https://doi.org/10.48047/AFJBS.6.5.2024.10405-10411

AfricanJournalofBiological Sciences

IoT Based Smart Health Monitoring System for Human

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***Abstract* -Critical care around the world has seen a remarkable impact from the growing usage of mobile and smart devices in the health sector. With the use of these technologies, medical professionals and specialists are able to significantly alter the provision of medication in clinical settings. The Internet of Things is making it possible to connect devices that can connect to the Internet, monitor patient health, and send data to medical professionals on a continual basis. Today's world's biggest issue is health monitoring. A patient's major health problems are caused by inadequate health monitoring. Many Internet of Things (IoT) gadgets are available nowadays to track a patient's health online. Medical professionals are using these smart devices to monitor their patients as well. IoT is quickly changing the healthcare sector, as evidenced by the plethora of new healthcare technology start-ups. Our project involves creating an Internet of Things (IoT)-based health monitoring system that monitors a patient's heart rate, body temperature, respiration, spo2 levels, and electrocardiogram (ECG). The system will also send out an alert when any of these measurements exceed crucial limits. Values are transmitted using GSM.**

Keywords:Internet of Things, ECG, GSM, COVID, LCD, WiFi

I. INTRODUCTION

Due to the requirement to support multiple sectors, wireless technology has grown in the last few years. IoT has dominated industrial areas, particularly automation and control, in recent years. Among the latest trends towards improving healthcare is biomedical. IoT technology is being used not only in hospitals but also in personal health care facilities. Therefore, with a smart system, different characteristics that boost efficiency and reduce cost and power consumption are noted. This work is reviewed based on this smart system.

Doctors are crucial to the traditional approach of health check-ups. The registration, appointment, and check-up phases of this process take a long time. Reports are also produced afterwards. Working individuals often overlook or put off routine checkups because of the lengthy process involved. This contemporary method shortens the process's duration. Due to the necessity of supporting numerous sectors, the use of wireless technology has increased recently. The Industrial Internet of Things (IoT) has dominated the automation and control space in recent years. One contemporary movement towards improving health care is biomedical. The Internet of Things has opened up personal health care facilities in addition to hospitals. With a smart system, therefore, several parameters that use energy, cost money, and boost efficiency are monitored. This document is reviewed in compliance with this intelligent system.

For many years, medical professionals have worked to improve human happiness and health care through innovation and study. We cannot overlook their enormously significant contribution to the medical field. The foundational concepts of yesterday's fundamentals are found in today's automotive structures. Moreover, With the help of modern technologies, early diagnosis of chronic illnesses may be simple. Vital signs such as blood pressure, respiration rate, body temperature, and heart rate are important indicators of an illness. Using

IoT, this project provides heart rate and temperature readings.

A. Introduction of IoT:

The term "Internet of Things," or "IoT," describes the billions of physical objects that are currently linked to the internet and are all gathering and exchanging data. Anything can be made a part of the Internet of Things (IoT), from as little as a pill to as large as an airliner, thanks to the advent of incredibly affordable computer processors and the widespread use of wireless networks. By connecting and adding sensors to all these disparate objects, devices that would otherwise be dumb gadgets gain a degree of digital intelligence that allows them to exchange real-time data without the need for human intervention. The convergence of the digital and physical realms is being facilitated by the Internet of Things, which is making the environment around us more intelligent and responsive. Aside from a few early projects, such as an internet-connected vending machine, the idea of adding sensors and intelligence to everyday objects was discussed throughout the 1980s and 1990s (and there are probably some much earlier ancestors as well). However, progress was sluggish because the necessary technology was not yet available. Chips were excessively large and heavy, and items could not properly communicate with one another. Depending on how it is implemented, the Internet of Things can be beneficial for businesses; in most cases, agility and efficiency are the most important factors. The notion is that businesses should be able to make more adjustments as a result of having greater access to data regarding their own internal systems and products.

B. History and Future Embedded System:

It is impossible for the first embedded systems to have existed before 1971, considering the definition of embedded systems provided earlier in this chapter. Intel unveiled the first microprocessor in history in that year. The Japanese company Busicom built a line of business calculators that were intended to use this chip, the 4004. For each of their new calculator models, Busicom requested that Intel create a set of unique integrated circuits in 1969. In response, Intel offered a general-purpose circuit that could be utilised across the whole range of calculators, the 4004, rather than designing specific circuitry for each calculator. The software would provide each calculator with a distinct set of functions, according to Intel's concept.

Over the following ten years, the microcontroller's use grew steadily as it became an overnight success. Computerised traffic signals, flight control systems for aeroplanes, and unmanned space missions were among the first embedded applications. Embedded systems stealthily navigated the microcomputer era of the 1980s, introducing microprocessors into everything from our living rooms (TVs, stereos, and remote controls) to our kitchens (bread makers, food processors, and microwave ovens) and offices (fax machines, pagers, laser printers, cash registers etc.).

The number of embedded systems will undoubtedly continue to rise quickly. There are already a number of intriguing new embedded devices with enormous market potential, such as digital cameras, dashboard navigation systems, intelligent airbag systems that don't inflate when children or small adults are present, light switches and thermostats that can double as central computers, and pal-sized electronic organisers and personal digital assistants (PDAs). It is obvious that there will be a long-term demand for people with the knowledge and motivation to design the next generation of embedded systems.

C. Real Time Systems:

At this time, it is appropriate to introduce one embedded subclass. A computer system with timing restrictions is referred to as a real-time system. Put another way, a real-time system's capacity to perform specific calculations or make judgements quickly is one of its specification. There are deadlines for doing these significant computations, so the story goes. Furthermore, erroneous answers are practically equivalent to missed deadlines.

One very important question is what to do if a deadline is missed. For instance, if the flight control system of an aeroplane incorporates a real-time system, a single missed deadline might risk the lives of both passengers and crew. On the other hand, the harm might only be contained in a single faulty data packet if the device is actually used for satellite communication. It is more likely to be claimed that the deadline is "hard" and that the system is a hard real-time system if the penalties are harsh. On the other side of this debate, real-time systems are said to have "soft" deadlines.

The subjects and illustrations covered in this book are all relevant to real-time system designers who take greater pleasure in their job. He is responsible for ensuring that the hardware and software operate dependably under all circumstances, to the extent that human lives depend on the correct operation of three systems, engineering calculations and descriptive documentation.

D. Overview of Embedded System Architecture

Custom hardware is the foundation of every embedded system, and it is centered around a Central Processing Unit (CPU). Additionally, memory chips on which the software is loaded are part of this hardware. The term "firmware" also refers to the software that runs on the memory chip. Both the operating system and the application software execute independently of the hardware. Any computer, even desktop computers, can use the same architecture. There are, nevertheless, notable distinctions. An operating system is not required for every embedded system.

An operating system is not necessary for small appliances like toys, air conditioners, remote controls, and the like; you can write software specifically for those kinds of devices. It is advisable to have an operating system for applications that require sophisticated processing. In this scenario, you must first transfer the whole programme to the memory chip and integrate the application with the operating system. Software won't need to be reloaded because it will operate for a very long time once it is transferred to the memory chip.

Let's now examine the individual components that make up an embedded system's hardware. The components, as depicted in Fig.1 are CPU, memory, input/output devices, communication interfaces, and circuitry specific to a particular application.

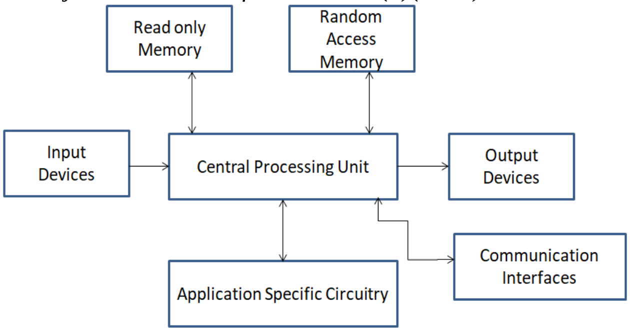

Fig. 1 Block diagram of hardware embedded system

II. LITERATURE SURVEY

According to R. Dayana and M. Balaguravaih, a human health monitoring system based on cortex-m3 is intended to monitor physiological signals simultaneously and is distinguished by its high precision, low power consumption, and large capacity. ECG, EEG, EMG, and pulse signals can be obtained by the system at low operating frequencies [1].According to Kiranmai.kota, N. Kiran Kumar, the use of a global network in healthcare applications can replace the use of conventional systems based on wireless sensor networks because it makes measurement easier[2].According to L. Vanitha, R. and WaseemFathima Temperature, heart rate, ECG, and EEG data are all recorded, displayed, and stored by the approach. By using an application, it also sends these data to the doctor's smartphone. Therefore, a patient monitoring system based on the Internet of Things can effectively monitor people's health and shield them from dangerous circumstances [3]. The "WIRELESS HUMAN HEALTH MONITOR" system, as described in this paper by C. Premalatha, R.P. Keerthana, and R. Abarna, uses temperature and pulse sensors to measure patient health parameters like heart rate and temperature. These sensors gather data, which is transmitted to the Arduino. The Arduino then uses a GSM modem to send the user the data as an SMS. The patient's health parameter recordings are texted to a designated recipient, such as a family member or physician[4].

The patient health monitoring system that A. Amuneand S. Chavanke proposed can be very helpful in emergency scenarios because it can be tracked, documented, and kept as a database on a daily basis[5]. According to ChanakyaMothukuri, K. CH. Prathap Kumar, this paper proposes an active network-based wireless technology with a sensor-microcontroller module and NWSPMS that is in charge of keeping track of the health of numerous patients in a single critical unit. This gauges body temperature, heart rate, and blood oxygen percentage. This paper investigates the design and development of a low-cost device that monitors a patient's health using GSM technology[6]. In this work, Prof. Vishal Jagtap, Priyanka Sarode, Tejashri Sonawane, and Mayuri Toke stated that patient data, including position, blood oxygen level, heart rate, blood pressure, temperature, and ECG, can be measured and sent to a server. Several sensors are attached to the patient's body to measure these parameters. Following that, the webpage will receive this information. By entering their login information, which includes their password and user name, doctors can access this data[7]. B. Venkataramanaiah, R. M. JoanyUtilising an Arduino and sensors to track temperature and pulse, a variety of human health issues can be detected. This Internet of Things device might measure pulse rate and take temperature. It continuously updates the pulse rate and ambient temperature to an IoT platform. [8]. Ali Hussain, Tariq Ahmed BarhamBaomar, and PrajoonaValsalan According to Omar Baabood, sensors are used by the system to monitor body temperature, pulse rate, and ambient temperature and humidity. The results are shown on an LCD. Wireless communication is then used to send these sensor values to a medical server.

After that, these data are received via an IoT platform on a personal smartphone that has been authorised. The physician then diagnoses the condition and the patient's state of health based on the values obtained[9]. This system monitors vital health parameters and transmits data through a wireless communication through a Wi-Fi module, according to K. Latha, G. Srivanth, N.V. Pavan Kumar, and b.V.S. Nagarjuna. The IOT platform allows for constant access to the data (Thing speak). A message service is used to promptly notify the doctors and carer in the event of any abnormal behaviour. Security is a key component of any well-designed remote monitoring system. Password-protected Wi-Fi modules and cloud computing manage patient data security, privacy, and authentication by granting limited database access[10]. According to Professor Virendrakumar, they developed a framework in this work that provides body temperature and pulse using separate LM35 and heartbeat sensors. These sensors require an Arduino UNO board controller. Arduino uses a wifi module to send information remotely.On the IoT stage, the ESP8266 is used for remote information transmission, such as thing speaking. On thing speak, information is represented. in order for the data record to be kept for a long time. This data is stored on a web server so that it can identify who logged in[11]. According to R. Alekya, Neelima Devi Boddeti, K. Salomi Monica, Dr. R. Prabha, and Dr. V. Venkatesh, the framework offered is unique and suitable for managing network and cloud device data that is unique to a patient. Based on the Internet of Things and its design principles, the cloud application facilitates direct communication between sensor devices and is both flexible and efficient in serving users, stored data, and sensors.

Wireless sensor networking allows for a single point of access to embedded sensor control systems and all system functionalities[12]. The goal of the proposed work, according to SasippriyaSaminathan, K. Geetha, is to design and develop a mobile-IoT based healthcare system with a Pattern Matching Algorithm. This will be accomplished by collecting patient data from multiple PHD sensors and promptly alerting the doctor and carer via messaging. It remotely tracks the patient's physiological parameters and makes an early illness diagnosis. Wireless Body Area Network can be used to implement this in wearable alert systems[13]. ShambhaviTolnur, SoumyaPotnis, and Prema T. Akkasaligar Numerous sensors in this system gather data on various aspects of the human body. An IoT platform can be used to transmit it[14]. According to Ahmed Abdulkadir Ibrahim and Wang Zhuopeng, the purpose of this paper is to design a system that uses internet connectivity to monitor a patient's body at any time. This system's purpose is to measure certain biological parameters of the patient's body, such as blood pressure, heart rate, and body temperature. It does this by using sensors, which detect the patient's body temperature, heart rate, and blood pressure and transmit the data via a WIFI module to an IOT Cloud platform[15].

A. Problem definition

Given the high contagiousness of COVID, it is critical to quarantine patients; however, physicians must also closely monitor the health of COVID patients. Patients' health needs to be routinely monitored by doctors. The doctors have an increasing number of patients to keep an eye on. The risk of infection for monitoring purposes alone puts the doctors at risk.

III. PROPOSED METHODOLOGY

We have designed a remote IOT-based health monitor system that enables the online remote monitoring of multiple COVID patients in order to address this problem. The system uses a heartbeat sensor, temperature sensor, and blood pressure sensor, respectively, to monitor the patient's heartbeat, temperature, and blood pressure. ThecomponentsusedareLM35temperaturesensor,Respiratorysensor,Heartratesensor,pulseoximeter,esp8266, LCD, buzzer. The proposed system helps totrack the patienthealth relentlessly.

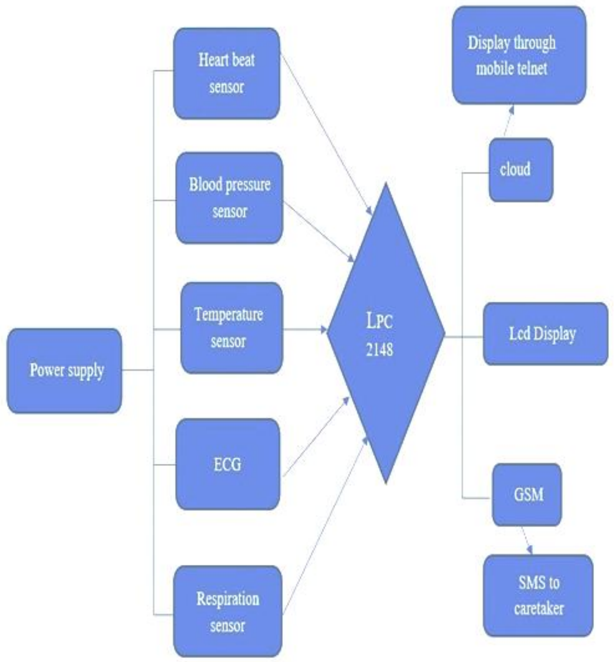

Fig.2 Proposed Block Diagram

A. ARM7basedLPC2148Microcontroller

Philips (NXP Semiconductor) designed the LPC2148 microcontroller, which has a number of built-in features and peripherals. These factors will make it a more dependable and effective choice for an application developer. Based on the ARM7 family, the LPC2148 is a 16- or 32-bit microcontroller.

A1.FeaturesofLPC2148

The following are some of LPC2148's primary features.

- The LPC2148 is a microcontroller from the ARM7 family that comes in a small LQFP64 package. It can operate at 16 or 32 bits.
- Utilizing on-chip boot loader software, either as an ISP (in system programming) or IAP (in application programming).
- 8 kB–40 kB of on-chip static RAM, 32 kB–512 kB of on-chip flash memory, a 128 bit wide interface, and an accelerator that enables 60 MHz high-speed operation are all available.
- Erasing the entire chip takes 400 milliseconds, while programming 256 bytes takes 1 millisecond.
- Embedded ICE RT and Embedded Trace interfaces provide on-chip Real Monitor software and high-speed instruction execution tracing for real-time debugging.
- The device controller supports USB 2.0 full speed and has 2 kB of endpoint RAM. Additionally, this microcontroller provides 8kB of on-chip RAM close to USB via DMA.
- With a low conversion time of 2.44 µs/channel, one or two 10-bit ADCs can provide six or fourteen analogue input/output.
- Changeable analogue output is only provided by 10 bit DAC.
- PWM unit, watchdog, external event counter, and two 32-bit timers.
- 32 kHz clock input and low power RTC (real time clock). many serial interfaces, including two 16C550 UARTs and two 400 kbit/s I2C buses.
- Quick general purpose 5 volt tolerant Small LQFP64 package with input/output pins.
- External interrupt pins 21: The maximum CPU CLK-clock that can be obtained from the programmable-on-chip phase-locked loop by solving time is 60 MHz.
- The chip's integrated oscillator will operate on an external crystal with a frequency range of 1 MHz to 25 MHz.
- Idle and power down are the two main power-conserving modes.
- Peripheral functions can be individually enabled or disabled, and peripheral CLK scaling is available for extra power optimization.

B. Power supply

The regulated power supply provides the circuit's input. The transformer steps down the 230V a.c. input from the mains supply to 12V, which is then sent to a rectifier. A pulsing DC voltage is what the rectifier produces as its output. Therefore, the rectifier's output voltage is sent through a filter to eliminate any remaining a.c components in order to obtain a pure d.c voltage. This voltage is now applied to a voltage regulator in order to produce a clean, steady DC voltage.

C. LCD

The LCD, also known as liquid crystal display, is a very useful tool for debugging and for supplying user interface. Based on Hitachi's HD44780 controller or other similar models, character-based LCDs are most frequently utilised. One-line, two-line, and four-line LCDs with a single controller and a maximum character support of 80 are the most widely used LCDs on the market today.

D. Temperature Sensor:

The temperature sensor that translates temperature readings into electrical signals. An IC known as the LM 35 was employed as a temperature sensor. The precision integrated-circuit temperature sensors in the LM35 series have an output voltage that is linearly proportional to the temperature in Celsius. The LM35 has internal calibration, thus it doesn't need additional calibration. With typical accuracy of ±104°C at ambient temperature and ±3Ú4°C over the whole temperature range of −55°C to +150°C, the LM35 does not require any external calibration or trimming.

E. SPO2(Pulse Oximeter Sensor)

Your blood's oxygen levels, or your oxygen saturation level, can be determined with pulse oximetry, a non-invasive, painless test. The arms and legs, which are the extremities farthest from the heart, are among those that can quickly identify even minute variations in the efficiency of oxygen delivery.

One finger, earlobe, or toe is used to implant a tiny clamp-like device during a pulse oximetry reading. Tiny light beams enter the finger's blood and measure the oxygen content. To achieve this, it measures variations in light absorption in blood that is either oxygenated or deoxygenated. This process doesn't hurt at all. As a result, the pulse oximeter may provide you with information on both your heart rate and oxygen saturation levels.

Fig. 3 SPO2 Sensor

F. Respiration Sensor

In many medical devices, including oxygen concentrators, respiratory devices, sleep diagnostic devices, spirometers, and devices for sleep apnea therapy (CPAP), air and gas flows, as well as line and therapy pressures, must be tracked and managed. In addition to detecting flow rates of several hundred l/min, high-quality sensors in respiratory devices measure minute flow rates surrounding the respiratory flow zero point. High anesthetic resistance is required for certain applications in anesthetic equipment. Pressure sensors in regulated CPAP machines track the therapy pressure continually, enhancing patient comfort and treatment quality. Spirometers use specialized pneumotachographs, which use effective differential pressure sensors to monitor respiratory flow.

G. ECG Sensor

The heart's electrical activity can be measured with this affordable board sensor. An electrocardiogram, or ECG, can be created from this electrical activity and output as a digital reading. Because ECGs can be very noisy, the AD8232 Single Lead Heart Rate Monitor functions as an op-amp to make it easier to distinguish between clear signals from the PR and QT intervals.

For use in biopotential measurement applications such as ECG, the AD8232 is an integrated signal conditioning block. In noisy environments, including those brought on by motion or distant electrode placement, it is intended to extract, amplify, and filter tiny biopotential signals.

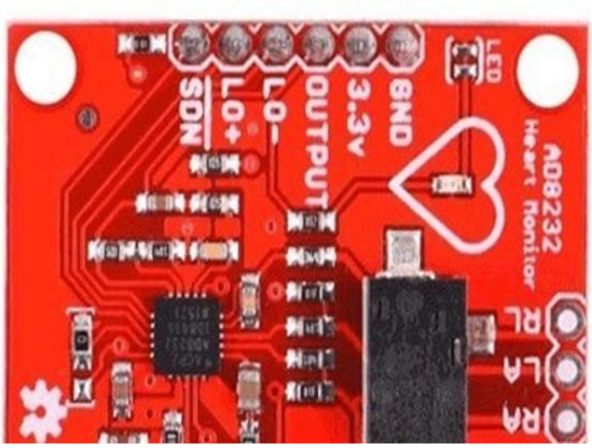

Fig. 4 AD8232 ECG Sensor

H. ESP 8266 Wifi module

Any microcontroller can gain access to your WiFi network with the help of the ESP8266 WiFi Module, a self-contained SOC with an integrated TCP/IP protocol stack. Either all WiFi networking functions can be offloaded from another application processor, or the ESP8266 can host an application. Every ESP8266 module is pre-configured with an AT command set firmware, so all you have to do is connect it to your Arduino device and you'll have almost the same amount of WiFi functionality as a WiFi shield right out of the box! The ESP8266 module has a large and constantly expanding community and is a very affordable board.

With minimal development required up front and minimal loading during runtime, this module's powerful on-board processing and storage capacity enables it to be integrated with sensors and other application-specific devices through its GPIOs. The front-end module is made to take up the least amount of PCB space due to its high level of on-chip integration, which permits the use of very little external circuitry. The ESP8266 is compatible with Bluetooth co-existence interfaces and APSD for VoIP applications. It doesn't require any external RF components and has an inbuilt self-calibrated radio that enables it to function in all operating environments.

Fig.5ESP8266Wi-Fimodule

I. GSM Module

A PC Card or PCMCIA card can be used as an external device or a GSM modem. A USB or serial cable is usually used to connect an external GSM modem to a computer. A laptop computer can be used with a GSM modem that looks like a PC Card or PCMCIA card. A laptop computer's PC Card or PCMCIA Card slot is where it should be placed. Similar to a GSM phone, a GSM modem needs a SIM card from a wireless provider in order to function.

The following data is stored on a SIM card: SIM card state, operator service code, PIN, PUK, authentication key, and subscriber phone number (SSN).

Fig. 6 GSM module

J. Working Principle

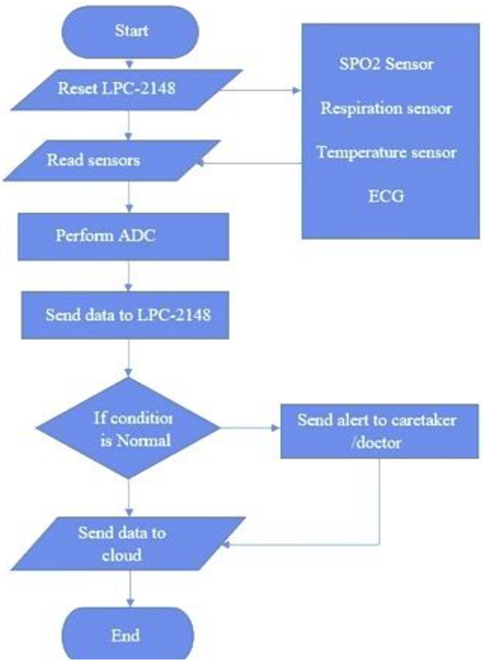

Fig. 7Flow Chart of working principle

A 220v AC power supply Input is converted to a 9 volt DC supply. A 9 volt DC supply is used to power the LPC2148 board. The parameters that include the temperature sensor, respiration sensor, ECG sensor, and Spo2 sensor are powered by the same 9 volt DC supply. Records exist for the inputs. The LCD display shows these analogue values after they have been digitally transformed. The LCD simultaneously displays the data it continuously receives from the LPC2148.

While Spo2 sensors measure the amount of oxygen in the blood, temperature sensors measure the body's temperature. The respiration sensor is used to measure breathing rate, while the ECG sensor measures heart rate. The LCD display presents these parameters. These readings are simultaneously sent to the carers via the GSM module, and the data is also sent simultaneously to the cloud via an ESP8266 Wi-Fi module.An alert is sent to the cloud and the carer whenever the breathing rate is elevated, allowing them to take appropriate action.

IV.RESULTS AND DISCUSSIONS

Fig. 8 Prototype with sensors

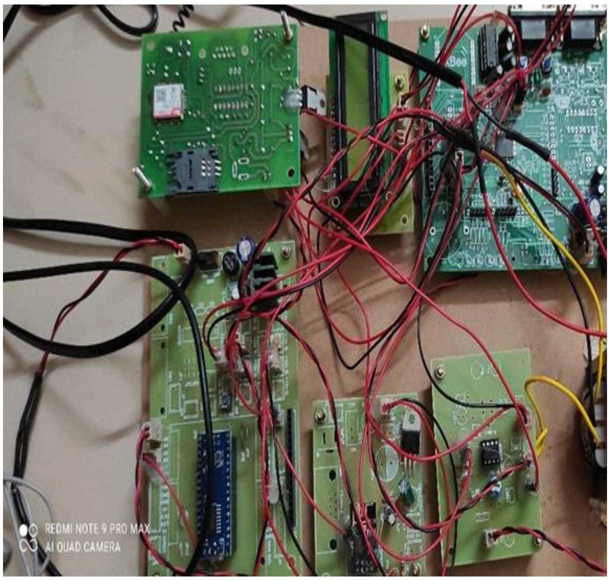

Fig.9 Circuit of Prototype

Fig. 10 output messages

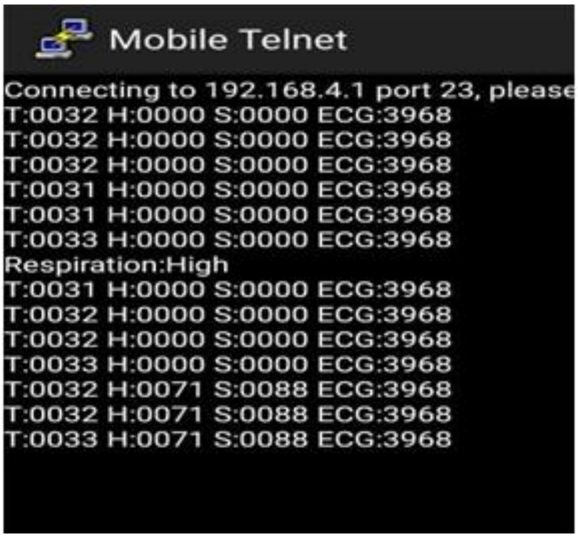

Fig. 11 Continuous data transmission to the and alerts to caretaker cloud

Fig.8 and 9 are the prototype figures and fig.10 shows the messages, which are sent to the caretaker and fig. 11 shows the continuous data transmission to the server.

V. CONCLUSION

Therefore, the suggested system could collect and read a variety of significant patient indicators, evaluate them on the cloud, and alert the physician or other concerned parties to the patient's health condition. It keeps an eye on vital signs and detects anomalies. The system stores data on a cloud platform.Unlike zigbee or bluetooth, this device allows doctors to monitor patients in real time from anywhere in the world by establishing a connection over the internet. One cutting edge technological innovation that benefits society is the internet of things (IoT) based patient monitoring system.

It allows users to access biomedical applications on their mobile devices.Applications for this system are possible in densely populated areas. This is a real-time IoT application system in a mobile IoT application environment. Data analytics is also used to manage the large amounts of data that are gathered from IoT devices. Real-time efficiency gains are made possible by this system. These methods can also be used for any type of healthcare service, including disease monitoring and senior care. The system is adaptable to industrial requirements and has numerous potential uses in addition to industrial ones and GSM transmits parameters to physicians.

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