

# IOT BASED HEALTH MONITORING SYSTEM USING ARDUINO UNO, GSM SIM900D MODULE AND WIFI MODULE ESP8266

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**Abstract**—The health related problems especially in remote area of Pakistan is one of the major issue. This deadlock issue has created the tremendous resistances to control the health related diseases. As it is the evident that the remote areas are devoid from hospitals. It is not easy to visit hospitals in big cities due to travelling, manpower, and cost issues. Such health related issues can be reduced to a certain limits by introducing and implementing a sophisticated patient health monitoring system based on internet of things. In this paper we have proposed such a patient monitoring system which is practically easy to implement and cost effective as well. The IOT based Health Monitoring system is atomized system consist of different modules to monitor various types of test parameters such as temperature, heart beats, blood pressure, Electrocardiography. The major modules of proposed system are GSM module, WiFi module, temperature sensor module, heart beat sensor sensing module, blood pressure sensor module and ECG sensor. These sensors collect necessary diagnostic test information and that is transferred to the concerned doctor through Wifi module. This paper presents both proposed design of the patient management system and which is validated by the simulation results and the hardware prototype.

**Key words**— Electrocardiogram, ESP8266 WIFI module, GSM sim900D module.

## I. INTRODUCTION

Happiness and prosperity is proportional to the health of person. No happiness can be achieved without health. Health is necessary in order to live more happily. But at other hand, health related diseases increases day by day with the development and advancement of science and technology. Science and technology is in search to control health related diseases. Being electrical engineer, we are also trying to control the health related diseases such as heart related diseases, brain related diseases and body temperature related diseases by designing health monitoring system. Here in this research IOT based health monitoring system is designed in order to monitor the activity of heart with help of ECG sensor [1-2], to monitor heart beats of person by using heart beats sensor [1] and to monitor the temperature of the body by using temperature sensor [1]. The health monitoring system can prove more beneficial for the people far away from cities and living in villages. These people cannot reach to the hospital in proper time to save the life of patient. By designing such type of system along with SMS alert and WIFI alert modules, one can easily save the life of patient by connecting the IOT based health monitoring system with body of patient and doctor can easily diagnosed the patient online through internet and SMS. A Doctor can diagnose the patient by providing online prescription according to the health condition in order to hospitalize the patient on time if required so that

the risk of losing life of patient can be minimized. IOT based health monitoring system consist of different modules such as temperature sensor, heart beats sensor, ECG monitoring module, GSM module, WIFI module, and Arduino UNO module [1-2]. The temperature sensor of IOT based health monitoring system is LM35 IC. It has three pin IC and it can operate with 5V DC. The temperature sensor is connected with Arduino UNO module in order to sense the temperature of human body. The range of temperature of the LM35 is programmed in arduino UNO. The heart beats sensor is a tiny chip with four pins. It is also connected with arduino UNO to monitor the pulses of heart in form beats. Electrocardiograph module is a chip that can be connected with arduino UNO in order to monitor the electrocardiogram of patient. This research paper consists of five sections. First section deals with LM35 temperature sensor, second section deals with heart beats sensor, third section deals with Blood pressure module, fourth section deals with Electrocardiograph module and fifth section deals with GSM and WIFI module.

## II. TEMPERATURE SENSOR

The hotness or coldness of the human body is called human body temperature. The instrument that can sense the human body temperature is called temperature sensor. The human body temperature can be measured with help of the following instruments.

- i. Clinical thermometer
- ii. Infrared thermometer
- iii. LM35 temperature sensor

There are different way to measure the temperature of human body by using clinical thermometer.

- i. Auxiliary temperature
- ii. Tympanic temperature
- iii. Rectal temperature
- iv. Oral temperature
- v. Temporal artery temperature

The more common method in order to measure the human body temperature is oral temperature technique. Thermometer is placed in mouth in oral temperature technique. But the technique can cause serious disease such as AIDS, Hepatitis, cold sore, mononucleosis. In order to reduce the chances of such types of diseases, engineering and technology

designed a new type of temperature measuring device, named as LM 35 Temperature sensor. LM 35 temperature sensor is more beneficial and advantageous than that of clinical thermometer and infrared thermometer. It is because of the fact that it can be used to measure the temperature of human body through temporal artery temperature technique. The LM 35 temperature sensor probes are placed on the surface of temporal artery, located in forehead. LM 35 temperature sensing technique is free of the infectious diseases transfer through saliva. More importantly, LM35 temperature sensor can measure the temperature of human body more accurate than that of thermometer and infrared thermometer. Because infrared thermometer can work without any physical contact. The value measured with help of it can fluctuate with the environmental temperature. That is why LM35 temperature sensor is more beneficial than that of infrared thermometer. LM35 temperature sensor is also GSM alert and internet alert. Doctors can analyze the report of body temperature of patient through SMS and internet. LM35 temperature sensor is composed of two transistors, two OPAMPs and four resistors. All these components are packed in small tiny package with the three pins.

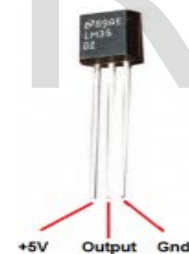


Figure (1.1) LM35 Temperature sensor with pin configuration.

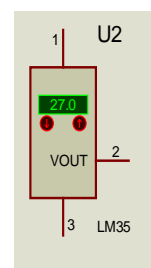


Figure (1.2): Block diagram of LM35 Temperature sensor.

One OPAMP is connected with base of the transistors and compare the temperature of base of the both transistor. The other OPAMP is connected with emitter of the transistor and convert the temperature into Celsius temperature or Fahrenheit temperature

depending the serial number of sensor. Here in this research, LM35 is connected with Arduino UNO in order to measure the temperature of human body and show the result on internet and through SMS. The Proteus simulation of the temperate sensor is given in figure 1.3 and 1.4.

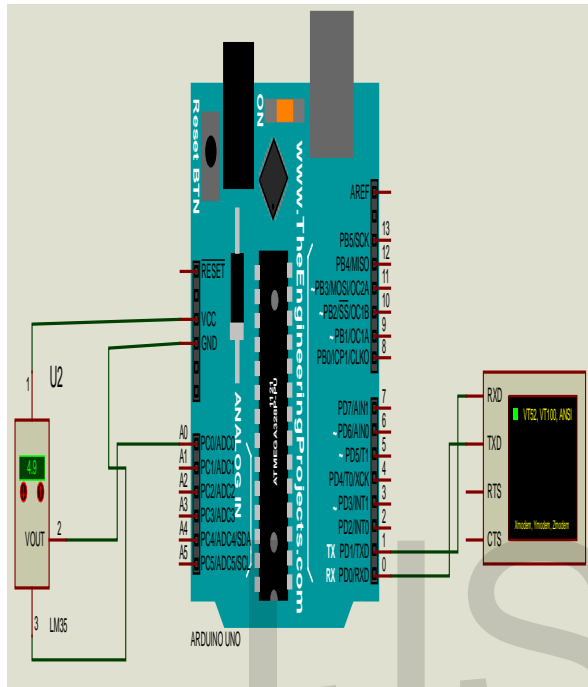


Figure (1.3): Proteus simulation of LM35 sensor using Arduino UNO and virtual terminal.

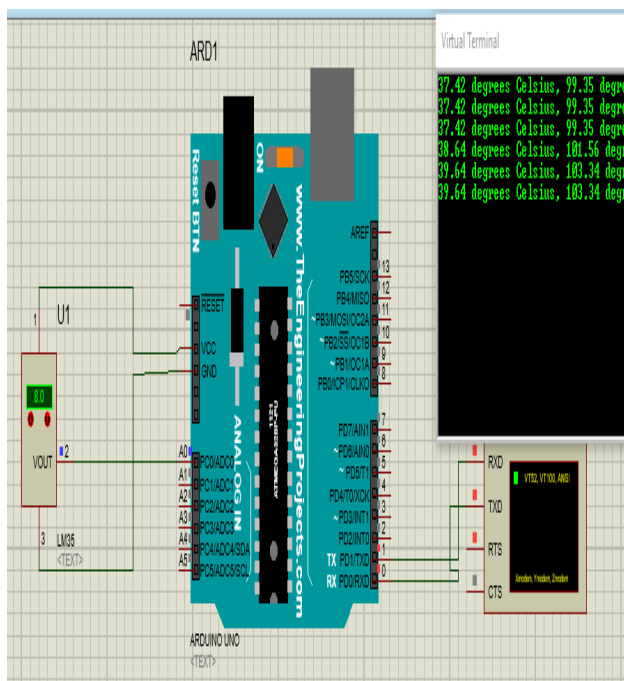


Figure (1.4): Output result of LM35 with Arduino UNO.

### III. HEAT BEAT SENSOR

Heart beat is the rate of the contraction of heart per minute. The unit of heart beat is bpm. The normal heart beat of human being is called sinus rhythm. The sinus rhythm is from 50bpm to 90 bpm depending upon the physical needs and activities of the body. The heart rhythm is the exchange of sodium and potassium ions. The sodium and potassium ions can be change with various factor such as hyponatremia (low sodium ions concentration), hypokalemia (low potassium ions concentration), hypothermia (low body temperature), hypoxia (low oxygen supply to the body) and acidosis (low PH value with high concentration of hydrogen ions). These mentioned factor can cause the heart rhythm. Heart beat rhythm should count in order to protect the human beings from the mentioned factors. The heart rate can be measured with help of wrist heart beat monitor and heart beat sensor. Heart beat sensor is device that is used to measure the heart rhythm of human body. Heart beat can be measured in any part of the body such as index of fore finger, wrist of hand, neck, elbow and toes of feet. But here in this research, heart beat can be measured with apex of forefinger. The Proteus simulation of heart beat sensor has been given in figure 1.5.

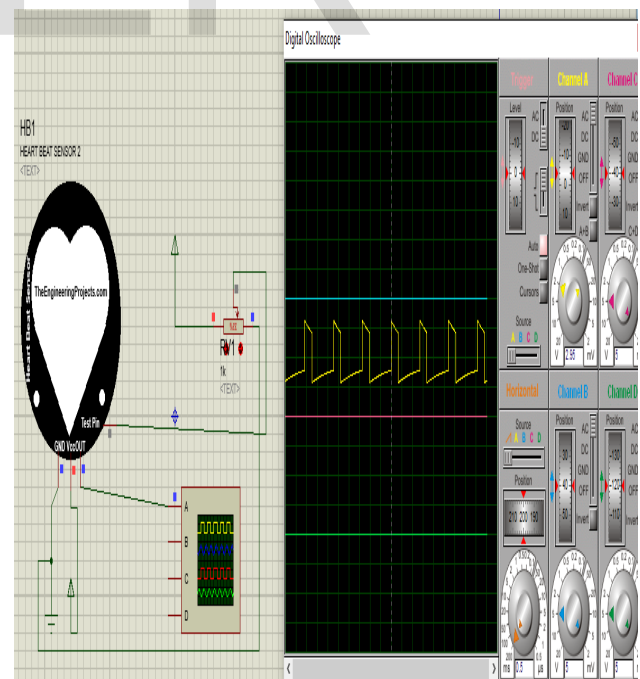


Figure (1.5): Proteus simulation of heart beat using oscilloscope and heart beat sensor 2.

In figure 1.5 the waveform consist of ones and zeros. Ones represent the dub of heart while zeros represent the hub of heart. During dub heart pumps blood to the body while during hub heart receive blood from the body. Dub sound represent systolic and hub sound represent diastolic of the heart. The hub sound is long, soft and low pitch while the dub sounds is short, sharp and high pitch. The heart beat sensor used in this research paper is small and tiny chip. It is operated with 5 volt DC and it can be connected with GSM module and arduino in order to shows the result of heart beat of a person via SMS and internet.

#### IV. BLOOD PRESSURE MODULE

The blood pressure module of IOT based health monitoring system, monitor the blood pressure of human by wearing the module at wrest of left hand. The blood pressure can be easily monitor with help of blood pressure module. It is better than the sphygmomanometer. Because it is has a vacuum pump that can be pressed by itself according to the coding coded in arduino UNO. It also does not required stethoscope. The result it give is also more accurate and more efficient. The blood pressure is shown in figure 1.6.



Figure 1.6: Blood pressure module

#### V. ELECTROCARDIOGRAPH

The electrocardiograph is a device (machine) used to record the electrical activities of heart. Heart pumps blood to the rest of the body through vein and arteries. Pumping of heart depend upon the exchange of sodium and potassium ions. The exchange produce small electric current through the body. ECG sensor record the current due to sodium and potassium ions.

The waveform recorded by ECG sensor is called electrocardiogram. The electrocardiogram consist of horizontal axis and vertical axis. The horizontal axis represent time while vertical axis represent amplitude of the electrocardiogram. It is usually plotted on ECG paper. The 1mm represent 0.02second on horizontal axis while 1mm represent 0.5mv on y-axis. The waveform of ECG is consist of “P wave”, “Q wave”, “R wave”, “S wave” and “T wave”. “p” wave is positive wave and it is also called “atrial complexes”. “Q wave is small negative wave” and it is continue until “R wave” begin while “R wave” continue until “S wave” begin. All the three waves form “QRS” complex. “QRS” is also called initial ventricular complex. “T wave” is called final ventricular complex. It is a positive wave. Electrocardiograph consist of three leads. The leads of electrocardiogram should be placed on the surface of body in order to record the electrocardiogram. These leads are placed on left arm, right arm and left leg in order to record the electrocardiogram. The ECG sensor used in this research consist of arduino UNO, ECG module (AD8232), ECG electrodes along with contactors, power supply and connecting wires. AD 823 is a small module which can operate with 3.3 volt DC. It consist of 9 pins which are LO<sup>+</sup>, LO<sup>-</sup>, output pin, 3.3V pin, ground pin, SDN, RA pin, LA pin and LL pin. LO<sup>+</sup> is connected with the 10 Pin of arduino UNO, LO<sup>-</sup> is connected with 11 pin of arduino UNO, output pin is connected with analog 1 (A1) pin of arduino UNO, 3.3V pin is connected with Vcc of arduino UNO, ground pin is connected with ground of arduino, RA pin is connected with the with right arm electrode, LA is connected with left arm electrode and LL is connected with the left leg electrode.



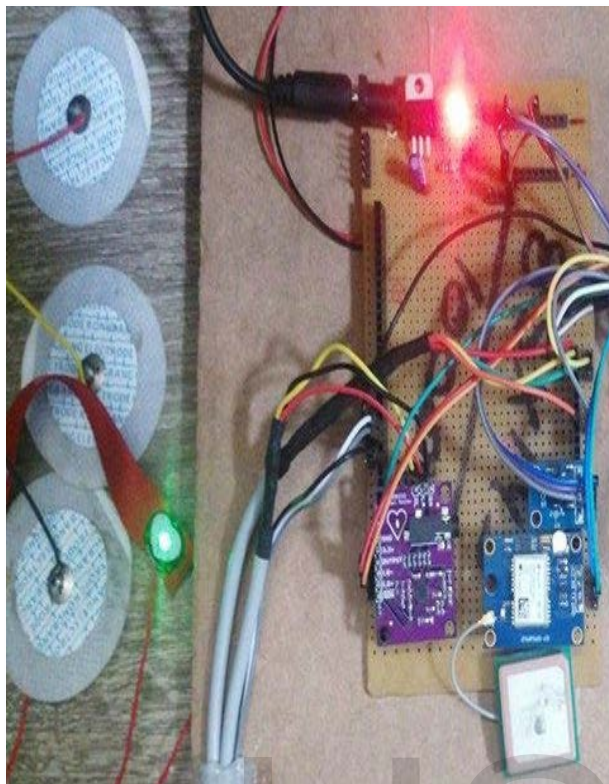


Figure (1.6): ECG module (AD8232) along with Arduino UNO.

## VI. GSM MODULE

Group special mobile is a network to which cellular phones are connected in order to transfer information. The information sent by GSM are quick and immediate with more accuracy. Here in this research the GSM sim900 module is used. The GSM 900 is operated with 900MHz frequency band. The GSM sim900 has a port of subscriber identity module card (SIM card). The SIM has memory which is non-Volatile. When the SIM card is inserted in the port then it is connected with other cellular phones for transferring of information. The SIM consist of international mobile subscriber identity (ISMI) number. ISMI number is used by GSM module to identify the subscriber. ISMI number does not exceed than 15 digits. The first three digits should be the mobile country code (MCC). The next two digits are the mobile network code (MNC). The remaining digits are the mobile subscriber identification number (MSIN). GSM send information in form of Alpha-Numeric text messages which is termed as Short message service (SMS). It is connected with arduino UNO to transfer information from one place to another place. It is connected with arduino UNO in order to send information of patient to concern

doctor. The GSM module consist of two pins. Pin TXD is connected with RXD of arduino UNO and RXD is connected with TXD of arduino. As shown in figure 1.8.

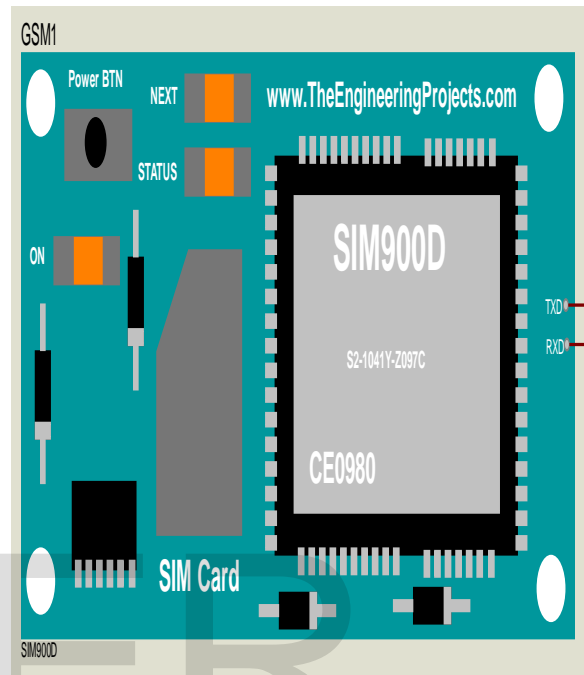


Figure (1.7): the block diagram of GSM SIM 9600D.

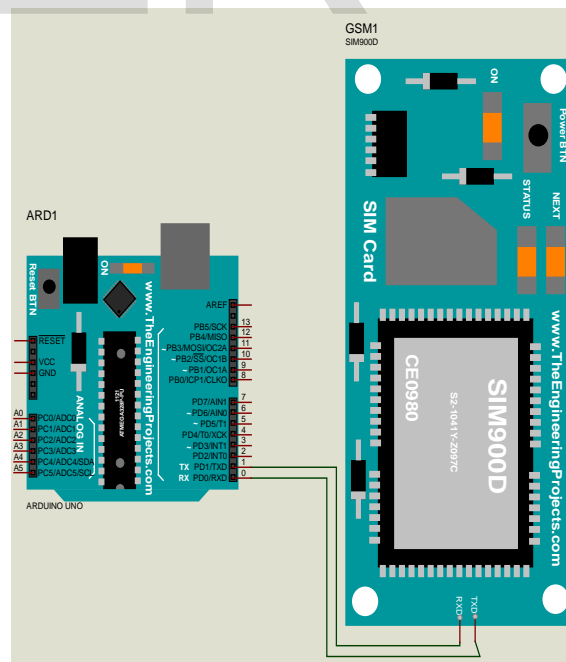


Figure (1.8): connection diagram of arduino UNO with GSM sim900.

## VII. ESP8266 WIFI MODULE

ESP WIFI module consist of eight (8) pins. The pins are divided into two rows. The pins of WIFI module are Ground pin, RX pin, TX pin VCC pin Reset pin and enable pin. The ESP8266 is work on 3.3 or less voltage otherwise it will blast and burnout. ESP8266 WIFI module should be enabled before using it. Enable pin is connected with 3.3V of arduino UNO and VCC of ESP8266 is also connected with 3.3V of arduino UNO. The TX of WIFI module is connected with RX of arduino UNO while RX of WIFI module is connected with TX of arduino UNO. Where TX represent transmitted signal and RX represent receiving signal. Arduino UNO and ESP8266 can communicate with other through RX and TX pins. The ESP8266 work with Attention command (AT). The different commands of ESP8266 are given in table 1 and ESP8266 WIFI module is shown in figure 1.9.

Table1: Commands of ESP8266

Command	Description	Type
AT+RST	To reset the module	Basic
AT+CWMODE	WIFI Mode	WIFI
AT+CIPMUX	Set multiple connection	TCP/IP
AT+CIPSERVER	Set as server	TCP/IP
AT + CWJAP	Join AP	WIFI

Figure 1.9: ESP8266 WIFI module

## VIII. APPLICATION OF IOT BASED HEALTH MONITORING SYSTEM

The Internet of things based health monitoring system has following applications.

- i. It can be used by doctors to monitor the temperature of the patient by reducing the chances of diseases transfer with help clinical thermometer.
- ii. It can be used to monitor the temperature of patient with more accuracy.
- iii. It can be used by patient to monitor the pluses of heart beats.
- iv. It can be used by doctor to monitor the electrocardiogram of heart patient.
- v. It does not need any electrocardiogram paper to plot the electrocardiogram because doctor can monitor it with liquid crystal display and oscilloscope.
- vi. It can be used by doctor to monitor the electroencephalogram on liquid crystal display and oscilloscope.
- vii. It can also be used by head of the ward of hospital to transfer information of patient to the concern doctor via SMS or through internet.
- viii. It can be also used by ambulance automobiles to transfer information of patient on the way to the emergency ward of concern hospital.
- ix. It can also be used by laboratory technician to monitor and diagnose the tests of concern disease.

## IX. CONCLUSION

Internet of the things has great importance, not only to monitor the health related problems but also transfer information of the patient to doctors. Internet of the things reduce the burden of doctor as well as the burden family member for the routine checkup of a patient. More importantly, it can reduce the chances of other fetal diseases spread from person to person in ward such as HBs. It can also reduce the time wasting of the patient and doctor for routine checkup.

## X. FUTURE WORK

It will be more beneficial for doctor as well as for patient to include the following features in IOT based health monitoring system.

- i. Malarial plasmodium tests.
- ii. HBs tests.
- iii. HIV tests.
- iv. Polycythemia tests
- v. Spirogram.

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