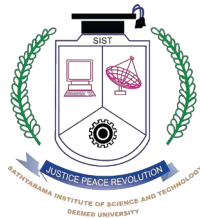


IOT BASED PATIENT MONITOR

Submitted in partial fulfillment of the requirements for the award of Master
of Technology Degree in

Medical Instrumentation by

BALAJI RAYAPPAN C (Reg No.40440002)



**DEPARTMENT OF BIOMEDICAL ENGINEERING SCHOOL
OF BIO AND CHEMICAL ENGINEERING**

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY (DEEMED
TO BE UNIVERSITY)

Accredited with Grade "A" by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119

MAY 2022



SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)

Accredited "A" Grade by NAAC I 12B Status by UGC I

Approved by AICTE

www.sathyabama.ac.in



DEPARTMENT OF BIOMEDICAL ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **BALAJI RAYAPPAN C (REG NO 40440002)** who have done the Project work as a team who carried out the project entitled " IOT BASED PATIENT MONITOR " under my / our supervision from January 2022 to May 2022

Dr. S. KRISHNAKUMAR, M.Sc., Ph.D.,

Internal Guide

Dr. T. SUDHAKAR, M.Sc., Ph.D.,

Head of the Department

Submitted for Viva voce Examination held on 11.05.2022

INTERNAL EXAMINER

Dr. J. Premkumar

EXTERNAL EXAMINER

DECLARATION

I, BALAJI RAYAPPAN C (40440002), hereby declare that the Project Report entitled “ IOT BASED PATIENT MONITOR” done by under the guidance of Dr. S. KRISHNAKUMAR, M.Sc., Ph.D., Department of Biomedical Engineering is submitted in partial fulfillment of the requirements for the award of Master of Technology Degree in Medical Instrumentation.

DATE: 05/05/2022

PLACE: Chennai

Handwritten signature of the candidate, C. Balaji Rayappan, in blue ink.

SIGNATURE OF THE CANDIDATE

ACKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to Board of Management of SATHYABAMA for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

I convey my thanks to **Dr. T. Sudhakar M.Sc. Ph.D.**, Head of the Department, Department of Biomedical Engineering for providing me necessary support and details at the right time during the progressive reviews.

I would like to express my sincere and deep sense of gratitude to my external Guide **Dr. S. KRISHNAKUMAR, M.Sc., Ph.D.**, Department of Biomedical Engineering for their valuable guidance, suggestions and constant encouragement paved way for the successful completion of my project work.

I wish to express my thanks to all Teaching and Non-teaching staff members of the Department of Biomedical Engineering who were helpful in many ways for the completion of the project.

ABSTRACT

Health monitoring is a major problem in today's world. Due to a lack of proper health monitoring, patients suffer from serious health issues. In a hospital, either the nurse or the doctor has to move physically from one person to another for the health check, which may not be possible to monitor their conditions continuously. Thus, any critical situations cannot be found easily unless the nurse or doctor checks the person's health at that moment. This may be a strain for the doctors who have to take care of a lot number of people in the hospital. Also, when medical emergencies happen to the patient, they are often unconscious and unable to press an Emergency Alert Button. In this project, we will make an IoT-based Health Monitoring System that records the patient's blood pressure (Non-Invasive Method), blood glucose (Non-Invasive Method), heartbeat rate, and body temperature. Health experts can also take advantage of these smart devices to keep an eye on their patients from anywhere in the world.

TABLE OF CONTENTS

CHAPTER NO	TITLE	PAGE NO
	ABSTRACT	
	LIST OF EXPERIMENTS	
	LIST OF FIGURES	
	LIST OF TABLES	
1.	INTRODUCTION	01
	1.1 PATIENT MONITORING SYSTEM	01
	1.2 INTERNET OF THINGS	02
	1.2.1 BENIFITS OF INTERNET OF THINGS	03
	1.3 HEART RATE MONITORING	03
	1.3.1 NEED FOR HEARTV RATE MONITORING	03
	1.4 TEMPERATURE	04
	1.4.1 NEED FOR TEMPERATURE	04
	1.5 SPHYGMOMANOMETER	05
	1.5.1 NEED OF SPHYGMOMANOMETER	05
	1.6 GLUCOMETER	05
2.	LITERATURE REVIEW	06
	2.1 GENERAL	06
	2.2 LITERATURE REVIEW	06
3.	AIM AND SCOPE	09
	3.1 AIM	09
	3.2 EXISTING SYSTEM	09

	3.3 PROPOSED SYSTEM	09
4.	MATERIALS AND METHODS	10
	4.1 HARDWARE COMPONENTS	10
	4.1.1 ARDUINO MEGA 2650	10
	4.1.2 Temperature Sensor	11
	4.1.3 KY Sensor	12
	4.1.4 ESP8266 Node MCU WiFi	13
	4.1.5 LM35 SENSOR	14
	4.1.6 POWER SUPPLY	15
	4.1.7 LCD Display	18
	4.1.8 ESP-12E WiFi Module	21
	4.1.9 LED	24
	4.2 SOFTWARE USED	25
	4.2.1 ARDUINO IDE	25
	4.2.2 THINGSPEAK	26
	4.3 ARDUINO CODE	27
	4.3.1 IOT NODE	27
	4.4 BLOCK DIAGRAM	38
5.	RESULTS AND DISCUSSION	39
	5.1 RESULTS	39
	5.1.1 GLUCOSE	39
	5.1.2 TEMPERATURE	40
	5.1.3 HEART BEAT	41
	5.1.4 BLOOD PRESSURE	42
	5.1.5 THINGSPEAK IOT STORAGE	43
6.	SUMMARY AND CONCLUSION	44

6.1 SUMMARY AND CONCLUSION	44
6.2 FUTURE WORK	44
REFERENCE	45

TABLE OF CONTENTS

CHAPTER NO	TITLE	PAGE NO
4.1	ARDUINO MEGA 2650	11
4.2	KY SENSOR	12
4.3	NODE MCU ESP-8266	13
4.4	LM35 SENSOR	14
4.5	POWER SUPPLY	15
4.6	LCD DISPLAY	20
4.7	ESP 12E WIFI MODULE	22
4.8	ARDUINO IDE	26
4.9	THINGSPEAK	27
5.1	GLUCOSE SENSOR	39
5.2	OUTPUT FOR GLUCOSE	39
5.3	TEMPERATURE SENSOR	40
5.4	OUTPUT FOR TEMPERATURE SENSOR	40
5.5	IR SENSOR / OUTPUT FOR HEARTBEAT	41
5.6	PHOTOPLETHISMOGRAPHY TECHNIQUE	
	OUTPUT FOR BP	42
5.7	THINGSPEAK REPRESENTATION	43

LIST OF ABBREVIATIONS

ABBREVIATIONS	FULL FORM OF ABBREVIATIONS
ECG	ELECTRO CARDIOGRAM
PPG	PHOTOLETHISMOGRAPHY
IOT	INTERNET OF THINGS
SPO2	SATURATION OF PERIPHERAL OXYGEN
MCU	MICRO CONTROLLER UNIT
LCD	LIQUID CRYSTAL DISPLAY
IC	INTEGRATED CIRCUITS
UART	UNIVERSAL ASYNCHRONOUS RECEIVER TRANSMITTER
IDE	INTEGRATED DEVELOPMENT ENVIRONMENT

CHAPTER 1

INTRODUCTION

Many countries around the world are experiencing an increase of elderly people. In 2016, the number of elderly people reached 929 million out of the total world population of 7,433 million people, representing 12.5 percent. The aim of this project is to develop a heartbeat, body temperature monitoring system, pulse level, systolic and diastolic value and blood glucose to support the emergency patients who are in continuous monitoring stage

1.1 PATIENT MONITORING SYSTEM

A Patient Monitor (also known as Vital Signs Monitors) are a medical monitor or physiological monitor or display, is an electronic medical device that measures a patient's vital signs and displays the data so obtained, which may or may not be transmitted on a monitoring network. Physiological data are displayed continuously on a CRT or LCD screen as data channels along the time axis, They may be accompanied by numerical readouts of computed parameters on the original data, such as maximum, minimum and average values, pulse and respiratory frequencies, and so on. In critical care units of hospitals, bedside units allow continuous monitoring of a patient, with medical staff being continuously informed of the changes in general condition of a patient. Some monitors can even warn of pending fatal cardiac conditions before visible signs are noticeable to clinical staff, such as atrial fibrillation or premature ventricular contraction (PVC). Old analog patient displays, in contrast, were based on oscilloscopes, and had one channel only, usually reserved for electrocardiographic monitoring (ECG). Therefore, medical monitors tended to be highly specialized. One monitor would track a patient's blood pressure, while another would measure pulse oximetry, another the ECG. Later analog models had a second or third channel displayed in the same screen, usually to monitor respiration movements and blood pressure. These machines were widely used and saved many lives, but they had several restrictions, including sensitivity to electrical interference, base level fluctuations and absence of numeric readouts and alarms. Several models of multi-parameter

monitors are networkable, i.e., they can send their output to a central ICU monitoring station, where a single staff member can observe and respond to several bedside monitors simultaneously. Ambulatory telemetry can also be achieved by portable, battery-operated models which are carried by the patient and which transmit their data via a wireless data connection. Digital monitoring has created the possibility, which is being fully developed, of integrating the physiological data from the patient monitoring networks into the emerging hospital electronic health record and digital charting systems, using appropriate health care standards which have been developed for this purpose by organizations such as IEEE and HL7. This newer method of charting patient data reduces the likelihood of human documentation error and will eventually reduce overall paper consumption. In addition, automated ECG interpretation incorporates diagnostic codes automatically into the charts. Medical monitor's embedded software can take care of the data coding according to these standards and send messages to the medical records application, which decodes them and incorporates the data into the adequate fields. Long-distance connectivity can avail for telemedicine, which involves provision of clinical health care at a distance.

1.2 INTERNET OF THINGS

The IoT allows objects to be sensed or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention. When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, virtual power plants, smart homes, intelligent transportation and smart cities. "Things", in the IoT sense, can refer to a wide variety of devices such as heart monitoring implants, biochip transponders on farm animals, cameras streaming live feeds of wild animals in coastal waters, automobiles with built-in sensors, DNA analysis devices for environmental/food/pathogen monitoring, or field operation devices that assist fire

fighters in search and rescue operations. Legal scholars suggest regarding "things" as an "inextricable mixture of hardware, software, data and service". These devices collect useful data with the help of various existing technologies and then autonomously flow the data between other devices.

1.2.1 BENEFITS OF INTERNET OF THINGS

1. Ubiquitous networks – personal wi-fi on your mobile phone and on every other device. Everyone (and everything) wants and needs to be connected.
2. Connected computing – we want all of our devices, phones, televisions, music players, vehicles, etc. to keep track of what we are doing, viewing, reading, and listening to as we move through our day, from place to place – the handoffs from device to device are already happening.
3. Ubiquitous sensors – on everything. It is already here – the Internet of Everything and the wearables revolution.
4. Intelligence at the periphery of the network – Jim Gray, the visionary database guru from Microsoft, envisioned smart sensors acting as a mini-database with embedded machine learning algorithms. Here is how he said it (10 years ago): "Intelligence is moving to the periphery of the network. Each disk and each sensor will be a competent database machine."

1.3 HEALTH RATE MONITORING

A heart rate monitor (HRM) is a personal monitoring device that allows one to measure/display heart rate in real time or record the heart rate for later study. It is largely used to gather heart rate data while performing various types of physical exercise.

1.3.1 Need for Heart Rate Monitoring

A heart rate monitor helps to ensure that you are maximising the effectiveness of your training and, for time constrained amateur riders, this is essential. The British Cycling Training Plans use heart rate and cadence to ensure that you are getting the most from every pedal stroke you make. As we have already said a heart rate monitor doesn't need to be expensive and, if you are a technophobe, it doesn't

need to be complicated either. Look for a monitor that allows you to custom set at least one training zone, recall time spent in, above and below that zone and, important for threshold testing, also recalls average heart rate.

1.4 TEMPERATURE

Temperature sensors in the medical field have been used from time immemorial to measure the body temperature and monitor the medical condition of patients. With a temperature sensor attached to the body of the patients, measurement of absolute temperature of the patient will be accurate, and the system allows for continuous monitoring of a patient's differential change in temperature. The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of $\pm 1/4^{\circ}\text{C}$ at room temperature and $\pm 1/4^{\circ}\text{C}$ over a full -55 to $+150^{\circ}\text{C}$ temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only $60\text{ }\mu\text{A}$ from its supply, it has very low selfheating, less than 0.1°C in still air. The LM35 is rated to operate over a -55° to $+150^{\circ}\text{C}$ temperature range.

1.4.1 Need for Temperature:

A Temperature Sensor will often play an important part in an application. There are many applications where maintaining a specific temperature is vital, for example, if products must be kept at a certain temperature or for patient monitoring, the responsiveness and accuracy of the temperature sensor is critical. More frequently temperature sensor applications will also incorporate instances where although the temperature is not the forefront of the process, other components may not be able to function at certain temperatures so the temperature must be monitored within the

application for this reason. The temperature sensor will indicate when the environment becomes too hot or cold and preventative action can be taken to ensure that the entire device is not compromised.

1.5 SPHYGMOMANOMETER

Sphygmomanometer, instrument for measuring blood pressure. It consists of an inflatable rubber cuff, which is wrapped around the upper arm and is connected to an apparatus that records pressure, usually in terms of the height of a column of mercury or on a dial (an aneroid manometer). An arterial blood pressure reading consists of two numbers, which typically may be recorded as x/y. The x is the systolic pressure, and y is the diastolic pressure. Systole refers to the contraction of the ventricles of the heart, when blood is forced from the heart into the pulmonary and systemic arterial circulation, and diastole refers to the resting period, when the ventricles expand and receive another supply of blood from the atria. At each heartbeat, blood pressure is raised to the systolic level, and, between beats, it drops to the diastolic level. As the cuff is inflated with air, a stethoscope is placed against the skin at the crook of the arm. As the air is released, the first sound heard marks the systolic pressure; as the release continues, a dribbling noise is heard. This marks the diastolic pressure, which is dependent on the elasticity of the arteries.

1.5.1 Need Of Sphygmomanometer

- Measuring Blood Pressure
- Monitoring Effectiveness Of Medications
- Helps to control Hypertension

1.6 GLUCOMETER

A Glucometer is a small, portable device that lets you check your blood sugars at home. No matter what type of diabetes you have, a glucometer can give you valuable information. Also called glucose meters, these devices can tell you in seconds if your blood sugar is too low, too high, or on target. Regular monitoring helps you manage your diabetes, but it's important to use your glucometer the right.

CHAPTER 2

LITERATURE REVIEW

2.1 GENERAL

Previous works are focused on The Patient Monitoring System (PMS) is a very critical monitoring systems, it is used for monitoring physiological signals including Electrocardiograph (ECG), Respiration, Invasive and Non-Invasive Blood Pressure, Oxygen Saturation in Human Blood (SpO₂), Body Temperature and other Gases etc.

2.2 LITERATURE SURVEY

Alvee Rahman et al. 2021 Used a well-designed Patient monitoring is the health care system nowadays, either at hospitals or at home. This paper proposes an intelligent patient monitoring system that automatically screens the patient's health condition through various sensors. The data is then processed using a Raspberry Pi and useful information is saved to the IoT cloud. Primarily the system would be extracting the bio signal, ECG using an ECG sensor. Through continuous monitoring and graphical representation of the patient's information, doctors/nurses/relatives can remotely check the patient's condition. Furthermore, if the condition becomes critical, a notification is sent to the doctor/nurse/relative to inform them and either party will have the opportunity to start a video call.

D. Shiva Rama Krishnan et al. 2019 Used a Well-designed Health-care has developed science and knowledge based on Wireless-Sensing node Technology oriented. Patients are facing a problematic situation of unforeseen demise due to the specific reason of heart problems and attack which is because of nonexistence of good medical maintenance to patients at the needed time. This is for specially monitoring the old age patients and informing doctors and loved ones. So we are proposing a innovative project to dodge such sudden death rates by using Patient HealthMonitoring that uses sensor technology and uses internet to

communicate to the loved ones in case of problems. This system uses Temperature and heartbeat sensor for tracking patients health. Both the sensors are connected to the Arduino-uno. To track the patient health micro-controller is in turn interfaced to a LcD display and wi-fi connection to send the data to the web-server(wireless sensing node).

Prajoona Valsalan *et al.* 2020 Used a Well-designed IoT based health is the best solution for such an epidemic. Internet of Things (IoT) is the new revolution of internet which is the growing research area especially in the health care. With the increase in use of wearable sensors and the smart phones, these remote health care monitoring has evolved in such a pace. IoT monitoring of health helps in preventing the spread of disease as well as to get a proper diagnosis of the state of health, even if the doctor is at far distance. In this paper, a portable physiological checking framework is displayed, which can constantly screen the patient's heartbeat, temperature and other basic parameters of the room .

R Ani et al. 2019 Used for an Well-designed ubiquitous growth of its Things (IoT) and its medical applications has improved the effectiveness in remote health monitoring systems of elderly people or patients who need long-term personal care. Nowadays, chronic illnesses, such as, stroke, heart disease, diabetes, cancer, chronic respiratory diseases are major causes of death, in many parts of the world. In this paper, we propose a patient monitoring system for stroke-affected people to minimize future recurrence of the same by alarming the doctor and caretaker on variation in risk factors of stroke disease. Data analytics and decision-making, based on the real-time health parameters of the patient, helps the doctor in systematic diagnosis followed by tailored restorative treatment of the disease.

Alexandru Archip et al. 2017 Used a Well-designed surgical procedure,

monitored in an ICU until physically stable, after which are discharged to a ward for further evaluation and recovery. Usually, ward evaluation does not imply continuous physiological parameters monitoring and therefore patient relapse is not uncommon. The present paper describes the steps taken to design and build a low-cost modular monitoring system prototype. This system aims to offer mobile support in order to facilitate faster and better medical interventions in emergency cases and has been developed using low-power dedicated sensor arrays for EKG, SpO2, temperature and movement.

V Tamilselvi et al. 2019 Used Well-designed IoT places a vital role in health monitoring. Continuous fitness monitoring can save up to 60% of human lives through timely detection. The device is specially designed for actual time monitoring of the health parameters of the coma sufferers. It has more suitability by means of the use of GSM and IoT to recognize the status or condition of the patient. This proposed method consists of numerous smart sensors like Temperature, Heartbeat, Eye blink and SPO2 (Peripheral Capillary Oxygen Saturation) sensors for fetching the patient's body temperature, coronary heart rate, eye movement and oxygen saturation percentage of the patient. This system uses ARDUINO-UNO board as a microcontroller and Cloud computing concept.

CHAPTER 3

AIM AND SCOPE

3.1 AIM

To continuously monitors patient's vital signs and sense abnormalities. To medical st To continuously monitors patient's vital signs and sense To alerts the medical stthe medical staff about the abnormal parameter. the need for manual monitoring do monitoring done by the medical staff. from sensors to the cloud platform.

3.2 EXISTING SYSTEM

In a hospital, either the nurse or the doctor has to move physically from one person to another for the health check, which may not be possible to monitor their conditions continuously. Thus, any critical situations cannot be found easily unless the nurse or doctor checks the person's health at that moment. This may be a strain for the doctors who have to take care of a lot number of people in the hospital. Also, when medical emergencies happen to the patient, they are often unconscious and unable to press an Emergency Alert Button.

3.3 PROPOSED SYSTEM

In this project, we will make an IoT-based Health Monitoring System that records the patient's blood pressure (Non-Invasive Method), blood glucose (Non-Invasive Method), heartbeat rate, and body temperature. Health experts can also take advantage of these smart devices to keep an eye on their patients from anywhere in the world.

CHAPTER 4

MATERIALS AND METHODS

4.1 HARDWARE COMPONENTS

4.1.1 Arduino Mega 2560

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560 (datasheet). It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Mega is compatible with most shields designed for the Arduino Duemilanove or Diecimila.

Specification

- Microcontroller ATmega2560
- Operating Voltage 5V
- Input Voltage (recommended) 7-12V
- Input Voltage (limits) 6-20V
- Digital I/O Pins 54 (of which 14 provide PWM output)
- Analog Input Pins 16
- DC Current per I/O Pin 40 mA
- DC Current for 3.3V Pin 50 mA
- Flash Memory 256 KB of which 8 KB used by bootloader
- SRAM 8 KB
- EEPROM 4 KB
- Clock Speed 16 MHz

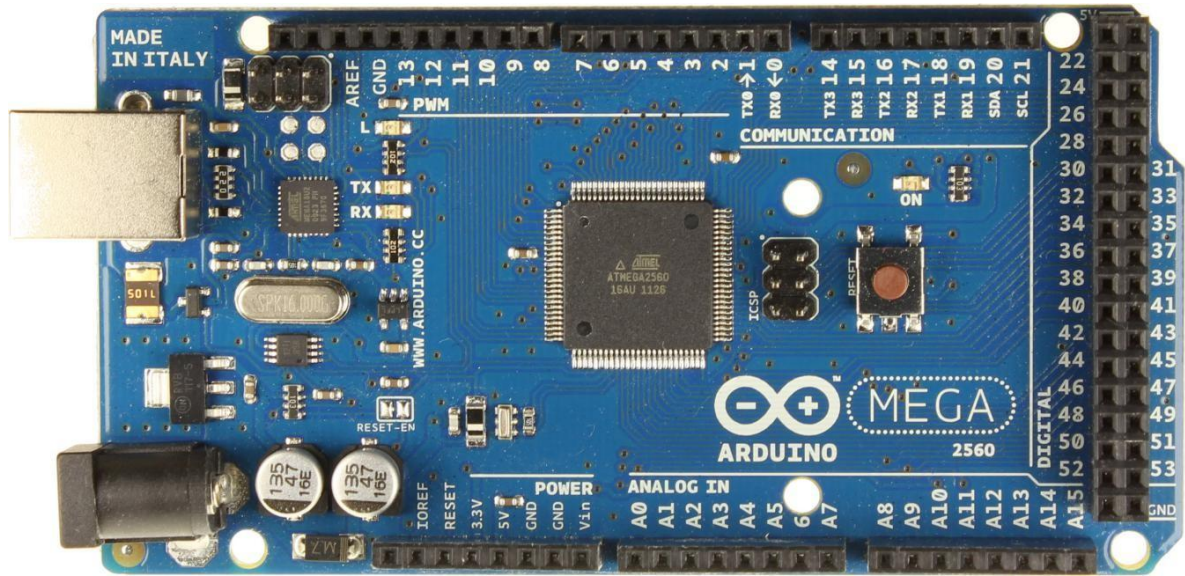


Fig 4.1 Arduino Mega 2650

4.1.2 Temperature Sensor

The LM78XX series of three terminal regulators is available with several fixed output voltages making them useful in a wide range of applications. One of these is local on card regulation, eliminating the distribution problems associated with single point regulation. The voltages available allow these regulators to be used in logic systems, instrumentation, HiFi, and other solid state electronic equipment. Although designed primarily as fixed voltage regulators these devices can be used with external components to obtain adjustable voltages and currents. The LM78XX series is available in an aluminum TO-3 package which will allow over 1.0A load current if adequate heat sinking is provided. Current limiting is included to limit the peak output current to a safe value. Safe area protection for the output transistor is provided to limit internal power dissipation. If internal power dissipation becomes too high for the heat sinking provided, the thermal shutdown circuit takes over preventing the IC from overheating. Considerable effort was expended to make the LM78XX series of regulators easy to use and minimize the number of external components. It is not necessary to bypass the output, although this does improve transient response. Input by-passing is needed only if the regulator is located far

from the filter capacitor of the power supply. For output voltage other than 5V, 12V and 15V the LM117series provides an output voltage range from 1.2V to 57V.

4.1.3 KY Sensor

Ky-039 is a Low cost Heart beat Sensing Module. This Heart beat detection module uses bright infrared (ir) led and a photo-transistor to detect the pulse of the finger, a red led flashes with each pulse. The sensor is made to shine an infrared led through your finger. The infrared sensor on the other side can then pick up slight changes in the light transmittance through your finger when blood is pumped in. When the sensor senses light, it becomes more resistant, causing the voltage reading in the serial monitor to go down. However, if your sensor is anything like mine, the LED is not bright enough to be detected by the sensor even when nothing is obstructing it, so the sensor constantly reads 5v. I tried replacing the LED with a stronger one and got slightly better results, but I don't think the sensor itself is sensitive enough to be able to detect a heartbeat over random noise and movements. You could try replacing the sensor as well, but then you've just replaced the entire module. Continue as you see fit. The sensor is a simple 3-pinned analog sensor. Plug the ground in the -, the 5v to the middle pin and A0 to the S pin.



Fig 4.2 KY sensor

4.1.4 ESP8266 Node MCU WiFi

The ESP8266 is the name of a micro controller designed by Espressif Systems. The ESP8266 itself is a self-contained WiFi networking solution offering as a bridge from existing micro controller to WiFi and is also capable of running self-contained applications. This module comes with a built in USB connector and a rich assortment of pin-outs. With a micro USB cable, you can connect NodeMCU devkit to your laptop and flash it without any trouble, just like Arduino. It is also immediately breadboard friendly. The ESP8266 is a low-cost Wi-Fi microchip, with built-in TCP/IP networking software, and microcontroller capability, produced by Espressif Systems in Shanghai, China. The chip first came to the attention of Western makers in August 2014 with the ESP-01 module, made by a third-party manufacturer Ai-Thinker. The ESP8266 WiFi Module is a self contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all WiFi networking functions from another application processor.

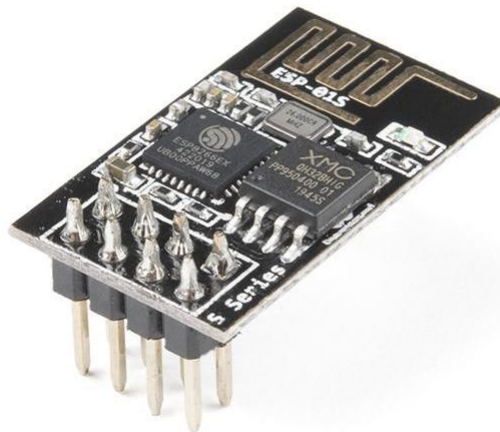


Fig 4.3 ESP8266 node MCU

4.1.5 LM35 Sensor

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of $\pm 1/4^\circ\text{C}$ at room temperature and $\pm 3/4^\circ\text{C}$ over a full -55 to $+150^\circ\text{C}$ temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only $60\text{ }\mu\text{A}$ from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35 is rated to operate over a -55 to $+150^\circ\text{C}$ temperature range, while the LM35C is rated for a -40 to $+110^\circ\text{C}$ range (-10 with improved accuracy). The LM35 series is available packaged in hermetic TO-46 transistor packages, while the LM35C, LM35CA, and LM35D are also available in the plastic TO-92 transistor package. The LM35D is also available in an 8-lead surface mount small outline package and a plastic TO-220 package.

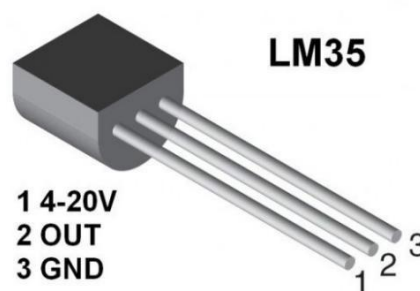
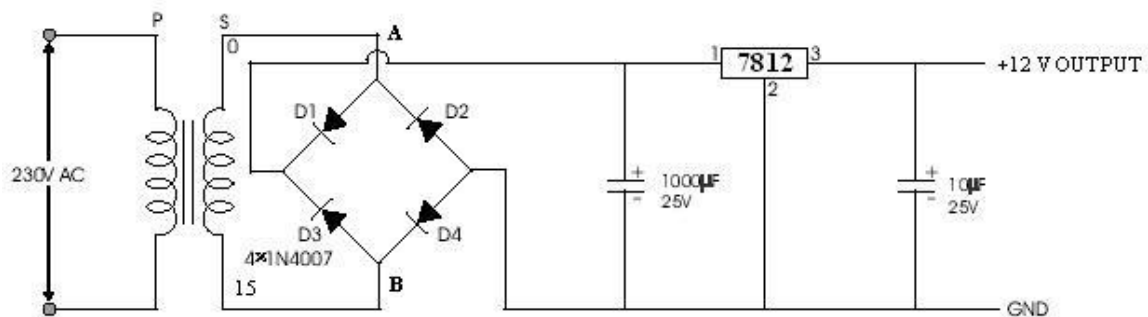


Fig 4.4 LM35 sensor

4.1.6 Power Supply

The ac voltage, typically 220V rms, is connected to a transformer, which steps that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation. A regulator circuit removes the ripples and also remains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.



4.5 POWER SUPPLY

A. Working principle

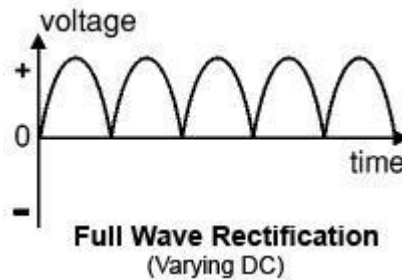
I. Transformer

The potential transformer will step down the power supply voltage (0-230V) to (0-15V) level. If the secondary has less turns in the coil than the primary, the secondary coil's voltage will decrease and the current or AMPS will increase or decreased depend upon the wire gauge. This is called a STEP-DOWN transformer. Then the secondary of the potential transformer will be connected to the rectifier.

II. Bridge rectifier

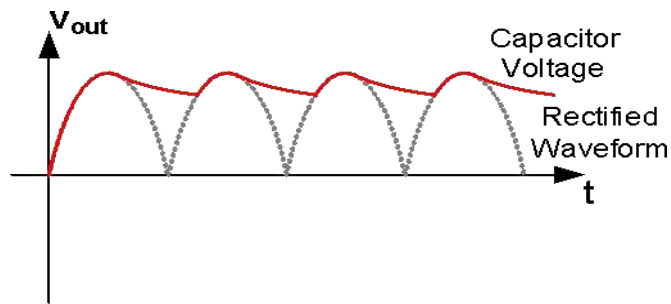
When four diodes are connected as shown in figure, the circuit is called as bridge rectifier. The input to the circuit is applied to the diagonally opposite corners of the network, and the output is taken from the remaining two corners. Let us assume

that the transformer is working properly and there is a positive potential, at point A and a negative potential at point B. the positive potential at point A will forward bias



D3 and reverse bias D4.

The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow current flow to pass through them; D4 and D2 are reverse biased and will block current flow. The path for current flow is from point B through D1, up through Load, through D3, through the secondary of the transformer back to point B. One-half cycle later the polarity across the secondary of the transformer reverse, forward biasing D2 and D4 and reverse biasing D1 and D3. Current flow will now be from point A through D4, up through Load, through D2, through the secondary of transformer, and back to point A. Across D2 and D4. The current flow through Load is always in the same direction. In flowing through Load this current develops a voltage corresponding to that. Since current flows through the load during both half cycles of the applied voltage, this bridge rectifier is a full-wave rectifier. One advantage of a bridge rectifier over a conventional full-wave rectifier is that with a given transformer the bridge rectifier produces a voltage output that is nearly twice that of the conventional half-wave circuit. This bridge rectifier always drops 1.4 Volt of the input voltage because of the diode. We are using 1N4007 PN junction diode, its cut off region is 0.7 Volt. So any two diodes are always conducting, total drop voltage is 1.4 volt.



III. Filter

If a Capacitor is added in parallel with the load resistor of a Rectifier to form a simple Filter Circuit, the output of the Rectifier will be transformed into a more stable DC Voltage. At first, the capacitor is charged to the peak value of the rectified Waveform. Beyond the peak, the capacitor is discharged through the load resistor until the time at which the rectified voltage exceeds the capacitor voltage. Then the capacitor is charged again and the process repeats itself.

IV. IC voltage regulators

Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustably set voltage. A fixed three-terminal voltage regulator has an unregulated dc input voltage, it is applied to one input terminal, a regulated dc output voltage from a third terminal, with the second terminal connected to ground. The series 78 regulators provide fixed positive regulated voltages from 5 to 24 volts. Similarly, the series 79 regulators provide fixed negative regulated voltages from 5 to 24 volts. This is a regulated power supply circuit using the 78xx IC series. These regulators can deliver current around 1A to 1.5A at a fix voltage levels. The common regulated voltages are 5V, 6V, 8V, 9V, 10V, 12V, 15V, 18V, and 24V. It is important to add capacitors across the input and output of the regulator IC to improve the regulation. In this circuit we are using 7812 regulator so it converts variable dc into constant positive 5V power supply. If the input voltage goes to below 14.6Volt means the output also varied. That is why we are using 230/15V step-down transformer. Transformer output is higher than the regulator minimum level input.

4.1.7 LCD Display

Liquid crystal displays (LCDs) have materials which combine the properties of both liquids and crystals. Rather than having a melting point, they have a temperature range within which the molecules are almost as mobile as they would be in a liquid, but are grouped together in an ordered form similar to a crystal. An LCD consists of two glass panels, with the liquid crystal material sandwiched in between them. The inner surface of the glass plates are coated with transparent electrodes which define the character, symbols or patterns to be displayed. Polymeric layers are present in between the electrodes and the liquid crystal, which makes the liquid crystal molecules to maintain a defined orientation angle. On each polariser is pasted outside the two glass panels. These polarisers would rotate the light rays passing through them to a definite angle, in a particular direction. When the LCD is in the off state, light rays are rotated by the two polarisers and the liquid crystal, such that the light rays come out of the LCD without any orientation, and hence the LCD appears transparent. When sufficient voltage is applied to the electrodes, the liquid crystal molecules would be aligned in a specific direction. The light rays passing through the LCD would be rotated by the polarisers, which would result in activating / highlighting the desired characters. The LCD's are lightweight with only a few millimeters thickness. Since the LCD's consume less power, they are compatible with low power electronic circuits, and can be powered for long durations. The LCD's don't generate light and so light is needed to read the display. By using backlighting, reading is possible in the dark. The LCD's have long life and a wide operating temperature range. Changing the display size or the layout size is relatively simple which makes the LCD's more customer friendly. The LCDs used exclusively in watches, calculators and measuring instruments are the simple seven-segment displays, having a limited amount of numeric data. The recent advances in technology have resulted in better legibility, more information displaying capability and a wider temperature range. These have resulted in the LCDs being extensively used in telecommunications and entertainment electronics.

The LCDs have even started replacing the cathode ray tubes (CRTs) used for the display of text and graphics, and also in small TV applications.

A. POWER SUPPLY:

The power supply should be of +5V, with maximum allowable transients of 10mv. To achieve a better / suitable contrast for the display, the voltage (VL) at pin 3 should be adjusted properly. A module should not be inserted or removed from a live circuit. The ground terminal of the power supply must be isolated properly so that no voltage is induced in it. The module should be isolated from the other circuits, so that stray voltages are not induced, which could cause a flickering display.

B. HARDWARE:

Develop a uniquely decoded 'E' strobe pulse, active high, to accompany each module transaction. Address or control lines can be assigned to drive the RS and R/W inputs. Utilize the Host's extended timing mode, if available, when transacting with the module. Use instructions, which prolong the Read and Write or other appropriate data strobes, so as to realize the interface timing requirements. If a parallel port is used to drive the RS, R/W and 'E' control lines, setting the 'E' bit simultaneously with RS and R/W would violate the module's set up time. A separate instruction should be used to achieve proper interfacing timing requirements.

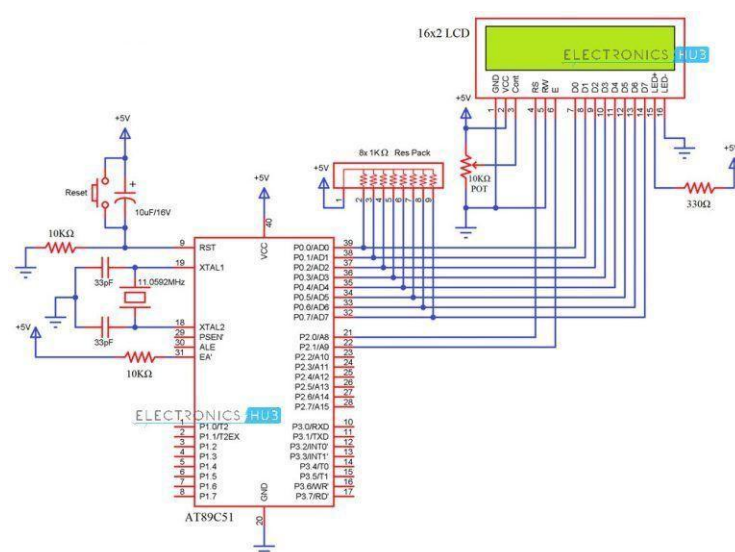
C. MOUNTING:

Cover the display surface with a transparent protective plate, to protect the polarizer. Don't touch the display surface with bare hands or any hard materials. This will stain the display area and degrade the insulation between terminals. Do not use organic solvents to clean the display panel as these may adversely affect tape or with absorbant cotton and petroleum benzene. The processing or even a slight deformation of the claws of the metal frame will have effect on the connection

of the output signal and cause an abnormal display. Do not damage or modify the pattern wiring, or drill attachment holes in the PCB. When assembling the module into another equipment, the space between the module and the fitting plate should have enough height, to avoid causing stress to the module surface. Make sure that there is enough space behind the module, to dissipate the heat generated by the ICs while functioning for longer durations. When an electrically powered screwdriver is used to install the module, ground it properly. While cleaning by a vacuum cleaner, do not bring the sucking mouth near the module. Static electricity of the electrically powered driver or the vacuum cleaner may destroy the module.

D. ENVIRONMENTAL PRECAUTIONS:

Operate the LCD module under the relative condition of 40°C and 50% relative humidity. Lower temperature can cause retardation of the blinking speed of the display, while higher temperature makes the overall display discolor. When the temperature gets to be within the normal limits, the display will be normal. Polarization degradation, bubble generation or polarizer peel-off may occur with high temperature and humidity. Contact with water or oil over a long period of time may cause deformation or colour fading of the display. Condensation on the terminals can cause electro-chemical reaction disrupting the terminal circuit.



4.1.8 ESP 12E WIFI Module

ESP-12E WiFi module is developed by Ai-thinker Team. core processor ESP8266 in smaller sizes of the module encapsulates Tensilica L106 integrates industry-leading ultra low power 32-bit MCU micro, with the 16-bit short mode, Clock speed support 80 MHz, 160 MHz, supports the RTOS, integrated Wi-Fi MAC/BB/RF/PA/LNA, on-board antenna. The module supports standard IEEE802.11 b/g/n agreement, complete TCP/IP protocol stack. Users can use the add modules to an existing device networking, or building a separate network controller. ESP8266 is high integration wireless SOCs, designed for space and power constrained mobile platform designers. It provides unsurpassed ability to embed Wi-Fi capabilities within other systems, or to function as a standalone application, with the lowest cost, and minimal space requirement. ESP8266EX offers a complete and self-contained Wi-Fi networking solution; it can be used to host the application or to offload Wi-Fi networking functions from another application processor. When ESP8266EX hosts the application, it boots up directly from an external flash. It has integrated cache to improve the performance of the system in such applications. Alternately, serving as a Wi-Fi adapter, wireless internet access can be added to any micro controllerbased design with simple connectivity (SPI/SDIO or I2C/UART interface). ESP8266EX is among the most integrated WiFi chip in the industry; it integrates the antenna switches, RF balun, power amplifier, low noise receive amplifier, filters, power management modules, it requires minimal external circuitry, and the entire solution, including front-end module, is designed to occupy minimal PCB area. ESP8266EX also integrates an enhanced version of Tensilica's L106 Diamond series 32-bit processor, with on-chip SRAM, besides the Wi-Fi functionalities. ESP8266EX is often integrated with external sensors and other application specific devices through its GPIOs; codes for such applications are provided in examples in the SDK. Espressif Systems' Smart Connectivity Platform (ESCP) demonstrates sophisticated system-level features include fast sleep/wake context switching for energy-efficient VoIP, adaptive radio biasing. for low-power operation, advance signal processing,

and spur cancellation and radio co-existence features for common cellular, Bluetooth, DDR, LVDS, LCD interference mitigation.

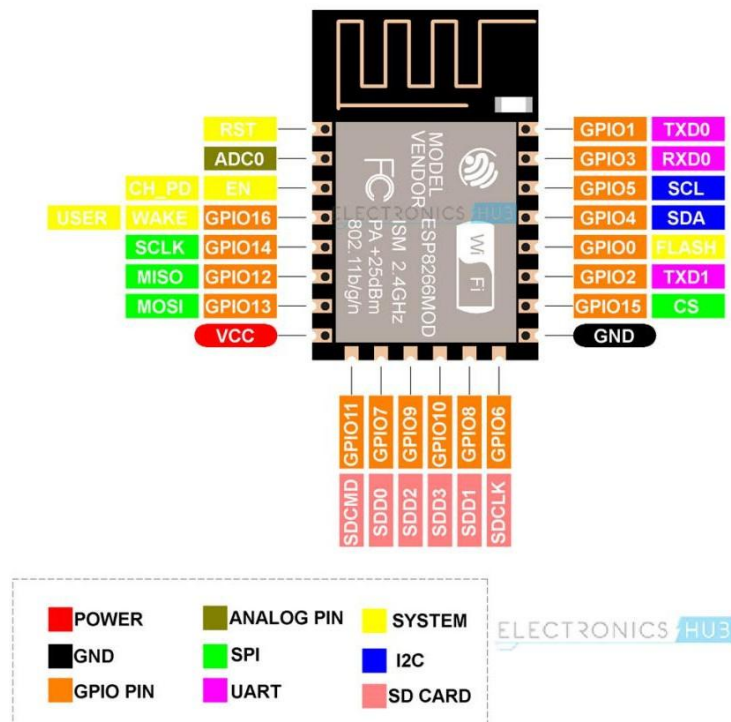


Fig 4.7 ESP 12E WIFI Module

I. Functional Descriptions

MCU

ESP8266EX is embedded with Tensilica L106 32-bit micro controller (MCU), which features extra low power consumption and 16-bit RSIC. The CPU clock speed is 80MHz. It can also reach a maximum value of 160MHz. ESP8266EX is often integrated with external sensors and other specific devices through its GPIOs; codes for such applications are provided in examples in the SDK.

II. Memory Organization

Internal SRAM and ROM

ESP8266EX WiFi SoC is embedded with memory controller, including SRAM and ROM. MCU can visit the memory units through iBus, dBus, and AHB interfaces. All memory units can be visited upon request, while a memory arbiter will decide the running sequence according to the time when these requests are received by the processor. According to our current version of SDK provided, SRAM space that is

available to users is assigned as below:

- RAM size < 36kB, that is to say, when ESP8266EX is working under the station mode and is connected to the router, programmable space accessible to user in heap and data section is around 36kB.)
- There is no programmable ROM in the SoC, therefore, user program must be stored in an external SPI flash.

External SPI Flash

This module is mounted with an 4 MB external SPI flash to store user programs. If larger definable storage space is required, a SPI flash with larger memory size is preferred. Theoretically speaking, up to 16 MB memory capacity can be supported.

Suggested SPI Flash memory capacity:

- OTA is disabled: the minimum flash memory that can be supported is 512 kB;
- OTA is enabled: the minimum flash memory that can be supported is 1 MB.

Several SPI modes can be supported, including Standard SPI, Dual SPI, and Quad SPI. Therefore, please choose the correct SPI mode when you are downloading into the flash, otherwise firmwares/programs that you downloaded may not work in the right way.

Crystal

Currently, the frequency of crystal oscillators supported include 40MHz, 26MHz and 24MHz. The accuracy of crystal oscillators applied should be $\pm 10\text{PPM}$, and the operating temperature range should be between -20°C and 85°C . When using the downloading tools, please remember to select the right crystal oscillator type. In circuit design, capacitors C1 and C2, which are connected to the earth, are added to the input and output terminals of the crystal oscillator respectively. The values of the two capacitors can be flexible, ranging from 6pF to 22pF, however, the specific capacitive values of C1 and C2 depend on further testing and adjustment on the overall performance of the whole circuit. Normally, the capacitive values of C1 and C2 are within 10pF if the crystal oscillator frequency is 26MHz, while the values of C1 and C2 are $10\text{pF} < \text{C1}, \text{C2} < 22\text{pF}$ if the crystal oscillator frequency is 40MHz.

4.1.9 LED

A Light emitting diode (LED) is essentially a pn junction diode. When carriers are injected across a forward-biased junction, it emits incoherent light. Most of the commercial LEDs are realized using a highly doped n and a p Junction. To understand the principle, let's consider an unbiased pn⁺ junction (Figure1 shows the pn⁺ energy band diagram). The depletion region extends mainly into the p-side. There is a potential barrier from E_c on the n-side to the E_c on the p-side, called the built-in voltage, V_0 . This potential barrier prevents the excess free electrons on the n⁺ side from diffusing into the p side. When a Voltage V is applied across the junction, the built-in potential is reduced from V_0 to $V_0 - V$. This allows the electrons from the n⁺ side to get injected into the p-side. Since electrons are the minority carriers in the p-side, this process is called minority carrier injection. But the hole injection from the p side to n⁺ side is very less and so the current is primarily due to the flow of electrons into the p-side. These electrons injected into the p-side recombine with the holes. This recombination(see Appendix 1) results in spontaneous emission of photons (light). This effect is called injection electro luminescence. These photons should be allowed to escape from the device without being reabsorbed.

The recombination can be classified into the following two kinds

- Direct recombination
- Indirect recombination

a) Direct Recombination:

In direct band gap materials, the minimum energy of the conduction band lies directly above the maximum energy of the valence band in momentum space energy shows the E-k plot(see Appendix 2) of a direct band gap material). In this material, free electrons at the bottom of the conduction band can recombine directly with free holes at the top of the valence band, as the momentum of the two particles is the same. This transition from conduction band to valence band involves photon emission (takes care of the principle of energy conservation). This is known as direct recombination. Direct recombination occurs spontaneously.

GaAs is an example of a direct band-gap material.

b) Indirect Recombination:

In the indirect band gap materials, the minimum energy in the conduction band is shifted by a k -vector relative to the valence band. The k -vector difference represents a difference in momentum. Due to this difference in momentum, the probability of direct electron-hole recombination is less. In these materials, additional dopants (impurities) are added which form very shallow donor states. These donor states capture the free electrons locally; provides the necessary momentum shift for recombination. These donor states serve as the recombination centers. This is called Indirect (non-radiative) Recombination. the E - k plot of an indirect band gap material and an example of how Nitrogen serves as a recombination center in GaAsP. In this case it creates a donor state, when SiC is doped with Al, it recombination takes place through an acceptor level. The indirect recombination should satisfy both conservation energy, and momentum. Thus besides a photon emission, phonon (See Appendix 3) emission or absorption has to take place. GaP is an example of an indirect band-gap material.

4.2 SOFTWARE USED:

4.2.1 ARDUINO IDE

A cross platform framework (for Windows, macOS and Linux) written with functions C and C++ is an Arduino Integrated Development Environment (IDE). It is used for writing and uploading Arduino compatible applications, but also for other developer boards with the support of third-party core systems. The IDE source code is released under the GNU General Public License, version 2. The Arduino IDE uses special code structuring guidelines to support the languages C and C++. The Arduino IDE supplies a wiring project software library that provides a number of common input and output procedures. User-written code only needs two simple functions to start the sketch and the main program loop, which are compiled and connected into an executable cyclic executive program with the GNU tool chain, which is also included with the IDE distribution. The Arduino IDE uses the software

to translate the source codes to a text file in hexadecimal that is loaded into the Arduino board by a loader program in the circuitry of the board.

➤ Initial Setup

If the Arduino IDE has been opened, here is what it looks like. It opens in a blank sketch where you can start programming right away. First, we need to customize the board and port settings to enable us to upload code. Connect your Arduino board to your PC with a USB cable.



Fig 4.8 Arduino IDE

4.2.2 Thingspeak

According to the programmers, "Thing Speak is an open access IoT program and API for storing and retrieving data from things over the Internet or a Local Area Network using the HTTP protocol. Thing Speak allows the development of sensor monitoring apps, location tracking applications, and a social network of objects with status updates.

Features

- Configure devices to share data through common IoT protocols through Thing Speak
- Real-time display of the sensor data



Fig 4.0 ThingSpeak

4.3 ARDUINO CODE

4.3.1 IOT Node

```
#include <ESP8266WiFi.h>
```

```
#include <SoftwareSerial.h>
```

```
#include "ThingSpeak.h"
```

```
SoftwareSerial ard_node(D5, D6); // red/org
```

```
int a, b;
```

```
char ssid1[] = "Balaji";
```

```
char password1[] = "123456789";
```

```
unsigned long channelID = 1593519;
```

```
const char * writeAPIKey = "AY3CEYNEU09ZDWIG"; // write API key for your  
ThingSpeak Channel
```

```
const char* server = "api.thingspeak.com";
```

```
String th;
```

```
String modefn = "";
```

```
int tup = 20;
```

```
WiFiClient client;
```

```
float temp_fn;
```

```
int pul_fn, sYs, dla, gul_fn;
```

```
void setup() {
```

```
    // put your setup code here, to run once:
```

```
    Serial.begin(115200);
```

```
    ard_node.begin(115200);
```

```
    ard_node.println("");
```

```
    delay(200);
```

```
    setupWifi();
```

```
    Serial.print("Connecting to ThingSpeak");
```

```
    ThingSpeak.begin(client);
```

```
}
```

```
void setupWifi() {
```

```
    Serial.println();
```

```
    Serial.println();
```

```
    Serial.print(ssid1);
```

```
    WiFi.begin(ssid1, password1);
```

```
    Serial.print("Connecting to ");
```

```
    while (WiFi.status() != WL_CONNECTED)
```

```
    {
```

```

        delay(800);
        Serial.print(".");
        Serial.println("");
        Serial.println("WiFi connected");
        Serial.println("IP address: ");
        Serial.println(WiFi.localIP());
        delay(1000);
    }
}

void loop() {

    getArd();
    UpdateServer();
    delay(50);
}

void getArd() {
    String SS = ""; String SSs = "";
    while (ard_node.available() > 0) {

        char S = ard_node.read();
        SS += S;

        delay(10);

    }
    if (SS.length() > 0)
        {Serial.println(SS);
        String temp = getSplitValue(SS , ',', 0);
        String pul =  getSplitValue(SS , ',', 1);

```

```

String sys = getSplitValue(SS , ',', 2);
String dia = getSplitValue(SS , ',', 3);
String gul = getSplitValue(SS , ',', 4);

temp_fn = temp.toFloat();
pul_fn = pul.toInt();
sYs = sys.toInt();
dla = dia.toInt();
gul_fn = gul.toInt();
ard_node.flush();

}
}

void UpdateServer() {

    tup++;
    if (tup >= 250) {

        if (client.connect(server, 80)) {

            ThingSpeak.setField(1, String(temp_fn));
            ThingSpeak.setField(2, String(pul_fn));
            ThingSpeak.setField(3, String(sYs));
            ThingSpeak.setField(4, String(dla));
            ThingSpeak.setField(5, String(gul_fn));

            // write to the ThingSpeak channel
            int x = ThingSpeak.writeFields(channelID, writeAPIKey);

```

```

        if (x == 200) {
            Serial.println("Channel update successful.");

        }
        else {
            Serial.println("Problem updating channel. HTTP error code " + String(x));

        }
    }
    tup = 0;
}

}

```

4.3.2 Split

```

String getSplitValue(String data, char separator, int index)
{
    int found = 0;
    int strIndex[] = { 0, -1 };
    int maxIndex = data.length() - 1;
    for (int i = 0; i <= maxIndex && found <= index; i++)
        {if (data.charAt(i) == separator || i == maxIndex) {
            found++;
            strIndex[0] = strIndex[1] + 1;
            strIndex[1] = (i == maxIndex) ? i + 1 : i;
        }
    }
    return found > index ? data.substring(strIndex[0], strIndex[1]) : "";
}

```

4.3.3 Splash

```

void splash1( int row, String txt)
{
    int curs = (17 - txt.length()) / 2;
    lcd.setCursor(0, row);
    lcd.print("_____");

    lcd.setCursor(curs, row);
    lcd.print(txt);
    delay(100);
}

void splash2( int row, String txt)
{
    int curs = (21 - txt.length()) / 2;
    lcd.setCursor(0, row);
    lcd.print("_____");
    lcd.setCursor(curs, row);
    lcd.print(txt);
    delay(70);
}

```

4.3.3 Mega

```
#include<LiquidCrystal.h>
```

```
#include <Wire.h>//sda scl
```

```
#include <BH1750.h>
```

```
BH1750 gul;
```

```
LiquidCrystal lcd(13, 12, 11, 10, 9, 8);
```

```
#define ard_mega Serial1
```

```

#define mega_node Serial2
#define splash splash2

#define temp A0
//#define gul A1
#define pul A2

int setDispC = 0;
int pul_fn, pul_c, sYs, dla;
float temp_fn;
int gul_fn;

void setup() {
    // put your setup code here, to run once:
    Serial.begin(9600);
    Wire.begin();
    ard_mega.begin(9600);
    mega_node.begin(115200);
    ard_mega.println("");

    LcDSet();
    splash(0, "Initializing");
    splash(1, "Sensors");
    pinMode(temp, INPUT);
    pinMode(pul, INPUT);
    gul.begin(); delay(2000);
    lcd.clear();
}

```

```

void LcdSet() {

    lcd.begin(20, 4);
    splash(0, "IoT Based");
    splash(1, "Patient");
    splash(2, "Health");
    splash(3, "Monitoring");
    delay(3000); lcd.clear();

}

void loop() {

    getArd();
    setDispC++;
    float temp_r  = analogRead(temp);
    pul_fn = analogRead(pul);
    gul_fn =  gul.readLightLevel();

    temp_fn = ( temp_r * 5.0 * 100 ) / 1023;

    pul_fn = ( pul_fn * 3.0 * 3.6 ) / 60;
    if (pul_fn < 20) {
        pul_fn = 0;
    }

    gul_fn = ( gul_fn * 4.2 * 12 ) / 100 ;

    if (gul_fn > 500 or gul_fn < 0) {

```

```

        gul_fn = 0;
    }
    if (setDispC > 10)
    {
        setDisp();
        setDispC = 0;
    }

    delay(100);

}

void setDisp() {

    lcd.setCursor(0, 0);
    lcd.print("Temp :          ");
    lcd.setCursor(9, 0);
    lcd.print(temp_fn);

    lcd.setCursor(0, 3);
    lcd.print("HB          :          ");
    lcd.setCursor(9, 3);
    lcd.print(pul_fn);

    lcd.setCursor(0, 1);
    lcd.print("BP SYS :          ");
    lcd.setCursor(9, 1);

```

```

lcd.print(sYs);

lcd.setCursor(0, 2);
lcd.print("BP DIA :          ");
lcd.setCursor(9, 2);
lcd.print(dIa);

lcd.setCursor(13, 2);
lcd.print("GLU  ");
lcd.setCursor(13, 3);
lcd.print(gul_fn);

mega_node.print(temp_fn);
mega_node.print(",");
mega_node.print(pul_fn);
mega_node.print(",");
mega_node.print(sYs);
mega_node.print(",");
mega_node.print(dIa);
mega_node.print(",");
mega_node.print(gul_fn);
mega_node.println();
}

void getArd() {
    String SS = ""; String SSs = "";
    while (ard_mega.available() > 0) {

        char S = ard_mega.read();
        SS += S;
        //SS = ard_mega.readString();
    }
}

```

```

    delay(10);
    //Serial.println(SS);
}
if (SS.length() > 0) {
    //    Serial.println(SS);
    String pul = getSplitValue(SS , ',', 0);
    String sys =  getSplitValue(SS , ',', 1);
    String dia =  getSplitValue(SS , ',', 2);
    //    //
    pul_fn = pul.toInt();
    sYs = sys.toInt();
    dla = dia.toInt();
    Serial.print(pul_fn);
    Serial.print(" , ");
    Serial.print(sYs);
    Serial.print(" , ");
    Serial.print(dla);
    Serial.println();
    ard_mega.flush();
    SS = "";
}
}

```

4.4 BLOCK DIAGRAM

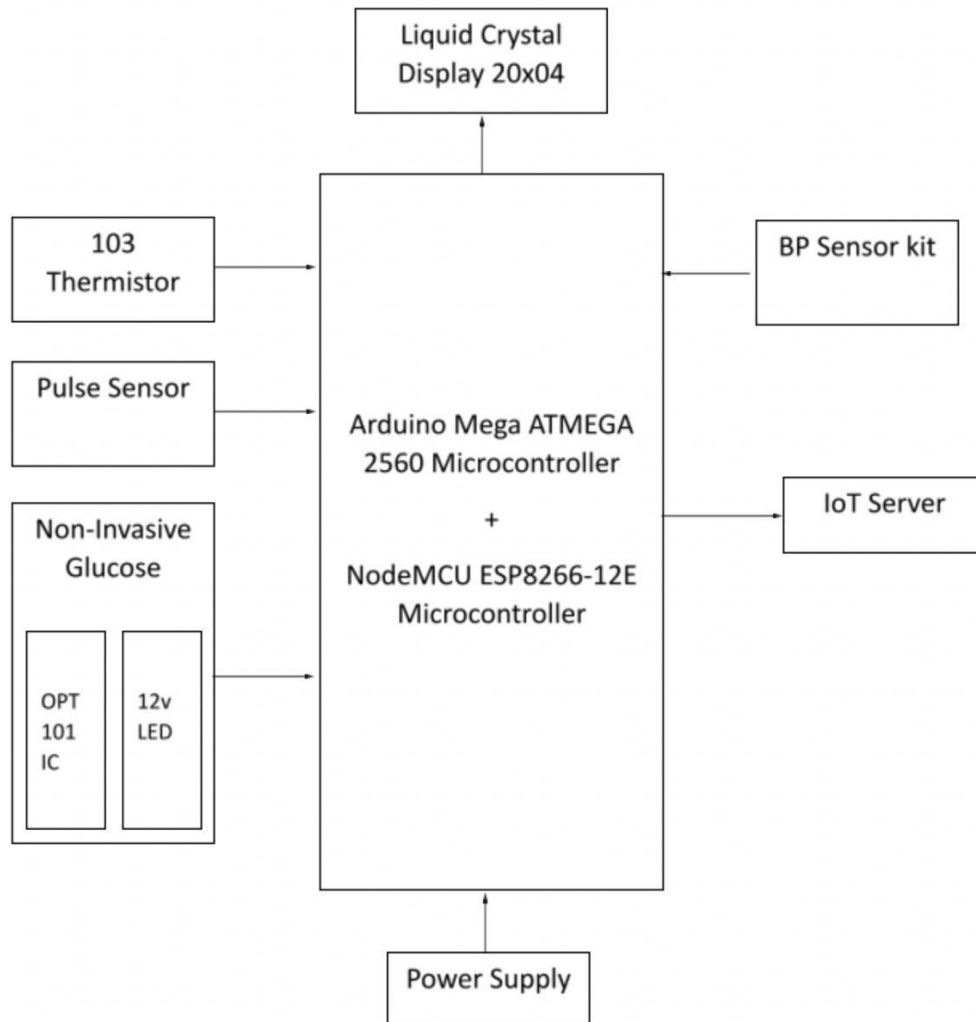


Fig 4.10 Block Diagram Of Patient Monitoring System

CHAPTER 5

5.1 RESULTS

5.1.1 Glucose

Once we placed the index finger on the sensor, It reacts with the program and it will generate the output

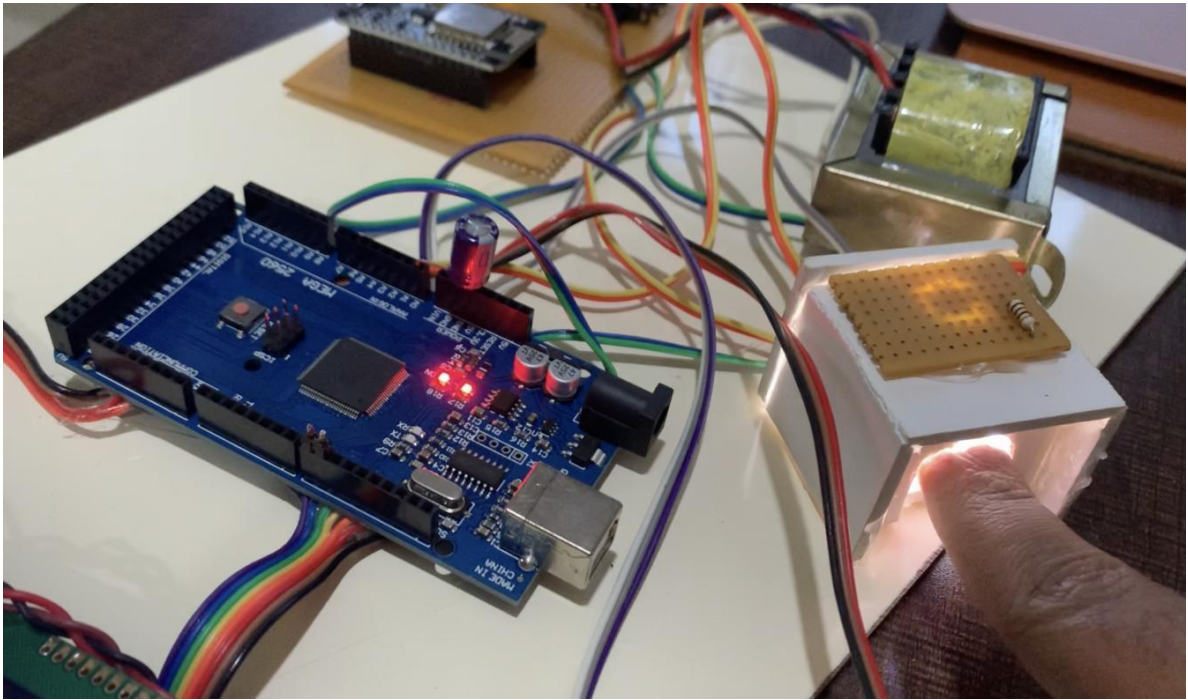


Fig 5.1 Glucose sensor

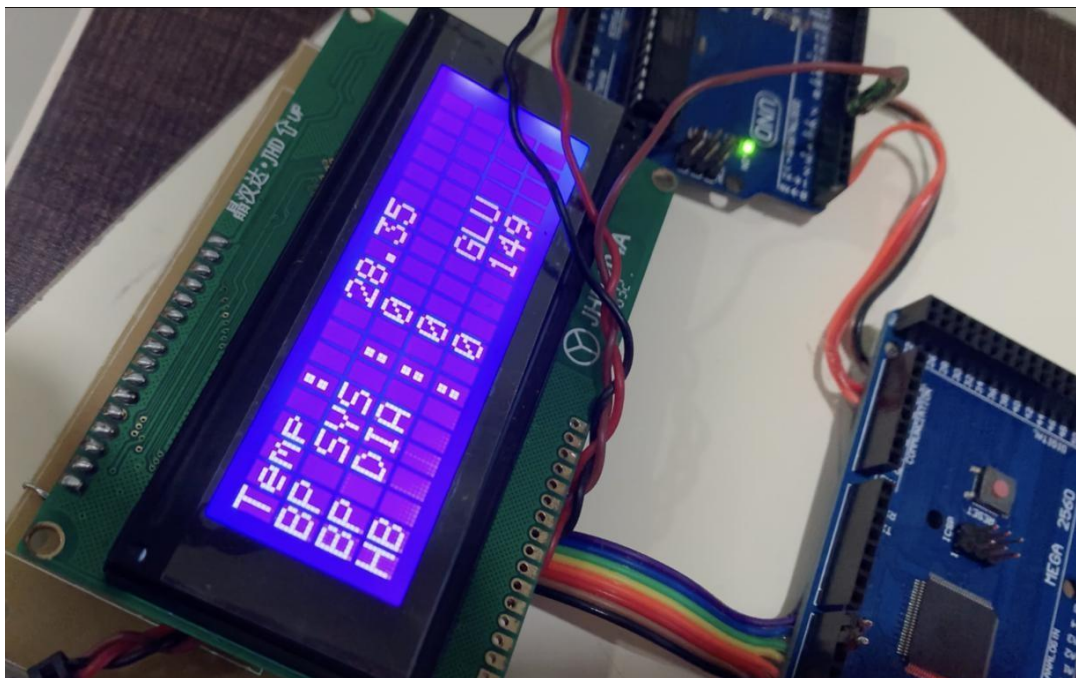


Fig 5.2 Output for glucose

5.1.2 Temperature

As we place the finger in the sensor, the output will generate

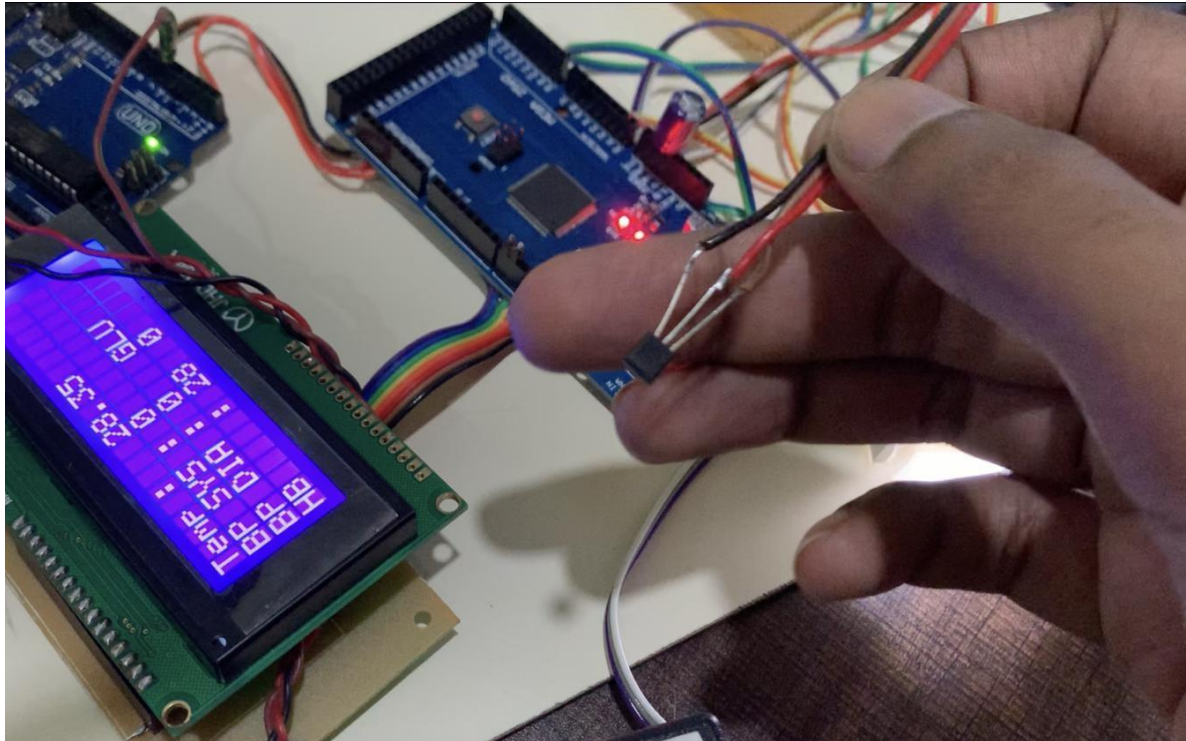


Fig 5.3 Temperature Sensor

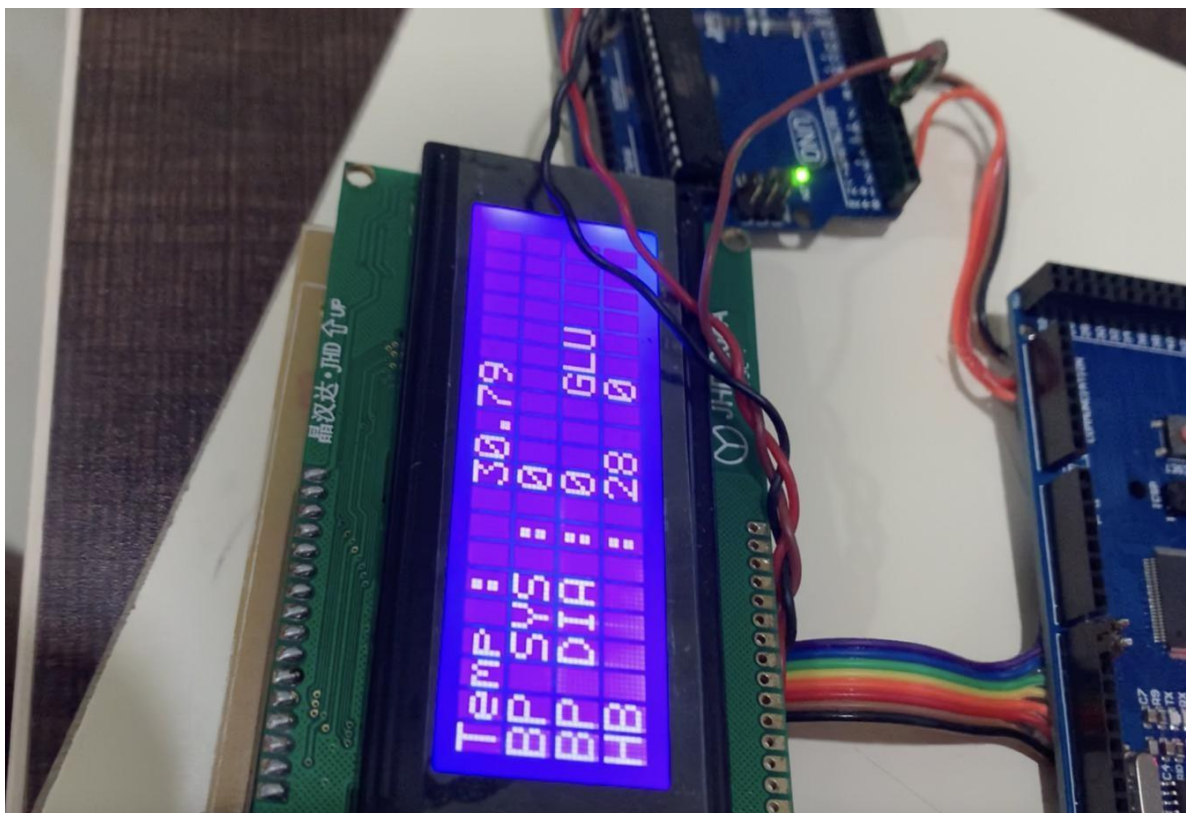


Fig 5.4 Output for Temperature

5.1.3 Heart Beat

As we place the finger in the sensor, the output will generate

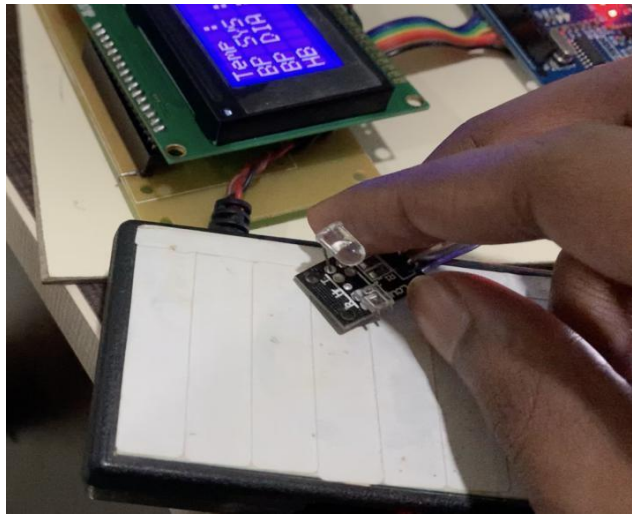


Fig 5.5 IR sensor

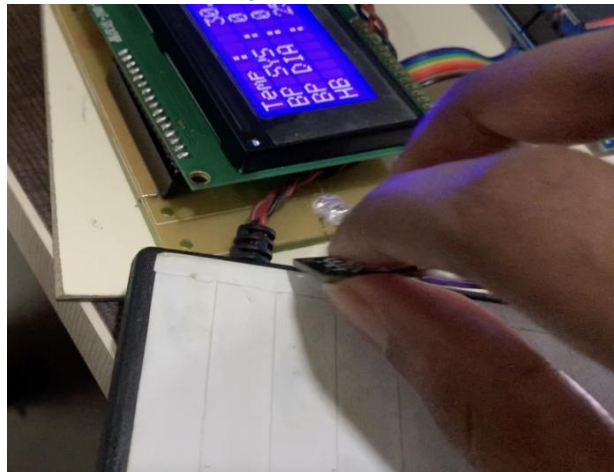


Fig 5.6 Finger placing on IR sensor



Fig 5.7 Output for Heart Beat

5.1.4 Blood Pressure (Systole & Diastole)

The Index finger left or right hand can place on IR sensor, Through Photo-Plethismography technique The output gets generated



FIG 5.8 Photo Plethismography Technique / Output for BP

5.1.5 THINGSPEAK IOT STORAGE

The graphical output at the Thing Speak cloud is seen and can be used only after logging in to the Thing Speak website with username and password, and the data can be downloaded as the excel form.



Fig 5.9 Thingspeak Representation

5.2 Discussion

The main findings with regard to the research questions are summarized and general conclusions based on the findings of the studies presented in this thesis are described. Furthermore, the strengths and limitations of this thesis are considered and discussed.

5.2.1 Findings

The findings of the study were obtained from the prototype testing results and the system usability questionnaire administered. It presents some of the results obtained from the system usability survey. The subsections below present a detailed description of the findings.

5.2.2 Convenience

The convenience was also measured 45.5% strongly agreeing that the system was highly convenient. An additional 36.4% agreeing that the system was convenient. And another 18.2 % were respondent neutral.

5.2.3 Performance

On performance, we subjected the respondents on the Patient monitoring capabilities of the system. 40% of the respondents agreed that Patient Monitoring on BP Findings and Temperature is easier and takes shorter duration as compared to the current method. 30% disagreed to this and another 30% respondent neutrally with comments.

5.2.4 User Interface

From the survey, 77.8% of the sample population agreed that the user interface was very friendly. The other 11% disagreed that it was not friendly, and another 11% . In a differently survey questions, 70% respondent that they could use the system with minimum training 20% disagreed with this and another 10% respondent neutrally with different comments.

CHAPTER-6

SUMMARY AND CONCLUSION

6.1 SUMMARY AND CONCLUSION

Health monitoring is a major problem in today's world. Due to a lack of proper health monitoring, patients suffer from serious health issues. In a hospital, either the nurse or the doctor has to move physically from one person to another for the health check, which may not be possible to monitor their conditions continuously. Thus, any critical situations cannot be found easily unless the nurse or doctor checks the person's health at that moment. This may be a strain for the doctors who have to take care of a lot number of people in the hospital. Also, when medical emergencies happen to the patient, they are often unconscious and unable to press an Emergency Alert Button. In this project, we will make an IoT-based Health Monitoring System that records the patient's blood pressure (Non-Invasive Method), blood glucose (Non-Invasive Method), heartbeat rate, and body temperature. Health experts can also take advantage of these smart devices to keep an eye on their patients from anywhere in the world.

6.2 FUTURE WORK

Our work has been done for 4 parameter as the first step to get the output as Non-invasive, To continue the process, We need to further work on the Calibration process with the standard one to check the output values we got from the prototype are correct or not and the second step to be followed is, continue the process with add on some extra parameter into it to get collective information data of patients in one prototype. Then the final fabrication should be done to get the exact value from the prototype and to view the LCD screen only. Fabrication avoids the disconnection of wire.

6.3 Conclusion

The Internet of Things is considered now as one of the feasible solutions for any remote value tracking especially in the field of health monitoring. It facilitates that the individual prosperity parameter data is secured inside the cloud, stays in the hospital are reduced for conventional routine examinations and most important that the health can be monitored and disease diagnosed by any doctor at any distance. In this paper, an IoT based health monitoring system was developed. The system monitored body temperature, pulse rate and room Glucose and temperature using sensors, which are also displayed on a LCD. These sensor values are then sent to a medical server using wireless communication. These data are then received in an authorized personals smart phone with IoT platform. With the values received the doctor then diagnose the disease and the state of health of the patient.

REFERENCES

- 1) M.S. Uddin, J.B. Alam and S. Banu, "Real time patient monitoring system based on Internet of Things", *4th International Conference on Advances in Electrical Engineering*, pp. 516-521, 2017.
- 2) K. Jaiswal, S. Sobhanayak, B.K. Mohanta and D. Jena, "IoT-cloud based framework for patient's data collection in smart healthcare system using raspberry-pi", *International Conference on Electrical and Computing Technologies and Applications*, pp. 1-4, 2017.
- 3) P. Singh and A. Jasuja, "IoT based low-cost distant patient ECG monitoring system", *International Conference on Computing Communication and Automation*, pp. 1330-1334, 2017.
- 4) M. Neyja, S. Mumtaz, K.M.S. Huq, S.A. Busari, J. Rodriguez and Z. Zhou, "AnIoT-Based E-Health Monitoring System Using ECG Signal", *IEEE Global Communications Conference*, pp. 1-6, 2017.
- 5) K.M. Hassan, "Intelligent hybrid remote patient- monitoring model with cloud-based framework for knowledge discovery", *Computers and Electrical Engineering*, 2018.
- 6) Anmol Singh Chhabra, Tanupriya Choudhury, Arjun Vaibhav Srivastava and Archit Aggarwal, *Prediction for big data and IoT in 2017* *2017 International Conference on Infocom Technologies and Unmanned Systems (Trends and Future Directions) (ICTUS)*, pp. 181-187, 2017.
- 7) Gulraiz J. Joyia, Rao M. Liaqat, Aftab Farooq, and Saad Rehman, Internet of Medical Things (IOMT): Applications, Benefits and Future Challenges in Healthcare Domain, *Journal of Communications* Vol. 12, No. 4, April 2017.
- 8) Shubham Banka, Isha Madan and S.S. Saranya, Smart Healthcare Monitoring using IoT. *International Journal of Applied Engineering Research* ISSN 0973-4562 Volume 13, Number 15, pp. 11984-11989, 2018.
- 9) K. Perumal, M. Manohar, A Survey on Internet of Things: Case Studies, Applications, and Future Directions, In *Internet of Things: Novel Advances and Envisioned Applications*, Springer International Publishing, (2017)

- 10) P. Rizwan, K. Suresh. Design and development of low investment smart hospital using Internet of things through innovative approaches, Biomedical Research. 28(11) (2017).
- 11) B. Zhou, Q. Ma, Y. Song and C. Bian, "Cloud-based dynamic electrocardiogram monitoring and analysis system", Proc. - 2016 9th Int. Congr. Image Signal Process. Biomed. Eng. Informatics CISP-BMEI 2016, pp. 1737-1741, 2017.
- 12) T. O. Prasetyono and N. Kusumastuti, "Optimal Time Delay of Epinephrine in One-per-mil Solution to Visualize Operation Field", Journal of Surgical Research, 2019.
- 13) S Mathusudhan, A L Nilla, A Pradeep, S Manibharathi and J. Geetha Ramani, "Employ Health Legacy", Journal of Emerging Technologies and Innovative Research (JETIR), June 2019.
- 14) S. Sampeter and S. Padmavath, "An improved health monitoring system for coma patients using internet of things", (IJETIE), vol. 5, pp. 408-412, 2019.
- 15) T. E. Dietz and P. H. Hackett, "High-Altitude Medicine" in Travel Medicine, Elsevier, pp. 387-400, 2019.