IoT Based Patient Health Observation System through SMS using GSM

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Abstract : With the miniaturization in sensors and advanced technologies there are number of procedures to use different fields to enhance the human life. IoT technology becomes a key area in designing of so many applications in health sector area. This paper is an attempt to create a solution for the patients in the society currently facing. The concepts of the Internet of Things (IoT) have been widely used to interconnect available medical resources and provide patients with intelligent, reliable and efficient health services. The main aim of this paper is to implement a system which is continuously monitors the patient health condition by the transferring of patient condition to the doctor mobile through SMS. The IOT-based patient health observation system using the GSM module works primarily to allow physicians or patient relatives to remotely check the health status of patients. The system measures the patient health parameters like heart beat and temperature of the body continuously and sends message to the doctor's registered phone number. If these parameters get worse that is exceed the certain limit then emergency alert will sent to the doctor's to save the condition immediately. To implement this system we used heart rate sensor, temperature sensor and Arduino Uno interfaced with LCD. The IoT based patient health observation system designed with a GSM to send health parameters to the doctor's registered mobile number. The system has also introduced a function through which a doctor can check the patient's condition after a certain period of time by sending a message. This system measures the accurate health parameters of the patient and eliminates the major risk factors by sending these parameters to the doctor.

Index Terms - Patient Health observation system, SMS, GSM, Pulse detector, temperature sensor.

I. INTRODUCTION

The Internet of Things is the network of physical devices, vehicles, appliances and other elements integrated into electronics, software, sensors, actuators and connectivity that enables these objects to connect and exchange data. The Internet of Things is a rapidly expanding technology that is preparing to bring the next revolution in information technology and computing. The IOT system has applications [1] in all industries thanks to its unique flexibility and suitable for any environment. It is an advanced automation and analysis system that harnesses networking, detection, Big Data and artificial intelligence technologies to provide a complete system for a product. The IOT removes repetitive tasks or creates things that simply weren't possible before, allowing more people to do repetitive work.

Telemedicine is a shame that did not start yesterday. There has been a lot of development behind this area. As in all other areas, technology plays a very important role because it reduces the burden on health officials, reduces the cost of treatment, monitoring and diagnosis of patients. Patient monitoring systems are already used in hospitals, among others. However, their costs are prohibitive and hospitals. This means that someone will always have to be there to monitor a patient in the hospital or at home. The proposed IoT based patient health observation system through SMS using GSM would benefit medical practitioners for appropriate and better treatment. It is also beneficial for parents or guardians who have been transferred from the Arduino to hospital health staff or a relative for a patient case at home.

In this paper we create an affordable prototype of heart rate and temperature monitor. It will use Arduino Atmega256, GSM module, LCD screen, temperature sensor and heart rate sensor. The Arduino is programmed to know when there is an anomaly in the parameters and also to send the signals in the form of SMS.

1.1 Boimedical Engineering

Recently, wireless sensor networks (WSN) have played a vital role in the technology and research community, which has led to the development of various high performance intelligent detection systems. A lot of new research aims to improve the quality of human life in terms of health by designing and manufacturing sensors that are either in direct contact with the human body (invasive), or indirect (non-invasive) in contact. The development of biomedical engineering is responsible for improving the diagnosis, monitoring and therapy of health care. The new idea of Health line is to provide quality health services to all. The idea is motivated by the vision of a biomedical surveillance system[2] without cables. Body sensors monitor vital parameters (blood pressure, ECG, temperature and heart rate) and transmit the data to the doctor via a wireless communication network. Periodic health monitoring (or preventive care) allows people to discover and treat health problems early, before they have consequences. Particularly for patients at risk and long-term applications, such technology offers more freedom, comfort and opportunities in clinical monitoring.

1.2 Use of Vital Signals in health analysis

Chronic disease has a significant influence on health care where the cost of healing chance of attack is common among people. The changing demographic structure and the shortage of health and social protection personnel force us to study new innovations, which could more than relieve these challenges. Elderly people should visit their doctor frequently to measure their vital signals. Regular monitoring of vital signals is essential because they are the main indicators of an individual's physical well-being. These vital signals include the pulse and body temperature. The goal is to develop a low cost, low power, reliable, non-intrusive and non-invasive vital signal monitor that collects different body types and the sampled parameters are wireless. data detection and conditioning system to acquire accurate readings of heart rate, ECG, blood pressure and body temperature. After processing the data, we need to find an appropriate method of signal transmission and display. Remote Patient Monitoring (RPM) is a technology for monitoring patients outside of conventional clinical settings (for example, at home), which can increase access to care and reduce the costs of providing health care.

1.3 Remote Patient Monitoring

Integrating RPM into chronic disease management can significantly improve an individual's quality of life. It allows patients to maintain their independence, prevent complications and minimize personal costs. RPM facilitates these goals by providing home care. In addition, patients and family members feel comfortable knowing that they are being monitored and will be supported if a problem arises. This is particularly important when patients are managing complex self-care processes such as home dialysis. Physiological data such as blood pressure and subjective patient data are collected by sensors on devices. Examples of peripheral devices: blood pressure cuff, pulse oximeter and glucometer. The data is transmitted to healthcare providers or third parties via wireless telecommunications devices. Data is evaluated for potential problems by a healthcare professional or via a clinical decision support algorithm, and the patient, caregivers, and healthcare providers are immediately alerted if a problem is detected.

1.4 Gathering of Sensor Signals

The pulse is the rate at which our heart beats. Our pulse is usually called our heart rate, which is the number of heart beats per minute (BPM). But the rhythm and strength of the heartbeat can also be noted, as well as whether the blood vessel is hard or soft. When our heart pumps blood into our body, we can feel a pulse in some of the blood vessels near the surface of the skin, such as our wrist, neck, or upper arm. Counting our pulse is a simple way to know how fast our heart is beating. The normal core body temperature of a healthy, resting adult human would be 98.6 degrees Fahrenheit or 37.0 degrees Celsius. Although the body temperature measured on an individual can vary, a healthy human body can maintain a fairly constant body temperature which is around the mark of 37.0 degrees Celsius. The normal temperature range of the human body varies due to an individual's metabolic rate; the higher (faster) it is, the higher the normal body temperature or the slower the metabolic rate, the lower the normal body temperature. Body temperature also varies across different parts of the body. Oral temperatures, which are the most practical type of temperature measurement, are 37.0 ° C. It is the longest and most inaccurate way to measure body temperature, the normal temperature drops to 97.6 ° F or 36.4 ° C. Temperatures are an internal measurement taken in the rectum, which drops to 99 , 6 ° F or 37.6 ° C. This is the shortest and most accurate type of body temperature measurement, being an internal measurement. But it is certainly not by far the most comfortable method of measuring body temperature.

II. Existing System

Many existing real-time health monitoring systems generally use an ATMEL 89C51 microcontroller (μc 8051). The microcontroller-controlled system essentially contains four parts, namely the process, the analog-to-digital converter, the control algorithm and the clock. The moments when the measured signals are converted into digital form are called the sampling instants; the time between successive samplings is called the sampling period and is noted h. The output of the process is a continuous time signal. The output is converted to digital form by the A - D converter. The conversion is done at the sampling times.

Some of the existing systems for temperature and pulse monitoring generally use an ATMEL 89C51 microcontroller (μc 8051). Due to the use of the 8051 microcontroller, the process of manufacturing an entire device becomes not only very complex, but also difficult and tedious. For operation, it requires an A-D converter, an external clock, a microcontroller development board.

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III. Proposed System

The proposed system is a design of an IOT-based patient health observation system through SMS using GSM and Arduino. As the objective of this system, we see a device that can detect diseases in a patient and inform them of the medical personnel concerned, without the intervention of the patient himself. This process is carried out using GSM technology. GSM technology is used to read and send SMS to the person concerned. The Arduino that runs through the device implements the various features of the system such as reading the sensor data, converting them into chains, transmitting them to the LCD screen and displaying the measured pulse rate and temperature on the GSM character module to send a message to the doctor.

The proposed system includes a microcontroller, a heart rate sensor, a temperature sensor, a regulated power supply, an LCD screen. The heart rate and temperature sensor are connected to the microcontroller via port pins. The heart rate is produced from the temperature rate of the LM 358 operational amplifier produced by LM35 and sent to the microcontroller. An LCD screen is used to display the detected data. The GSM modem is used to send messages from the patient to a doctor. Whenever the heart rate or BP exceeds the threshold value the microcontroller will automatically send the signals to the GSM modem. From the GSM modem, the message will be delivered to the person concerned or to a doctor. The LCD screen is used to continuously display the status of the GSM modem as well as the heart rate.

3.1 System Architecture

The IOT-based patient health observation system through SMS using GSM and Arduino is shown in Fig 1. A device that can detect diseases in a patient and inform them of the medical personnel concerned, without the intervention of the patient himself. This process is carried out using GSM technology. GSM technology is used to read and send SMS to the person concerned. The global mobile communication system (GSM) is a globally accepted standard for digital cellular communication. The Arduino Uno that runs through the device implements the various features of the project such as reading the sensor data, converting them into chains, transmitting them to the LCD screen and displaying the measured pulse rate and temperature. on the GSM character module to send a message to the doctor.

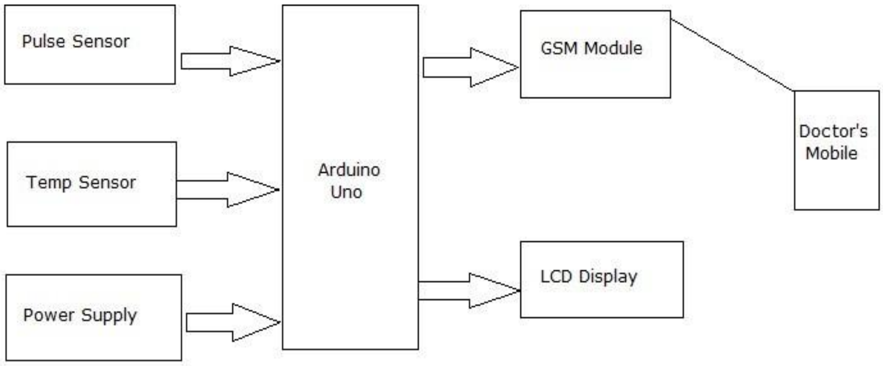

Fig 1. Functional Diagram

The functional diagram includes a microcontroller, a heart rate sensor, a temperature sensor, a regulated power supply, an LCD screen. The heart rate and temperature sensor are connected to the microcontroller via port pins. The heart rate is produced from the temperature rate of the LM358 op-amp produced by LM35 is sent to the microcontroller. An LCD screen is used to display the detected data. The GSM modem is used to send and receive messages from the patient to a doctor and vice versa.

Whenever the heart rate or BP exceeds the threshold value.The microcontroller will automatically send the signals to the GSM modem. Thanks to the GSM modem, the message will be delivered to the person concerned or to a doctor. The LCD screen is used to continuously display the status of the GSM modem as well as the heart rate.

Arduino Uno:

Arduino is an open source platform used [3] for the construction of electronic projects. Arduino consists of both a physical circuit board (often called a microcontroller) and software, or IDE (Integrated Development Environment) that runs on our computer, used to write and download computer code to the physical map.

The Arduino platform has become very popular with people new to electronics, and for good reason. Unlike most previous programmable PCBs, the Arduino doesn't need separate hardware (called a programmer) to load a new code onto the card - we can just use a USB cable. In addition, the Arduino IDE uses a simplified version of C, which makes it easier to learn programming. Finally, Arduino provides a standard form factor that breaks down the functions of the microcontroller into a more accessible package. The real Arduino board is shown in Fig 2.

Fig 2. Arduino Uno Board

GSM Modem:

The GSM / GPRS-RS232 modem shown in Fig 3, is built with a dual band GSM / GPRS motor - SIM900A, operates on the frequencies 900/1800 MHz. The modem comes with an RS232 interface, which allows us to connect a PC as well as a microcontroller with an RS232 chip (MAX232). The baud rate is configurable from 9600 to 115200 via the AT command. The GSM / GPRS modem has an internal TCP / IP stack to allow us to connect to the Internet via GPRS. It is suitable for SMS, voice and data transfer applications in the M2M interface. The integrated regulated power supply allows us to connect a wide range unregulated power supply. Using this modem, we can make audio calls, SMS, read SMS, attend incoming calls and Internet ect via simple AT commands.

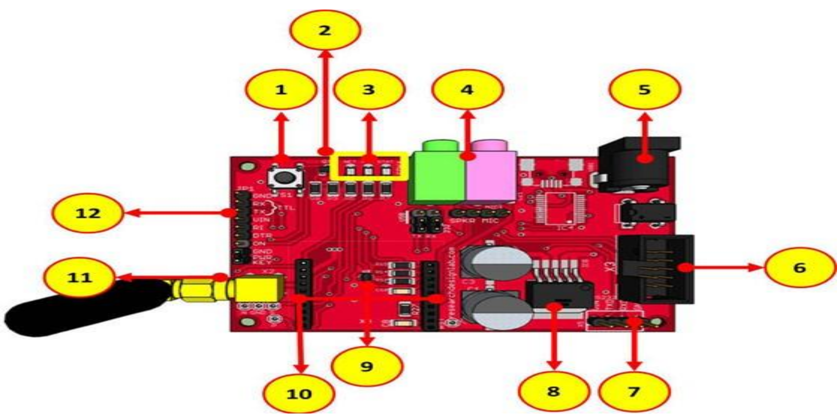

Fig 3. GSM Modem

Pulse Sensor:

Optical heart rate monitors are easy to understand in theory. If we have already pointed a flashlight through the tips of our fingers and seen our heart rate (something most children have done), we have a good idea of optical pulse sensor theory. In an optical pulse sensor, light is projected into the fingertip or the earlobe. Light bounces off a light sensor or is absorbed by blood cells. As we continue to make the light shine (say with your fingertips) and take light sensor readings, we quickly start to get a heart rate reading.

Fig 4. Pulse Sensor

The theory is easy to understand. In practice, it is difficult to master DIY optical heart rate sensors, or to make them operational at all. There are many tutorials online and in publications describing how to make DIY heart rate sensors. Due to our personal interests, we have tried to follow the guides online, but have generally failed or obtained unsatisfactory results. As teachers, year after year, we find that our students try to follow these published guides and fail to operate anything, or get poor results. It could very well be a human / user error on our parts. But from our perspective, making an optical pulse sensor is easier said than done. So we decided to create our own optical pulse sensor [4] that can be used in our own creative ideas and also available for students, creators, game developers, mobile developers, artists, sports trainers, etc.

IC LM35 Temperature Sensor:

The LM35 is a popular and inexpensive temperature sensor shown in Fig 5. It provides an output voltage of 10.0 mV for each centigrade degree of temperature from a reference voltage. The output of this device can be sent to the A / D converter; any microcontroller can be interfaced with any A / D converter to read and display the output of the LM35. The circuit must be designed so that the output is 0 V when the temperature is 0 degrees Celsius and rises to 1000 mV or 1 V to 100 degrees Celsius. To get the temperature value accurately, the output voltage must be multiplied by 100. For example, if we read 0.50 V, it would be 50 degrees centigrade.

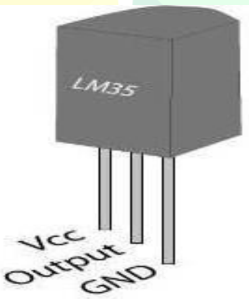

Fig 5. IC LM35Temperature Sensor

The LM35 series are precision integrated circuit temperature devices with an output voltage linearly proportional to the centigrade temperature. The LM35 device has an advantage over linear temperature sensors [5]calibrated in Kelvin, because the user is not required to subtract a high constant voltage from the output to obtain a practical centigrade scaling. The LM35 device does not require any external calibration or adjustment to provide typical accuracies of ± ¼ ° C at room temperature and ± ¾ ° C over a temperature range of −55 ° C to 150 ° C. Lower cost is assured by trimming and calibrating at the wafer level. The low output impedance, linear output and precise inherent calibration of the LM35 device facilitate interfacing with read or control circuits. The device is used with 2-application power supplies or with plus and minus power supplies. As the LM35 device consumes only 60 µA from the power supply, it has very little self-heating below 0.1 ° C in calm air. The LM35 device is designed to operate over a temperature range of -55 ° C to 150 ° C, while the LM35C device is designed to operate over a range of -40 ° C to 110 ° C (-10 ° with improved accuracy) . LM35 series devices are available in sealed TO transistor housings, while LM35C, LM35CA and LM35D devices are available in plastic TO-92 transistor housing.

Liquid Crystal Display:

LCD modules are commonly used in most integrated projects, the reason being their inexpensive price, availability and ease of programming is shown in Fig 6. Most of us would have come across these screens in our daily lives, either at PCO or on calculators. The appearance and pins have already been visualized above now, let us be a little technical. LCD 16 × 2 is so named because; it has 16 columns and 2 rows. There are many combinations available such as 8 × 1, 8 × 2, 10 × 2, 16 × 1, etc., but the most used is the 16 × 2 LCD screen. So it will have (16 × 2 = 32) 32 characters in total and each character will be 5 × 8 pixels. Now we know that each character has (5 × 8 = 40) 40 pixels and for 32 characters we will have (32 × 40) 1280 pixels. In addition, the LCD screen must also be informed about the position of the pixels. Therefore, it will be a daunting task to manage everything using the MCU, hence the use of an interface IC like HD44780, which is mounted on the back of the LCD module itself. The function of this CI is to obtain commands and data from the MCU and process them to display meaningful information on our LCD screen[6]. You can learn how to interface an LCD screen using the links mentioned above. If you are an advanced programmer and want to create your own library to interface your microcontroller with this LCD module, you should understand that the CI HD44780 works and the commands that can be found in its technical sheet.

Fig 6. Liquid Crystal Display

IV. METHODOLOGY

4.1 Working of a heart beat sensor:

The basic heart rate sensor consists of a light emitting diode and a detector such as a light sensing resistor or a photodiode. Heartbeats cause a variation in blood flow to different regions of the body. When a tissue is illuminated by the light source, i.e. the light emitted by the LED, it reflects (a finger tissue) or transmits light (ear lobe). Part of the light is absorbed by the blood and the transmitted or reflected light is received by the light detector. The amount of light absorbed depends on the blood volume in this tissue. The detector [7]output is in the form of an electrical signal and is proportional to the heart rate. This signal is actually a DC signal relating to tissue and blood volume and the AC component synchronous with the heart rate and caused by pulsatile changes in arterial blood volume is superimposed on the DC signal. Thus, the main requirement is to isolate this AC component because it is of primary importance. The internal circuit of Pulse sensor is shown in Fig 7.

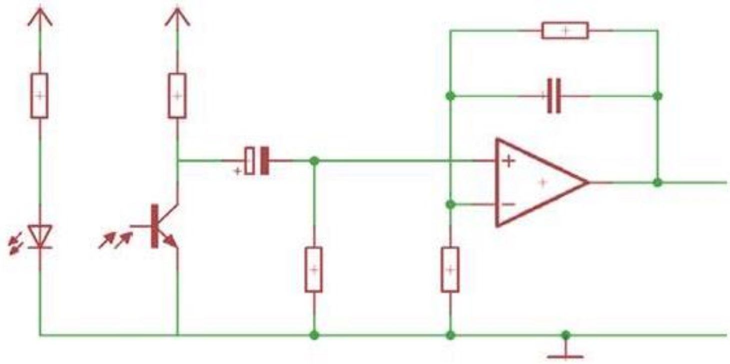

Fig 7.Internal circuit of Pulse Sensor

To obtain the task to get the alternating signal, the detector output is first filtered using a 2-stage HP-LP circuit, then is converted into digital pulses using a comparator circuit. or using a simple CAN. The digital pulses are given to a microcontroller to calculate the rate of heat, given by the formula: BPM (beats per minute) = 60 * f; where f is the pulse frequency.

4.2 Woking of Temperature Sensor:

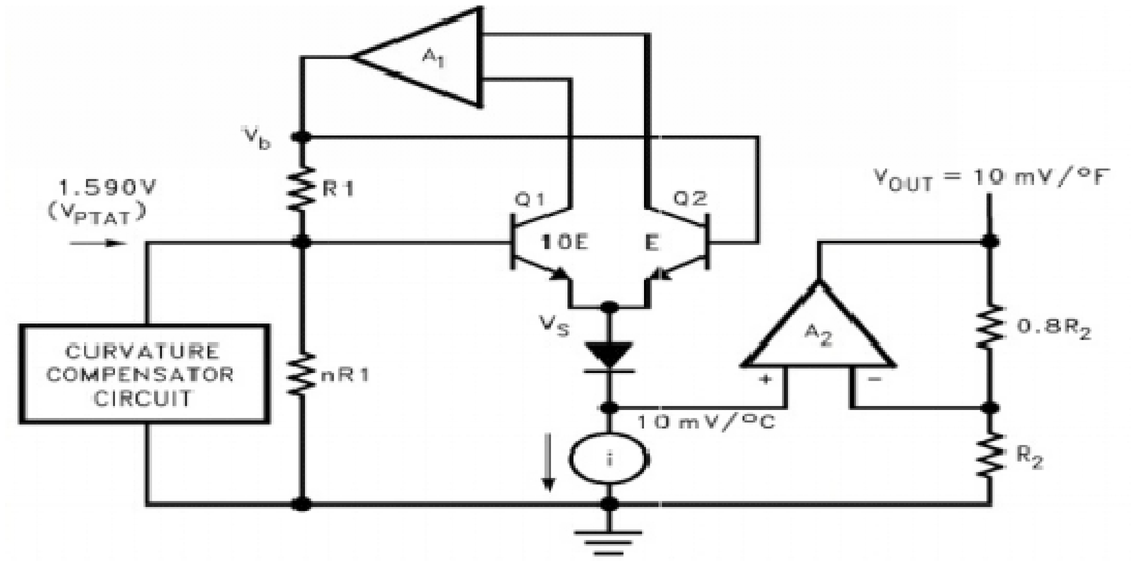

Fig 8. Internal circuit of IC LM35 Temperature Sensor

The internal circuit diagram of IC LM35 Temperature sensor[8] is shown in Fig 8. There are two transistors in the center of this circuit. One has ten times the transmitter area of the other. This means that it has a tenth of the current density, because the same current flows through the two transistors. This causes a voltage across the resistor R1 which is proportional to the absolute temperature and is almost linear in the range that interests us. A special circuit straightens the slightly curved voltage graph as a function of temperature.

The amplifier at the top guarantees that the voltage at the base of the left transistor (Q1) is proportional to the absolute temperature (PTAT) by comparing the output of the two transistors. The amplifier on the right converts the absolute temperature (measured in Kelvin) to Celsius. The small circle with the "i" is a constant current source circuit. The two resistors are calibrated at the factory to produce a very precise temperature sensor. The integrated circuit contains many transistors - two in the middle, some in each amplifier, some in the constant current source and some in the curvature compensation circuit. All this fits in the small box with three wires.

4.3 IoT Based Patient Health Observation System :

The circuit diagram of the proposed system is illustrated in the Fig 9. The circuit includes an Arduino Uno, a pulse sensor, a LM 35 temperature sensor, an LCD screen, a GSM module. We can power the Arduino board using a 7v or 12v wall wart or a plug-in adapter. The sensors are attached to the breadboard. The connection between the Arduino board and the sensor is made using connection wires. The work program is introduced into the Arduino board.

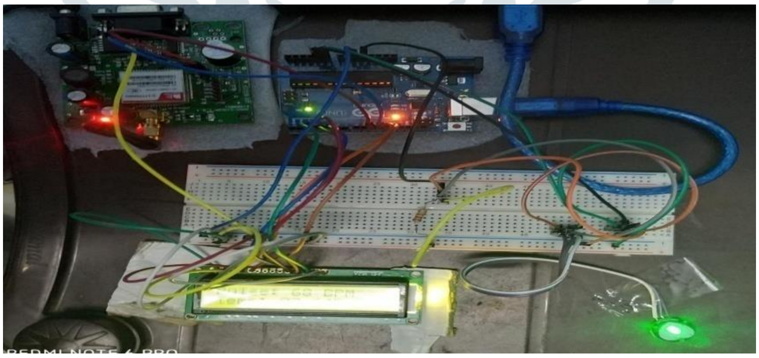

Fig 9. IoT Based Patient Health Observation System

In this IoT based patient health observation system trough SMS using GSM and using IC LM35 temperature sensor and pulse sensor. The signals detected by the patients are Millivolt but the volt sensors will be 5V sensors will have the amplifiers the detected signals are amplified and this will not cause damage to human health, then the signals are sent to the Arduino. Here we use Arduino (ATmega8) as the controller. This signal is given to the analog port (A0) and (A1) of the Arduino UNO. The Arduino UNO reads the analog input and converts this analog voltage into digital bits using an integrated A to D converter. It converts the analog voltage level to any number between 0 and 1023. It uses 10 bits for processing. This is given to the ATmega328 microcontroller, it then processes the digital data in respective centigrade degrees for temperature and in BHP for heart rate. LCD screens have a parallel interface, which means that the microcontroller must manipulate several interface pins at the same time to control the display. The interface consists of the following pins:

A Register Select (RS) pin that controls where in the memory of the LCD screen you write data. You can select either the data register, which contains what is displayed on the screen, or an instruction register, where the LCD controller searches for instructions on how to proceed.

A read / write pin (R / W) which selects the read or write mode An activation pin which allows writing to the data pins of registers8 (D0 -D7). The states of these pins (high or low) are the bits you write to a register when you write, or the values you read when you read. There is also a display contrast pin (Vo), power pins (+ 5V and GND) and LED backlight pins (Bklt + and Bklt-) which you can use to power the LCD screen, control the display contrast and turn the backlight LED on and off, respectively. The display control process involves placing the data that forms the image of what you want to display in the data registers, then placing the instructions in the instruction register. Using the GSM module, the results will be continuously transmitted to the medical managers and the data will be stored directly in the database.

V. Results and Discussion

The hardware implementation of the IoT based Patient health observation system through SMS using GSM is shown in Fig 10.

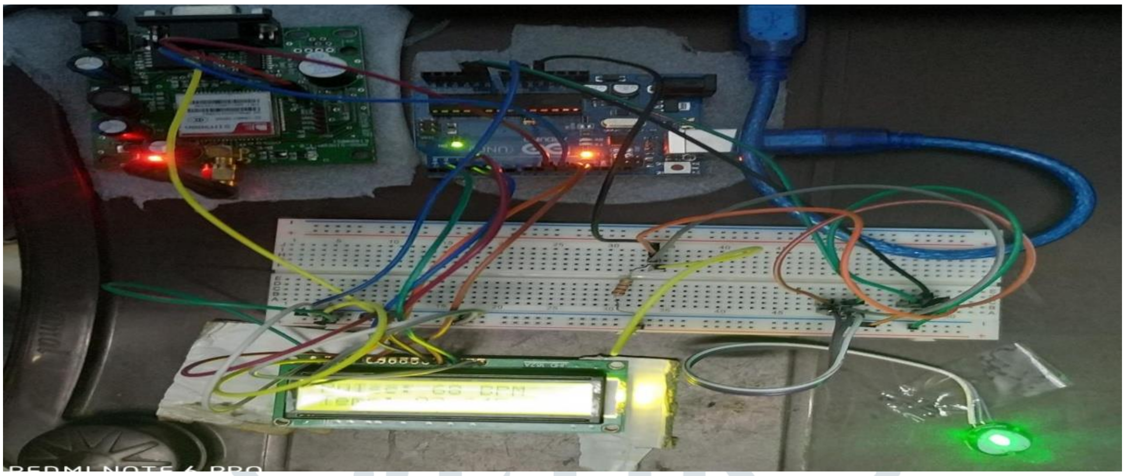

Fig 10. Implementation of Proposed System

Pulse and Temperature values continuously monitor on LCD display. The LCD view is shown in Fig 11.

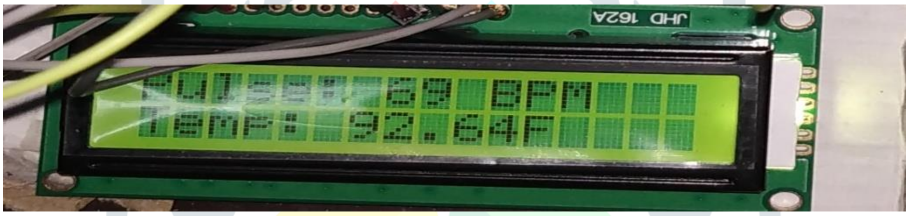

Fig 11. LCD view

The microcontroller will automatically send the signals to the GSM modem. Thanks to the GSM modem, the message will be delivered to the person concerned or to a doctor in critical reading. The message alert sent to the doctor is shown in Fig 12.

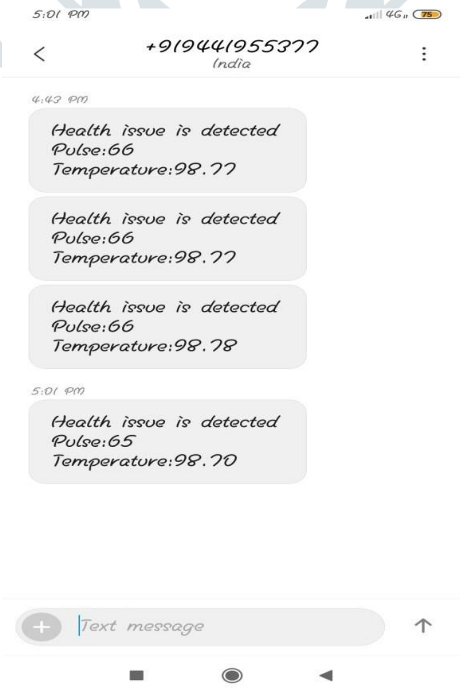

Fig 12. Mobile View

VI. CONCLUSION AND FUTUREWORK

Advances in biomedical engineering, science and technology have paved the way for new inventions and technologies. As we move towards miniaturization, practical electronic components are needed. New products and new technologies are being invented. ARDUINO has proven to be more compact, user-friendly and less complex, which could be easily used to perform several tedious and repetitive tasks. The simulation is carried out using Arduino software by placing appropriate sensors such as temperature and heart rate to detect the state of health and the results are analyzed under normal conditions and abnormal conditions. This paper can be further improved by detecting and displaying other vital statistics of a patient such as ECG, blood pressure, glucose level, etc., in a web page using Internet of Things technology. In the future, a portable health monitoring system can be designed using Arduino.

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