# IMPLEMENTATION OF A SYSTEM OF MEASUREMENT OF CHEMICAL POLLUTANTS IN THE WATER AND WIRELESS TRANSMISSION OF INFORMATION TO A CONTROL ROOM

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**Abstract:** The following article is the design and implementation of a system of measurement of methane gas and wireless data transmission to a control point, the main technological tools used in this project are: the communication modules Shield GPRS SIM900 which were used for the transmission and reception of data, arduino one and gas sensors MQ. Processing the data obtained is performed through the Matlab software platform, using the UART serial communication protocol.

**Keywords**: GPRS, sensors, Arduino, Matlab, communication

## I. INTRODUCTION

The design of the project implementation of a system of measurement of methane gas and wireless transmission of the data to control point, consists of the following stages for its development: Phase Calibration and conditioning circuit for the gas sensors MQ, Stage of communication of the data (transmitter and receiver) was carried out with the modules Shield GPRS SIM900 and the Arduino one, the last stage, which is the graphical interface of the data capture, display and report generation the software MATLAB version 2016ra in the work area guide. This project is added to the executable file of the application developed in Matlab, which allows us to the implementation of the program on another computer without the requirement of having the software installed Matlab.
Another important aspect mentioned in this article is the configuration of the communication modules GPRS SIM900, which work with the AT commands and using the UART serial communication protocol.

### 1.1. Background

In the following articles scientific research related to this project, which speaks about the work done in this field.

**Application of electronic nose for industrial odors and gaseous emissions measurement and monitoring**

In this article deals with the development of artificial olfaction (electronic nose) from the human smell, analyzing its functioning and behavior. Some studies of greenhouse gas emission and monitoring in industrial processes, implementing an electronic system of artificial olfaction (electronic nose) to determine and classify these smells.

**A novel sensor selection using pattern recognition in electronic nose**

This article studies the nose portable electronics (E-Nose) based on gas sensor MOS (Metal Oxide Semiconductor) for the detection of multiple classes of contaminating odours in the air. Caracteriscas features of portability, low cost, multiple phone detection and monitoring. Benzene, toluene, carbon monoxide and ammonia are the first phone proposals by E-Nose with benefits from the characteristics of wide spectrum, reproducibility, sensitivity and low cost of gas sensors.

**Organochlorine screening using food in fresh an electronic nose.**

In this research, propose a method or alternative to detect to family of pesticides of organoclorurosoraganofosfatos on fresh foods, especially fruits using electronic noses or multi-sensory systems. This electronic nose built, the goal is to achieve a qualitative classification into two classes, the presence of pesticides and organic food, which aims to reduce the rate of disease by excessive contamination of food and create a new methodology through a low cost. The electronic equipment is a tool for small and medium-sized farmers.

#### 1.1.1. Multi-sensory System

When multi-sensory systems are mentioned it has to be borne in mind that are devices designed to emulate the characteristics of the senses that we possess the living beings. These systems may be the electronic tongue or smell that is the object of study of this work. These senses and as explained below are composed of multiple membranes responsible for perceiving the patterns and send the corresponding electrical stimuli to the brain for processing the information.
In the artificial systems those that function are the different sensors as well as their peers in the human being send an electrical signal depending on the pattern present in the environment.

##### 1.1.1.1. Sensor

A sensor is a device that is able to detect actions or external stimuli and respond accordingly. These devices can transform the physical or chemical in electrical quantities.

#### 1.1.1.2. Gas Sensors

The chemical sensors can also be classified according to the principle of operation that use. The most commonly used are conductivity properties, voltages, capabilities, UPS, masses or optical constants which change by varying the concentration of the chemical species that interact with the sensitive coating on the sensor.

#### 1.1.1.3. Gas Sensors MQ

The gas sensors of the MQ Series employ a small heater in the interior with an electro-chemical sensor. Are sensitive to a range of gases and are used indoors at room temperature. They can be calibrated, but it requires knowledge of the concentration of the gas or gases measure present for adjustment. The sensor uses a load resistor, which ranges with values between (2 -47 [kΩ]).

## II. METHODOLOGY

### 2.1. PCB Sensors

The printed circuit of the sensors for the E-nose methane, are designed with the help of the Proteus Design Suite 8.4. This program has a few tools, which are used the area of design Schematic Capture and PCB Layout. This software does not have the PCB of this electronic device (sensors MQ) within your database, which was necessary to create your own PCB, proteus allows the creation of new models of electronic devices. This software is currently used in the laboratory of printed circuit board Electronic engineering program at the University of Pamplona.

#### 2.1.1. Design Schematic Capture

In the following figure 1, we can see how to create a new model of an electronic component in the Proteus.

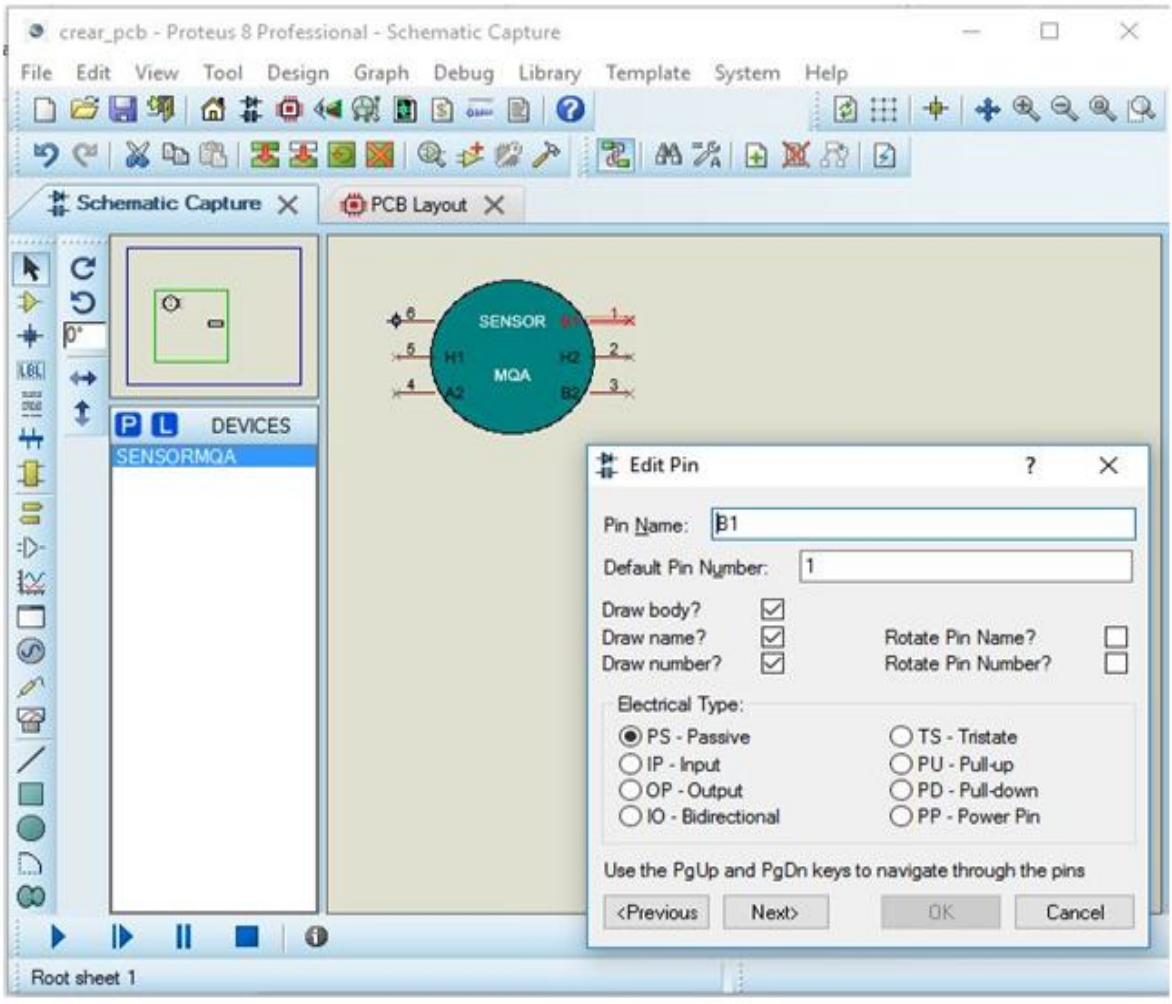


**Figure1: Design of a new schematic model of the sensor MQ**

Clicking on each pin created, there emerges a window called Edit Pin, where the pins are configured to use. In the following figure 2 shows how to save the new component created by clicking on the icon Make Device, where it appears a window, the corresponding steps and fill in the necessary fields and then save it to the USERDVC library.

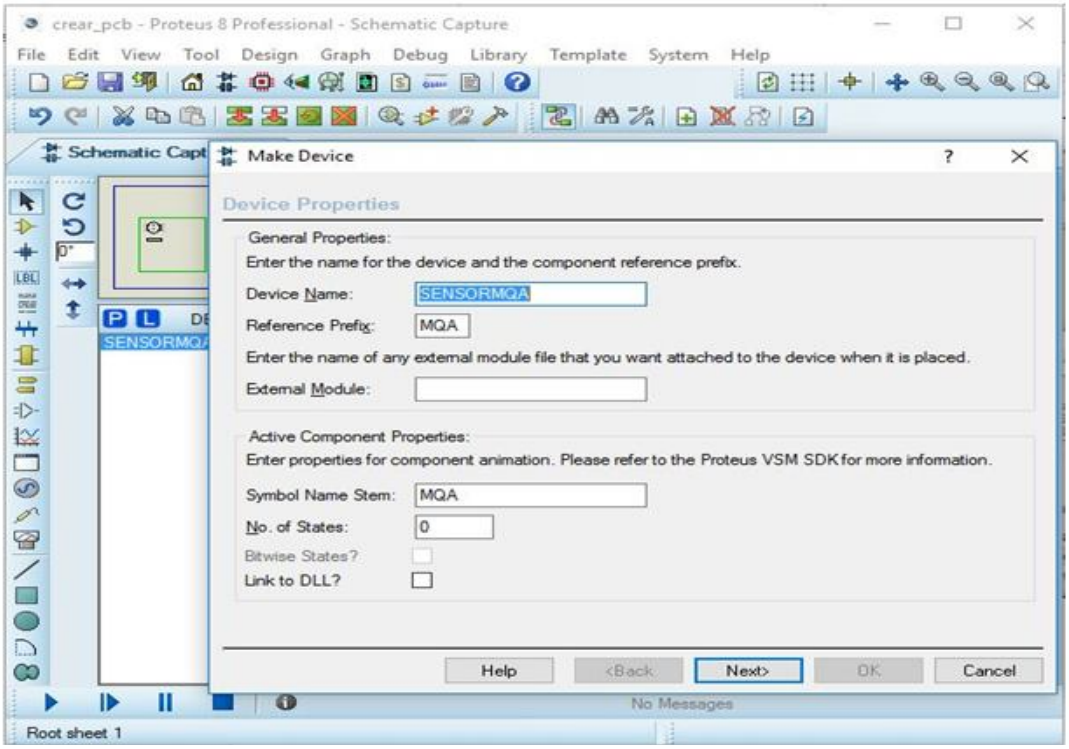


**Figure2: Save the new schematic model created**

Once all the above steps to create the new component, we can use our model in any design you want to run. In Figure 3, you can see how we use our component created.

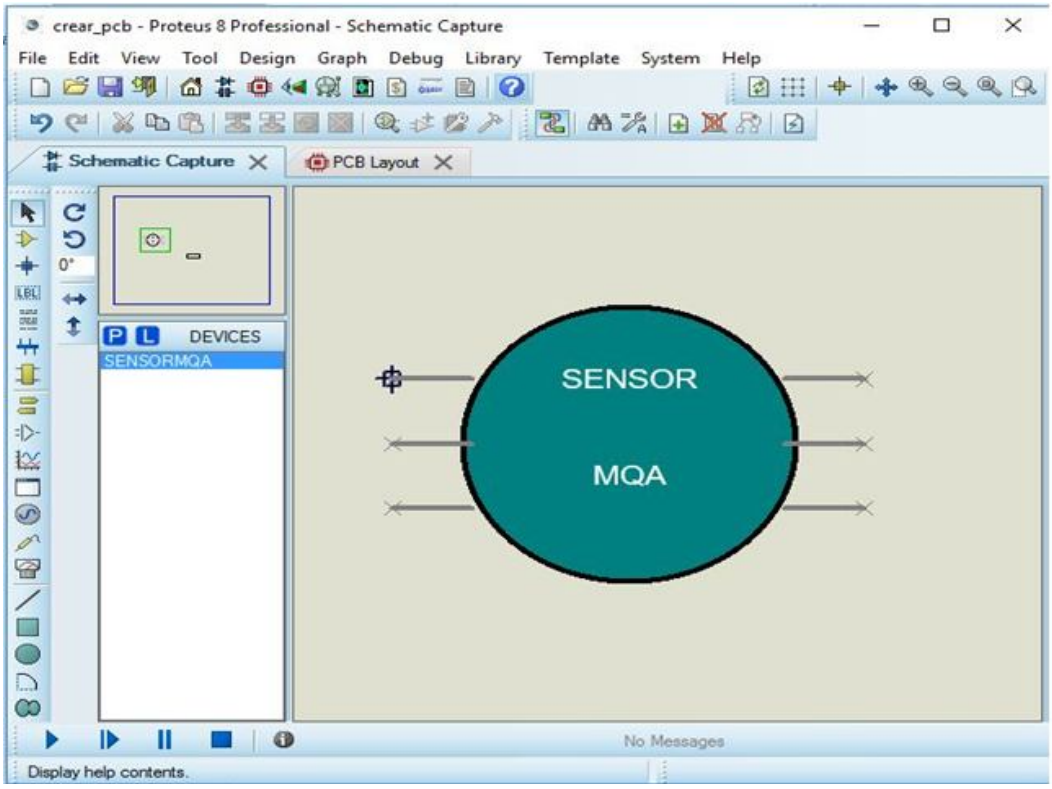


**Figure2: Use of the new component in shematic Capture**

### 2.1.2. PCB Design Layout

Once created our component, we must assign the package of PCBS, in order to make our Shield of the sensors. In the following figure 4, discusses how you create the PCB for the component you created earlier.

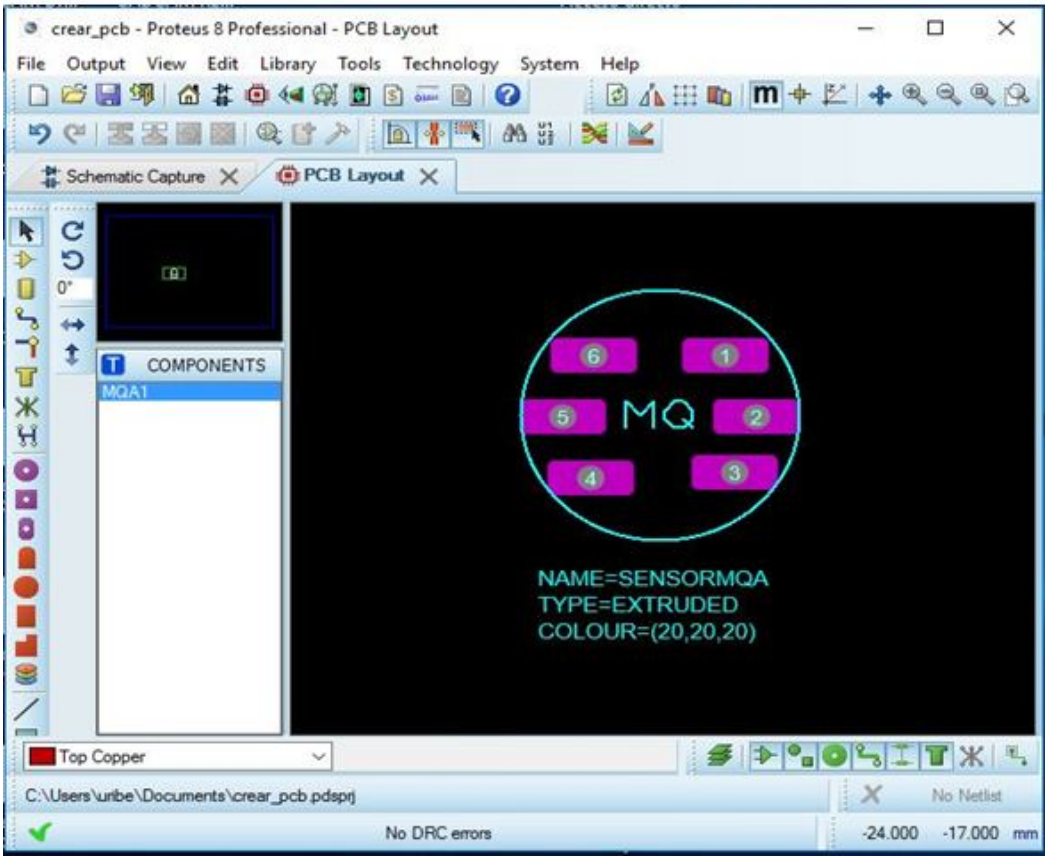


**Figure3: Allocation of the PCB for the model created**

In Figure 5 shows the model created of the PCB for the arduino one**.**

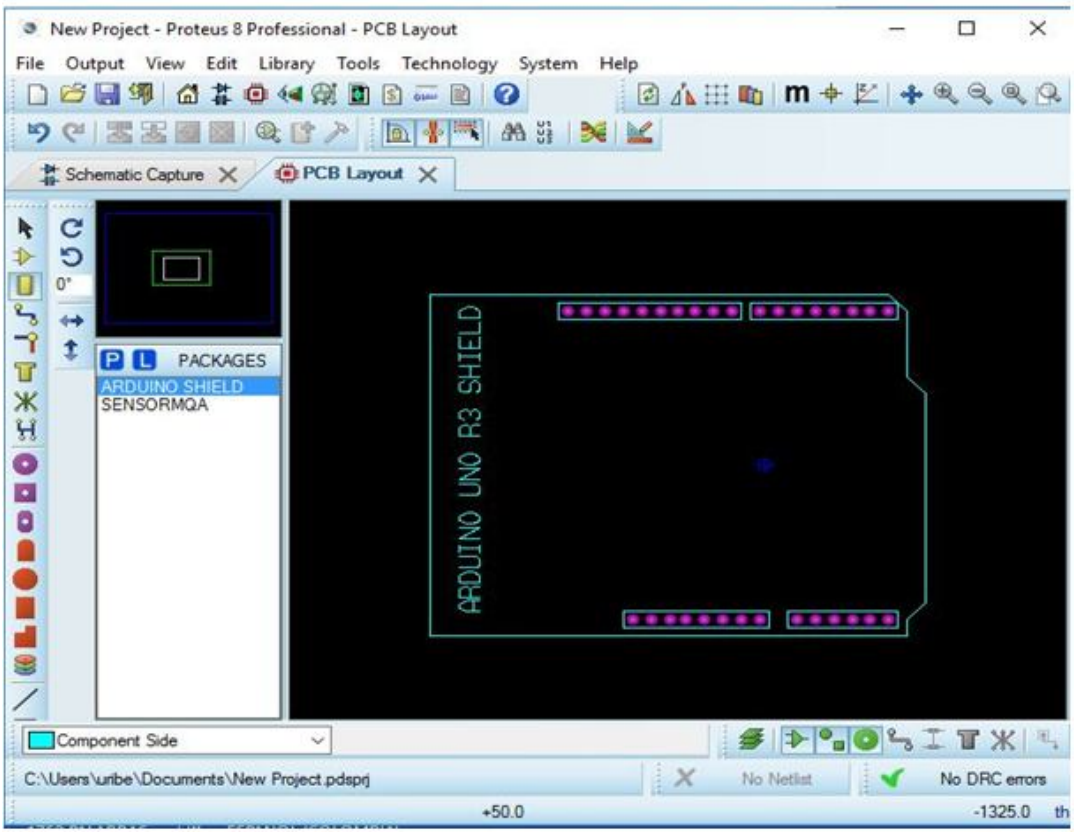


**Figure4: PCB for the Arduino one**

### 2.3. Arduino PCB design shieldsensors

The circuit of the Shield arduino sensors can be seen in the following figures 6 and 7, the schematic capture and PCB layout.

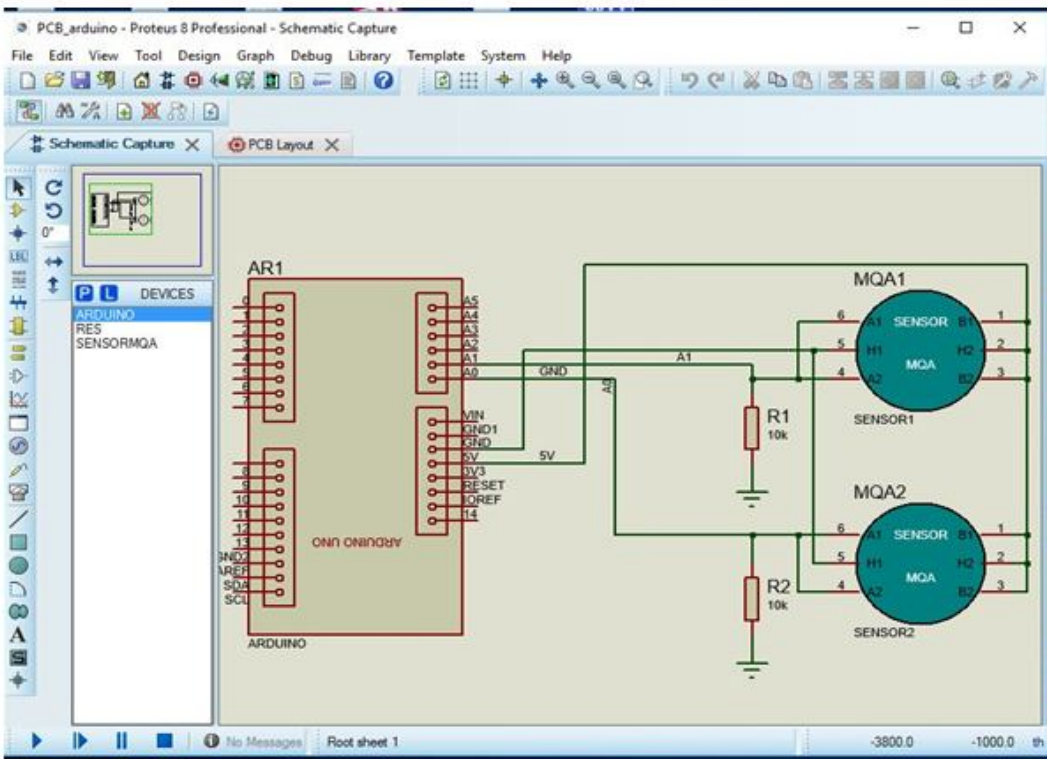


**Figure5: Arduino sensors design schematic capture**

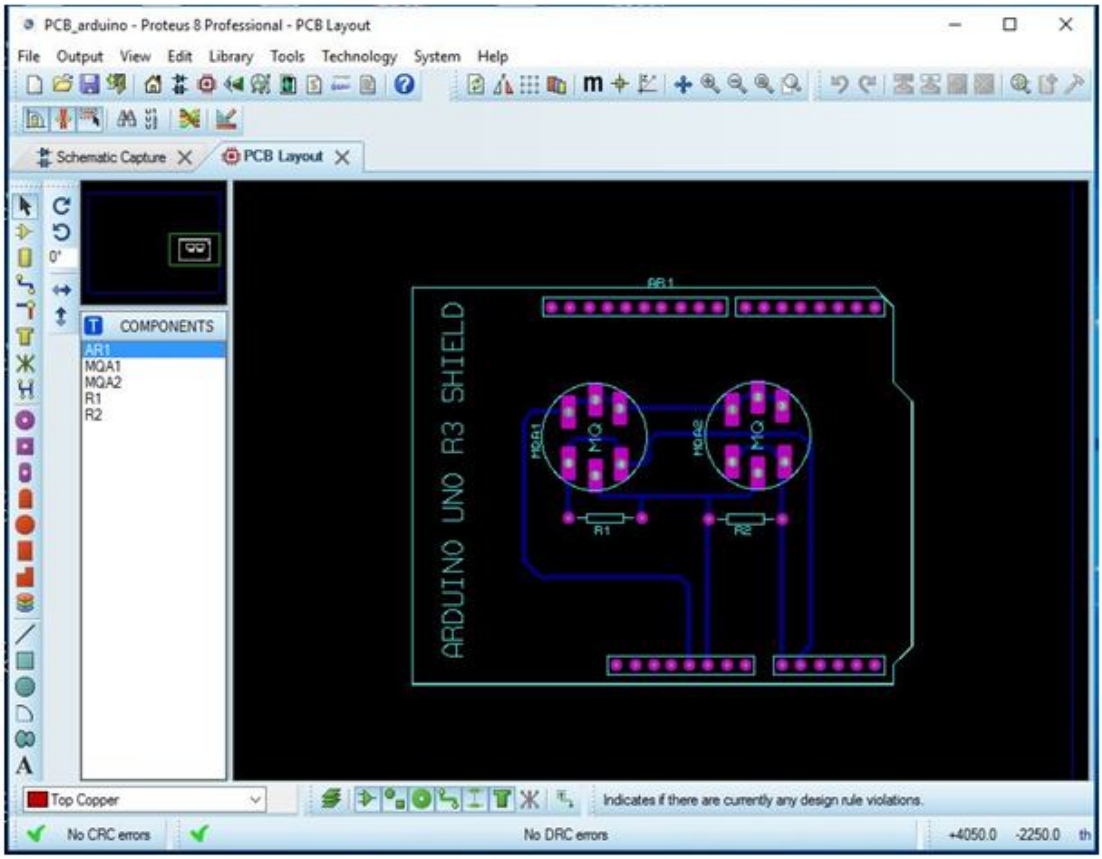


**Figura6: Design sensors Arduino PCB Layout**

### 2.4. Data communication

### 2.4.1. Connection of the module SIM900

In the following figure 8 displays the connection diagram for the GPRS module and the Arduino one, which employ the pins (Tx, Rx) for the communication of the data.

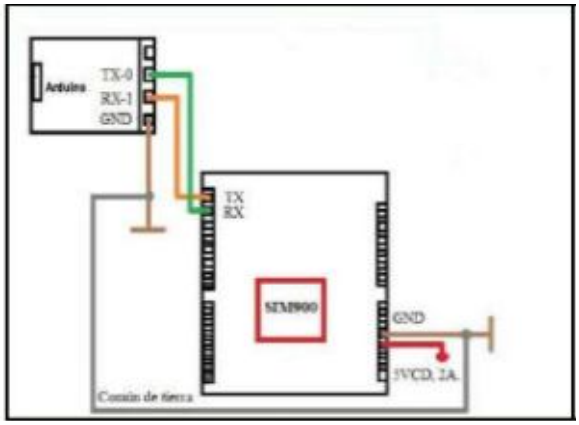


**Figure8: GPRS connection diagram and Arduino**

### 2.4.2. AT commands

The AT commands, also known as commands Hayes (in honor of its developer Dennis Hayes), are a series of instructions that make up a communication interface between user and modem. These commands allow us to perform actions such as: dialing a phone number, send or read an SMS, check the status of the network connection, read or write in the agenda of contacts, etc.

When you send a command at the SIM card should reply with an OK. Some of these are the following:

| AT | DESCRIPTION |
|---|---|
| **AT+CGMI** | See manufacturer's name |
| **ATI** | Product information |
| **AT+IPR=?** | Ask the Baud Rate that operates the SIM |
| **AT+IPR?** | Ask current Baud Rate |
| **AT+IPR=XXXX** | Configuration of the desired frequency |
| **AT+COPS?** | The name of the telephone company |
| **AT+CGSN** | Display the IMEI of the chip used |
| **AT+CSCS?** | Type of text |
| **AT+CSCS=”XXX”** | Configure the type of text |
| **AT+CMGF?** | See the format of a message, whether PDU(0) or 1(SMS)" |
| **AT+CMGS=04455XX** | Send an SMS is deployed the greater than symbol > Write message and when finished press Ctrl Z will return OK if the SMS was successfully sent. |
| **ATD04455XXXXX;** | To make a call to any mobile phone |
| **ATA** | Answering a call |
| **ATH** | Hang up a call |

**Table 1: AT Commands**

### 2.4.3. Transmission module (TX)

This module consists of the following components:

- Shield for Arduino.
- Arduino one.
- GPRS module SIM900.
- Power Source (Batteries).

To configure the Shield GPRS SIM900 as a transmitter module of the data captured by the sensors and the arduino one. You must program the respective code in the development environment (IDE in Arduino) which is in charge of the management of the connection between the PC and the Arduino hardware.

The message sent by the transmitter module must be coded for security reasons the system, so we can create our own communication protocol, and then be able to decode it in the receiver module, the function that is responsible for sending the messages to the receiver module can be seen in the following figure 9.

```
void mensaje_sms(){
  SIM900.print("AT+CMGF=1\r");
  delay(100);
//Receptor RX
  SIM900.println("AT+CMGS=\"3202146894\"");
  delay(100);
  SIM900.print('#');
  Read_sensor() // print el dato
  SIM900.println('*');
  delay(100);
  SIM900.println((char)26);
// End AT command with a ^Z, ASCII code 26
  delay(100);
  SIM900.println();
  delay(5000); // Tiempo para que se envie el mensaje
  Serial.println(" SMS sent successfully");
 }
```

**Figure7: Code of the function Send SMS**

### 2.4.4. Receiver module (RX)

This module consists of the following elements:

- Arduino one.
- GPRS module SIM900.
- Computer (PC).
- Graphical Interface (executable matlab).

In the Arduino IDE is program the following function, which is responsible for decoding the data sent by the transmitter module, then the captured data are sent through the serial communication protocol to the GUI application developed by the software Matlab. In Figure 10 shows the main function of the code of decoding of the received message.

```
void Read_SMS(){
   int lg=mensaje.length();
   int nc= mensaje.indexOf('#');
   sms= mensaje.substring(nc+1,lg-1);
   int dato = sms.toInt();
   delay(10);
     if( nc>=0){
        Serial.println(dato);
        delay(10);
        dato=0;
        sms="";
        mensaje ="";
        // borralo para la proxima vez
     }
    }
```

**Figure10: The function code to receive SMS**

### 2.5.Graphical Interface (MATLAB)

The data captured by the receiver module, are visualization and processed by the graphic interface, which is an executable program developed with the software matlab in the tool guide.

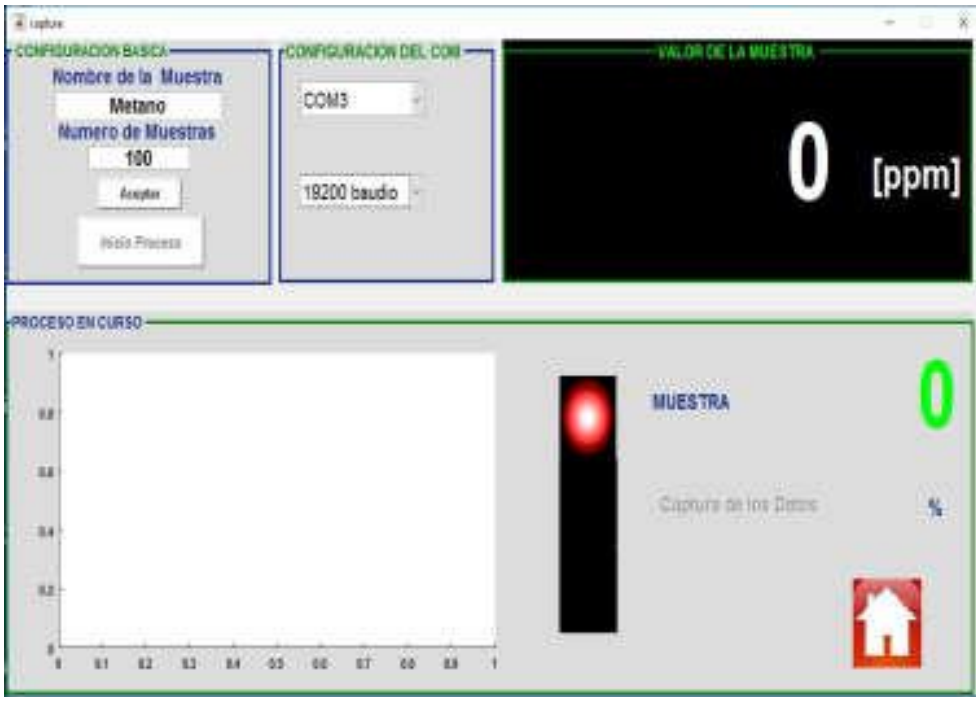


**Figure11: The function code to receive SMS**

In Figure 11, the window capture of the application GUI, which you can configure the following options:

- The name of the sample (the name of the file in which to store the captured data in .txt format and .xlsx)
- The number of samples to capture
- Select the COM port to use
- Select the speed of the Baud Rate for serial communication
- Start Button in the process
- Display where displays the value of the captured data
- Display which displays the number of the sample
- Display where displays the percentage dl process
- A traffic light where it is displayed the data acquisition process.
- A plot where real-time graphical data captured.

### 2.6. Create executable in MATLAB

The software matlab has the option to develop our own applications (.ex) of the programs carried out. Which allows us to run the programs on any computer where you have installed Matlab. In the following figure 12 shows the procedure to create executables (applications).

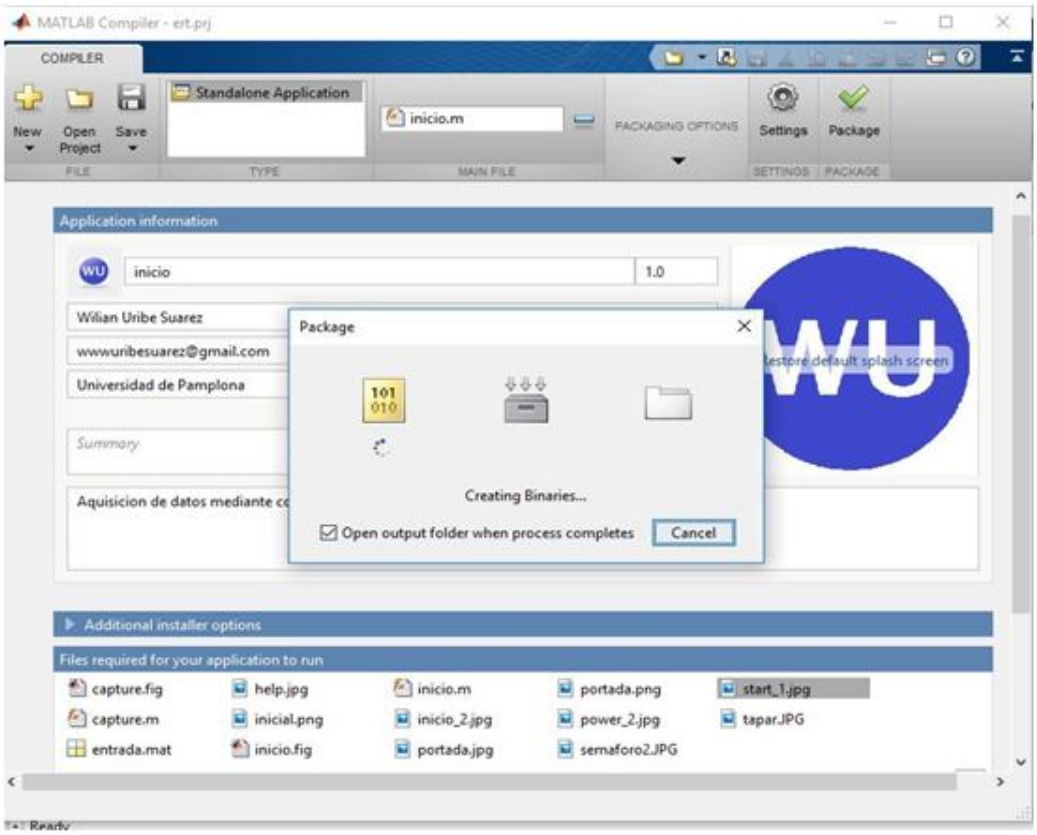


**Figure12: The function code to receive SMS**

In Figure 12 shows how to create our executable application in MATLAB, the procedure is very simple, click on the tab Compiler, where a window will appear, which has a few fields to complete, in the icon (-) is added to the main data file, and in the bottom icon (+) are added all of the files used for the implementation of the program, then click on the icon Package and begins to develop our executable file (.ex). Once the process correctly generates all files required to run our application without having the Matlab software installed.

## CONCLUSIONS

The program proteus allows us to design new models of components of electronic devices both in the schematic capture and PCB layout. Which makes it easier for us at the moment of creating our printed circuits, another advantage is that the program proteus is compatible with the machine printed circuit board that is in the laboratory of the University of Pamplona.

The SIM Card GPRS communication module900 gives us a great advantage in the transmission of data over long distances, it means that where there is a mobile phone coverage of some of the service operator, we can make this data transmission. The disadvantage that presents us with this module is the sampling rate of the data, which in the tests that were done to send messages (SMS), you must configure a delivery time between data and data that ranges between (2-3 seconds) to ensure the communication system. Which is a very high in the data sampling of a signal.

The creation of executable applications in the software matlab gives us the ease of being able to run our programs designed in which computer, but the disadvantage of using this platform is that it is a private service. The US generates costs in the marketing of our applications, you must have the respective licenses and permits.

## REFERENCES

[1] O. Gualdrón and O. Fiallo, “Organochlorine screening using food in fresh an electronic nose,” vol. 10, no. 3, pp. 17–25, 2016.
[2] T. Data, “MQ-4 Semiconductor Sensor for CO / Combustible Gas,” pp. 2–4.
[3] A. Szczurek and M. Maciejewska, “Sensors and Actuators B : Chemical ‘Artificial sniffing’ based on induced temporary disturbance of gas sensor response,” Sensors Actuators B. Chem., vol. 186, pp. 109–116, 2013.

[4] L. Zhang, F. Tian, and G. Pei, "A novel sensor selection using pattern recognition in electronic nose," MEASUREMENT, vol. 54, pp. 31–39, 2014.

[5] DURAN ACEVEDO, Cristhian Manuel, RODRIGUEZ GAMBOA, Juan Carlos. Sistema de olfatoelectrónico para la detección de compuestosvolátiles. En: RevistaColombiana de Tecnologías de Avanzada. No. 18(2008); ISSN: 1692-7257.

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