World Academics Journal of Engineering Sciences
Vol.9, Issue.2, pp.46-51, June (2022)

Research Paper

E-ISSN: 2348-635X

Design of Wireless Monitoring System of Body Health Using Electronic Face Mask

Mortada M. Abdulwahab[1*], Khalid H. Ahmed[2], Hamza M. Al-mehrabi[3], Mohammed A. Al-kateb[4], Yazid A. Al-mezgagi[5], Jwher Y. Al-rashdi[6]

[1]Electronics Engineering Department, Faculty of Engineering and Technology, University of Gezira, Sudan
[2,3,4,5]Electronics Engineering Program, Alnour College of Science and Technology

[*]*Corresponding Author: murtadaabdelwahab@gmail.com Tel.: +249910136722*

Available online at: www.isroset.org

Received: 09/Mar/2022, Accepted: 15/Apr/2022, Online: 30/Jun/2022

Abstract—Preventing respiratory diseases is a major challenge for all the peoples of the world, Modern Electronics technology play important role in developing techniques for preventing of spread diseases.Face mask is the first defense stage to prevent the spreading of respiratory diseases such as COVID-19. The objective of this paper is to design Advanced electronic face mask to be used to achieve real time monitoring of health status for the person who used the electronic mask. This design helps in early detecting of infection and reduce the spreading of diseases. The design consists of a group of sensors such as (Infrared thermometer Sensor, Heart-Rate Sensor) which connected to a microcontroller. Wireless communications and smart phone technologies were used to provide an efficient monitoring for peoples whom wearing the face mask. The design was examined in different operating cases and the obtained results were accurate and achieved the required goals.

Keywords—Arduino; Blutooth; Sensors; Design

I. INTRODUCTION

Recently Medical masks which known as surgical or procedure masks were recommended to be wearied all the time that we were been in groups, it has simple construction and available in flat shape to be easy fixed to the head. [1], The most critical way to avoid getting illness with respiratory diseases such as influenza and the coronavirus is wearing a mask because it helps the people around you from infection[2][3][4]. Masks can be in different types such as mask with valve, mask without valve and mask that can be reused for several times by washing it. COVID-19 is classified as virus disease which may spreads over the air but the knowledge of how it can be transmitted still under study due to the continues change of COVID-19 virus.That fact explain why COVID-19 spread widely in short time according to statistical records more than 100 million were infected since march 2021[5].

The aim of this paper is to combine between medical equipment and modern electronics knowledge to produce an efficient mechanism that helps many peoples from getting illness by respiratory diseases, that goal can be achieved by providing efficient monitoring system for the user of the mask; which helps for early detecting of any unusual changed of the major diagnostic factors such as temperature and heart rate. The design contributes in the efforts of fighting the spreading of COVID-19. Sensor networks is a group of sensors which used to connect the physical world with the digital world [6]. The wireless sensor network and the android technology are contribute to achieved this goals. The design used wireless sensor network connected to Arduino. The sensor network connected to smart phone via Bluetooth and GSM technology which give real time monitoring system. There are a lot of published papers in the field of face masks; some of those papers distinguished the types of face masks and their applications as well as discussing the industrial materials that used in manufacturing the face masks while a few of papers give an engineering design.

II. RELATED WORKS

Many doctors and scientists have improved designs to develop face masks that can help more in protection and limit the spread of infection. For instance the study in [7] focused on the difficulty of testing the new designs of masks therefore it provides an optical method to be used in evaluating the efficiency of face masks. The study in [8] highlight the habits of using the face mask during COVID-19 crisis, the study was done in china and it aimed to find the problems of using the mask. Similarly the study in [9] was done in German and discussed the behaviour of wearing masks during COVID-19 crisis. In [10] three types of face mask were developed based on material circularity indicator)of masks ,the paper aimed to find which type of reusable masks which can be used for a long life cycle. The design in [11] aimed to provide effective filtration; it contained a design of face mask consisting of three layers of filtering.

III. THE HEART-RATE SENSORS

The Heart-Rate Sensor (XD-85C) as shown in Fig .2 is a pulse sensor which considered the popular sensor that used to provide easily incorporate live heartrate data into Arduino. It gives pulse in real time real time. The pulse /heart beat sensor measures the heart beat by sensing the blood flow, It consists of LED on top side and electronic circuit on the other side when it used the finger placed above the LED to be as barrier, the received reflected intensity light due to blood flow in the fingers depends on the blood flow from the heart pumping and it can be used to calculate the heartbeat.[12]. An ear clip can be used for fixing the sensor to human ear easily.

Figure.1: Heart-Rate Sensor

Another model of sensors that available to be used for measuring heartbeat rate is The MLX90614 , this type of sensors calculate the heart beat based on the change of temperature using infrared light and it does not required any physical contact [13]. The electronic specification of this sensors are shown in Table.1.

Table. I: MLX90614 features

Features	Description
Type	Biometric Pulse Rate or Heart Rate detecting sensor
Current Consumption	4mA
Operating Voltage	+5V or +3.3V
Diameter	0.625”
Thickness	0.125”

IV. METHODOLOGY

The block diagram of the design as shown in Fig.2 consists of two major parts; the Arduino controller which responsible of processing data from the sensors and controlled the transmitted data via GSM and Bluetooth. Figure 3 shows the principle mechanism of how smart phone transmit data .

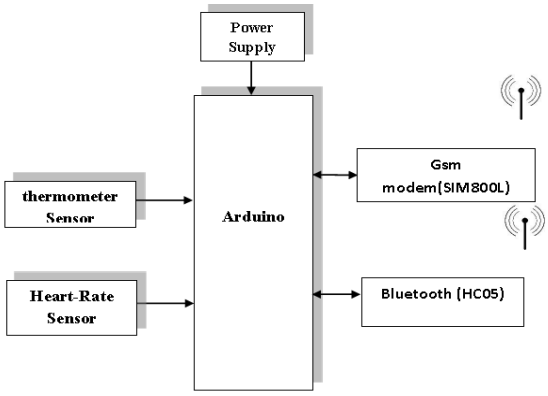

Figure.2: Block diagram

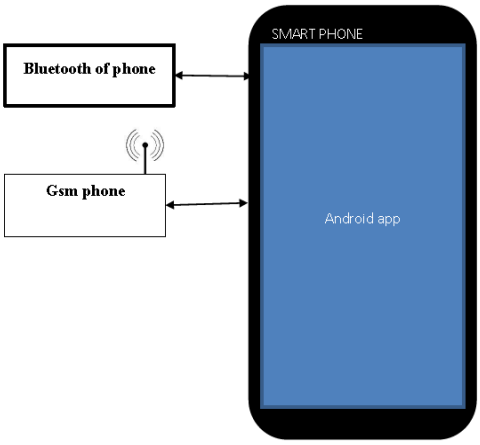

Figure.3: Smart phone connection

As shown in Figure 4 the electronic circuit consists of five major components Arduino, Bluetooth module, GSM ,Infrared thermometer Sensor and Heart-Rate Sensor. It also shows that Arduino device was connected to a group of vital signs sensors (temperature sensor and the heart sensor) which forms a sensor network connected via wireless devices (GSM, Bluetooth); where the sensors collect data to the Arduino unit, which in turn transmits it wirelessly to the smartphone.

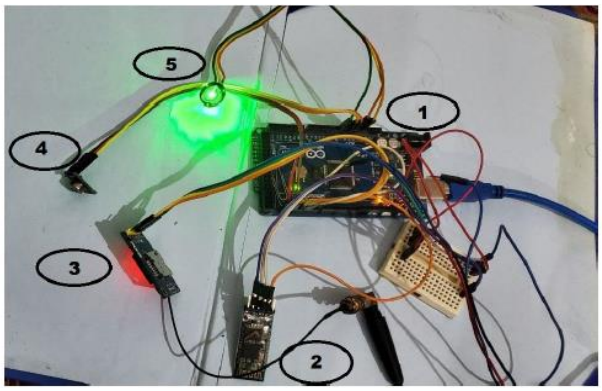

Figure 4:Circuit Schematic

Figure 5 shows the interface principle between GSM and Arduino is shown in the flow chart.

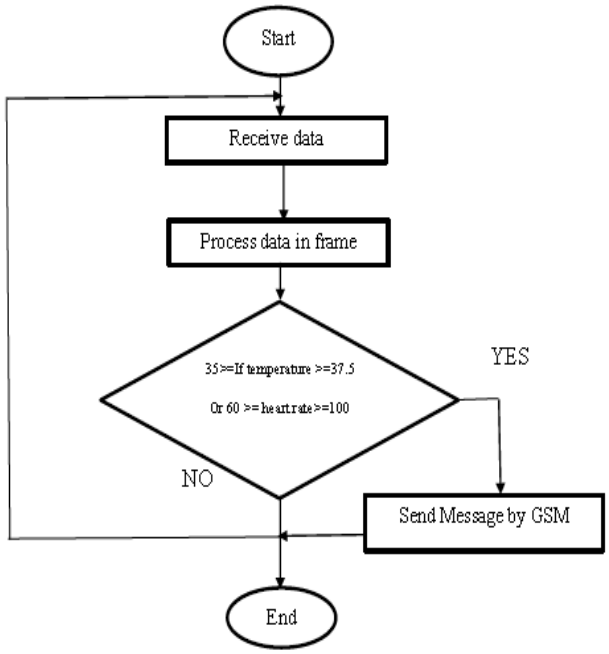

Figure 5: GSM interface

The interface is done between Arduino and GSM, when temperature or heart rate exceed the normal level which specified for experiment purpose in the range from 35 to 37.5, and 60 to 100 for temperature and heart rate respectively. The following code governed the temperature principle.

```
void max1(){
c= mlx.readObjectTempC();
f= mlx.readAmbientTempF()
void test_value(float temp,int bpm){
if(temp>37.5){send_alarm();}
if(temp<=35.5){de=0;
```

Similarly the following code used to control the operation of heart rate sensor.

```
void heart(){
int result=pulseSensor.getBeatsPerMinute(); // Calls
function on our pulseSensor object that returns BPM
as an "int".
myBPM=result;
if(myBPM<0){myBPM=-1*myBPM;}
}
void test_value(float temp,int bpm){
if(bpm>=100){send_alarm();}
if(bpm<=60){de=0;
```

The algorithm of real time interfacing of Bluetooth and Arduino is shown in Fig 6. The flow chart illustrates that Arduino is continuously connected to Bluetooth in order to receive and transmit data in real time using android application.

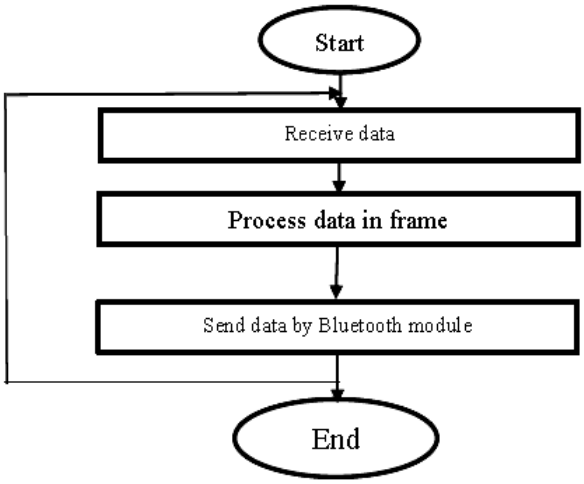

Figure 6: Bluetooth interface flow chart

The proposed system is based on the idea of monitoring via Bluetooth and GSM, the user can monitor the received data from Microcontroller via Bluetooth as shown in Figure 7.

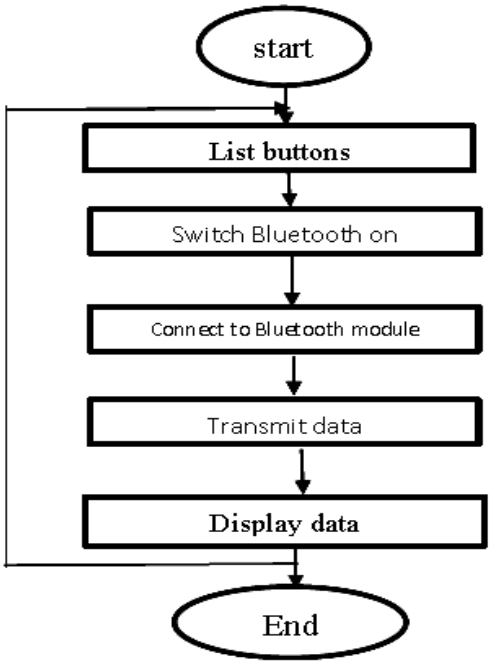

Figure 7:Bluetooth Algorithm

V. RESULTS AND DISCUSSION

This section of the paper discussed the monitoring results of the received data from the sensors. In this section; it has been clearly shown how the proposed system works in each operating case . The types of sensors that used in this system were Thermometer Sensor MLX90614 and Heart-Rate Sensor (XD-85C).

A. Results of Heart-Rate Sensor

Small size of Ear Clip can be used to fix the heart rate sensor DX-85C which connected to Arduino. Three types of displaying the collected results of the sensors, the application screen on the interface program, the interface application and GSM massage, the normal value of heart

rate differ in each type for experiment reason. Figure 8. Illustrates the results on the program interface screen when the sensor measured low pulse. For experiment purpose the pulse rate has been adjusted above 97 to represent the low pulse rate.

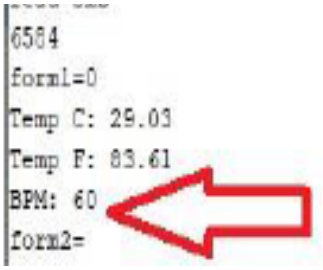

Figure 8: Low pulse rate on the program interface screen

In the case of high pulse rate; the measured values are uploaded to the program screen as shown in Fig 9.

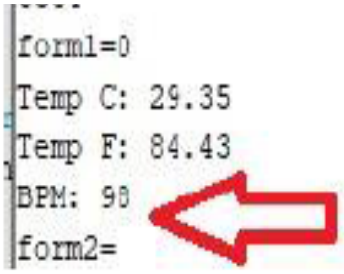

Figure 9: High Pulse rate on program screen

The results in the case of low and high pulse rate via Bluetooth were displayed via android application as shown in Figure 10 for high rate and Figure 11 for low rate.

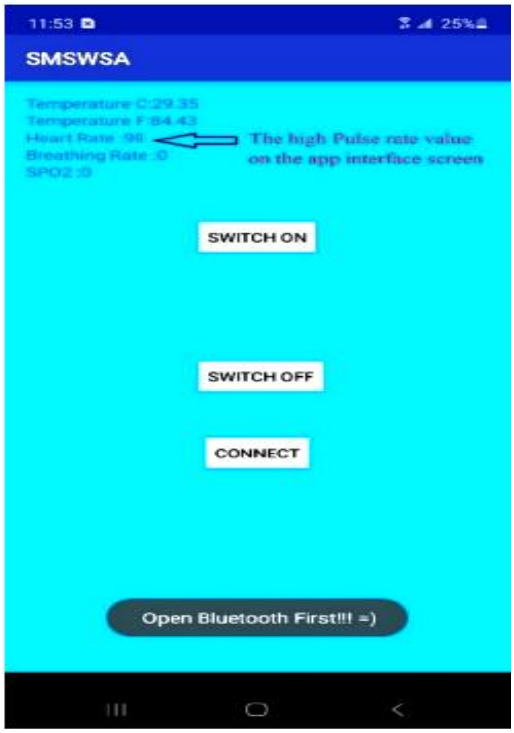

Figure 10: High Pulse rate on the app interface screen

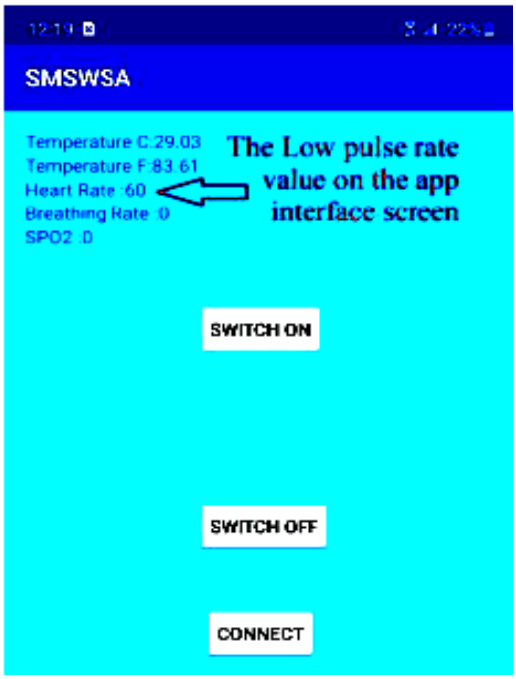

Figure 11: Low Pulse rate on the app interface screen

Similarly the Figure 12. Illustrates the GSM massage of low heart rate when the pulse rate drops of 70 selected for experiment purpose.

Figure 12: Low heart rate value on mobile by GSM

When the pulse rate exceeds 97 (selected as the normal level), the system sends a message containing the digital value of pulse rate to the mobile phone via GSM as text message. The massage as shown in Fig 13 alert that there is high rate case.

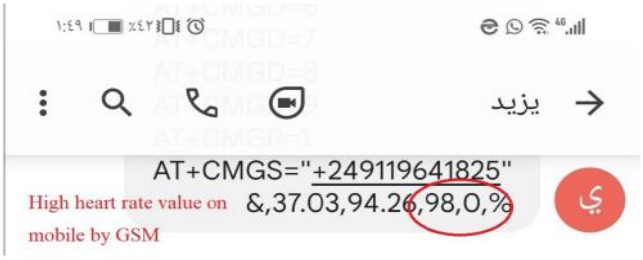

Figure 13: High heart rate results via GSM

*B. **Results of Thermometer Sensor (MLX90614)***

The MLX90614 contactless sensor therefore it can placed in any convenient place in the smart mask. As shown in Figure 14 ,when the temperature exceeds of 37.5 (the

normal limit), the system sends a message containing the temperature measurement to the mobile phone via GSM by text message.

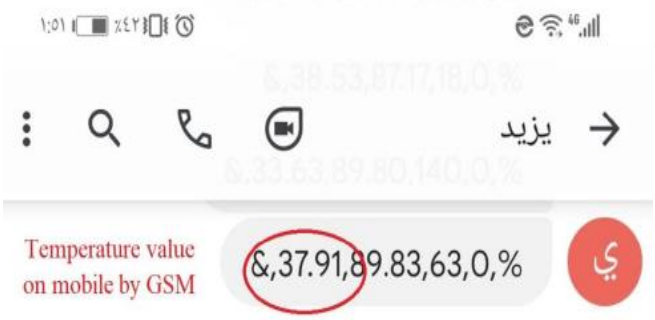

Figure 14: High Temperature value on mobile by GSM

Figure15 illustrates the GSM massage which had been sent , when the measured temperature drops of 35 which was selected as normal level for experiment purpose.

Figure 15: Low Temperature in GSM massage

Similarly the low level result displayed in the program screen as shown in Figure 16.

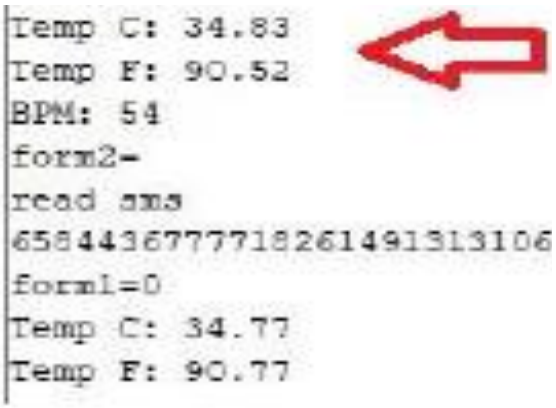

Figure 16: Low Temperature on the program screen

The program interface screen results for high temperature measured by the thermometer sensor is shown in Figure 17

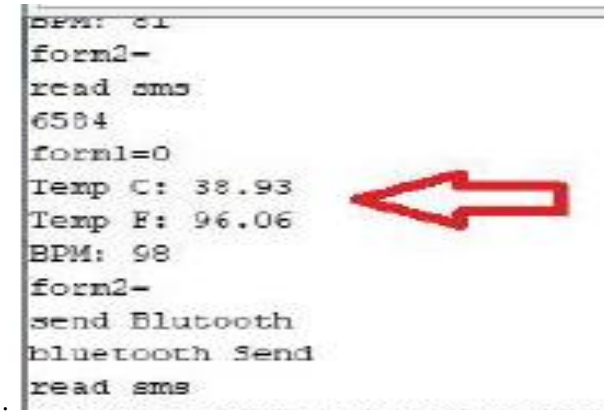

Figure 17: The low temperature on the program screen

The results of the thermometer sensor also had been monitored via android application using Bluetooth technology. Figure 18 illustrates the results on the android application when the temperature was below the specified normal level of temperature.

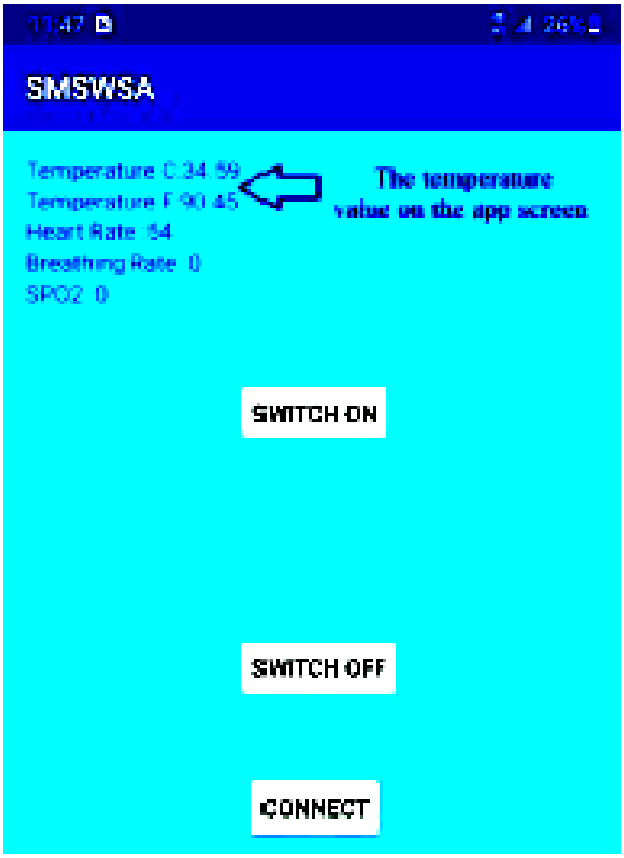

Figure 18: Low temperature on the app screen

Figure 19 illustrates the results on the android application when the temperature was above the specified normal level of temperature.

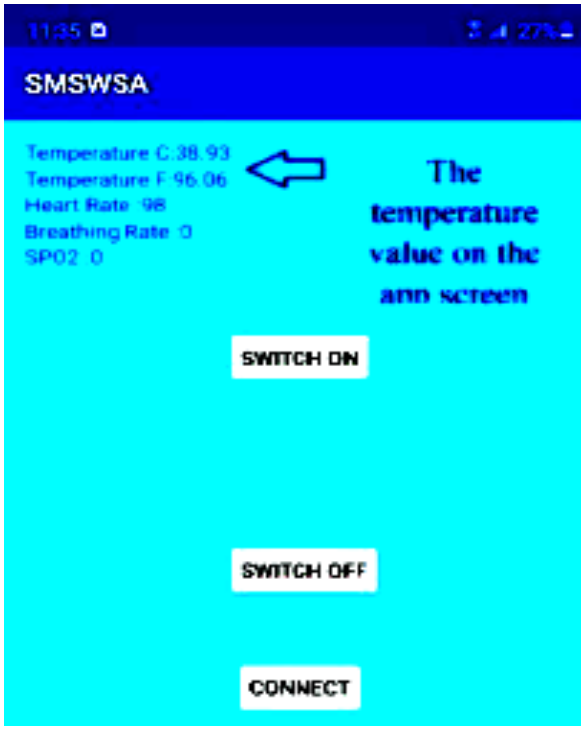

Figure 19: High temperature on the app screen

VI. CONCLUSION AND FUTURE SCOPE

The design in this paper used the modern electronic technology such as advanced sensors and wireless technology such as GSM and Bluetooth to construct smart face mask, this smart mask can be used for early detecting of many diseases such as COVID-19. Therefore it contributes in the efforts of fighting the fast spread of COVID-19. The results investigated different operating cases. As shown the overall results proved that the system able to achieve the required goals .In future the design can used smaller Arduino board such as Nano Arduino to minimize the size of the electronic face mask.

ACKNOWLEDGMENT

This research work was done under supervision of Alnour college of science and technology.

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AUTHORS PROFILE

Mr. Mortada.M.Abdelewahab, has Ph.D in Electronics Engineering, Sudan academy of science and technology in 2014. He is currently working as Associated Professor in Department of Electronics Engineering, university of Gezira. He has published more than 28 research papers in reputed international journals and conferences including IEEE. His main research works focuses on Cryptography Algorithms Embedded on FPGA, Electronics design of monitoring and controlling using wireless sensors networks. He has a teaching experience of 13 years and 10 years of research experience.

Khalid.H.Ahmed, Hamza .M. Al-mehrabi , Mohammed .A. Alkateb ,Yazid .A. Al-mezgagi and Jwher .Y. Al-rashdi are young researchers they have BSc degree from Alnour college of science and Technology in 2021.

