit_MLX90614();

LiquidCrystal_I2C lcd (0x3F, 2, 1, 0, 4, 5, 6, 7);

int contador = 0;

int aux = 0;
```

```
int setPoint = 1000;

void setup () {

  Serial.begin(9600);

  lcd.setBacklightPin(3, POSITIVE);

  lcd.setBacklight(HIGH);

  lcd.begin(16, 2);

  lcd.clear();

  sensorTEMP.begin();

  pinMode(sensorUp, INPUT_PULLUP);

  pinMode(sensorDown, INPUT);

  pinMode(buzzer, OUTPUT);

  attachInterrupt(digitalPinToInterrupt(sensorDown), decremento, RISING);}

void loop() {

  if(digitalRead(sensorUp))

  {aux = 1;

  if(aux == 1)

  {float tempPersona = sensorTEMP.readObjectTempC();

  if(tempPersona >= 38)

  {digitalWrite(buzzer, HIGH);}

  Else

  {contador++;

  if(contador > setPoint)

  {digitalWrite(buzzer, HIGH);}}}

  else{ digitalWrite(buzzer, HIGH);

  aux = 0;}}

  else

  {digitalWrite(buzzer, LOW); aux = 0;}

  lcd.setCursor(0, 0);

  lcd.print("TEMP = ");
```

```

lcd.print(tempPersona);

lcd.print(" °C");

lcd.setCursor(0, 1);

lcd.print("AFORO = ");

lcd.print(contador);}

void decremento()

{ contador--; }counter }

```

The final plate developed has an approximate size of 4x4 cm where all the devices used fit. The approximate cost of manufacturing with all components is shown below in Peruvian currency (PEN)

Table N°1: Table of Manufacturing Costs

Device	Cost
PCB	5
BOX 3D	10
TIP 122	1.5
BUZZER	4
AUXILIARY CIRCUITRY	5
LM7805	2
Atmega 328p	12
LCD SCREEN LM016L.	10
MODULE I2C LCD	5
MLX 90614	30
SENSOR E18D80NK	50
12V power supply	20
S/. 154.50 (PEN)

Figure N°9: "System Flow Diagram"

The module as a final product is shown simulated below:

Figure N°10: "Final Design of the PCB Module"

CONCLUSIONS

- It is possible to implement the temperature and capacity control module with a small budget, in this way the percentage of acquisition in all type of commercial establishments is increased.
- It is effective the use temperature sensors by means of IR waves that replace measurements made by people, by this way the human-human interaction it can be avoided in order to avoid the spread of the virus.

RESULTS

- The circuit was designed to be used in commercial establishments without making any excuse for the cost of the product, it approximately 40 dollars, because of its affordable price and portability it can be implemented and used in many places due to the wide operating ranges for the temperature measurements by the components used.
- The E18 D80NK infrared sensors used, allowed the adequate measurement of the capacity due to the interruptions to avoid errors and / or desynchronization at the time of counting. In addition, these sensors can perform a measurement with distances between 3 cm to 80 cm.
- A setpoint temperature of 38 °C as maximum was considered, which could be regulated in the ATmega programming, to restrict the entry of people with suspected of having SARS-Cov2.
- The device will reduce the influx of suspicious people who may have the SARS-Cov2 virus due to the filter implemented at the entrance of commercial establishments, to prevent the spread of the virus.

RECOMMENDATIONS

A robotic arm or a containment bar could be additionally implemented to prevent the entrance when the alarm rings, this would reinforce the security against unscrupulous people who try to circumvent the security system.

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