AN INNOVATIVE WEARABLE HEALTH MONITORING SENSOR USING IOT

Submitted in partial fulfilment of the requirements for the award of
Bachelor of Engineering degree in Electronics and Communication Engineering

By

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of R.SAKTHI AISHWARYA (39130389) who carried out the project entitled "**AN INNOVATIVE WEARABLE HEALTH MONITORING SENSORS USING IOT"**.

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DECLARATION

I, R. Sakthi Aishwarya (39130389) hereby declare that the Project Report entitled "**AN INNOVATIVE WAREABLE HEALTH MONITORING SENSORS USING IoT**" done by me under the guidance of "DR. I. REXILINE SHEEBA" is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering degree in Electronics and Communication.

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ABSTRACT

Internet of things(IOT) based real time health monitoring system is designed with the goal of reducing the stress and movement of sick and exhausted patients. For getting results immediately. IOT based real time health monitoring system allows the patients to perform all the required medical tests at the same spot within a short period of time. In this research work, all the six testing deviceswere merged which iskind of a broad innovation comparing to previous history. According to the survey, most of the patients would prefer to use such kind of devices for the purpose of medical testing. Four individual device(thermometer, blood pressure, pulse oximeter, heartbeat)are combined and turned into one device. In present days IOT plays an important role in the health care systems, remote health care monitoring has evolved at such a rapid pace, due to increased use of wearable sensors.This paper describes a wearable health monitoring system which can continuously monitor the patients heartbeat, temperature, blood pressure by ESP32.

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CHAPTER 1

1.1 INTRODUCTION

Internet of things is a network of interconnected devices that are equipped with software, sensors, network connectivity and electronic devices that allow them to exchange and collect data, allowing them to be more responsive. Internet of things divided into two parts that is internet and things, where internet describes that network that connects world widely by using some standardized protocols. Things that state the devices which are connected to it. In recent years IOT market in the healthcare sector has grown rapidly patients will be able to quickly access and track/monitor their health information thanks to the use of the internet in healthcare. With the growth of IOT, the healthcare industry has made a huge quantitative leap. The rapid implementation of the Internet of things(IOT) in healthcare has generated providers. People nowadays suffer from wide range of ailments and health issues, including high blood pressure, high rate IOT heart beat which are commonly seen in elderly people. So, a continuous monitoring device is required to ensure a proper medical care. This project discusses the advantages of utilising an ESP32-based system for monitoring the health of a patient.

1.2 INTERNET OF THINGS

To monitor and control the health Internet of things technology is used. The internet of things (IoT) is a set of technologies that uses sensors and actuators to inform us about the status of everyday items such as vehicles, tools and even living beings. It allows us to interact with them, enabling connectivity with platforms in the cloud that receive and process information for posterior analysis. This analyzed data is then used to make decisions. An IoT ecosystem consists of web-enabled smart devices that use embedded systems, such as processors, sensors and communication hardware, to collect, send and act on data they acquire from their environments. IoT devices share the sensor data they collect by connecting to an IoT gateway or other edge device where data is either sent to the cloud to be analyzed or analyzed locally. Sometimes, these devices communicate with other related devices and act on the information they get from one another. The devices do most of the work without human intervention, although people can interact with the devices for instance, to set them up, give them instructions or access the data. The Internet of Things (IOT) is a method for connecting and controlling any device online. An IOT platform connects things and gadgets with built-in sensors, integrating all the valuable data from various gadgets and utilising analytics to share the most crucial data with specific applications. Important decisions, recommendations, and the early detection of patterns and potential issues can all be made using this information.

1.2.1 WORKING WITH IOT DEVICES

The Internet of Things (IOT) is a method for connecting and controlling any device online. An IOT platform connects things and gadgets with built-in sensors, integrating all the valuable data from various gadgets and utilising analytics to share the most crucial data with specific applications. Important decisions, recommendations, and the early detection of patterns and potential issues can all be made using this information.

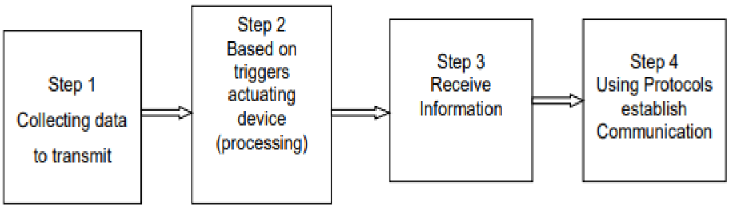

Figure 1.1 – Internet of things technology process

Sensors are frequently employed to acquire data from devices and are utilised in a variety of application areas. If a specific need is met after the trigger is activated, the device has to be actuated. Information obtained from the system is processed and used for analysis. In order to lisnk two or more networking devices, protocols are employed. MQTT, FTP, HTTP, Zigbee, and Constrained Application Protocol are a few examples of communication protocols.

1.2.2 ADVANTAGES AND DISADVANTAGES OF IOT

ADVANTAGES OF IOT

- Reduced cost
- Higher efficiency and productivity
- More business oppurtunities
- Improved costumer experience

- Increased mobility and agility

DISADVANTAGES OF IOT

- Security and privacy
- Technical complexity
- Connectivity and Power dependence
- Integration
- Higher costs

1.2.3 IOT IN HEALTHCARE SYSTEM

Modern healthcare systems are conducted with the help of various technical aspects such as wearable devices, a cloud of things, and IoT. According to Krishnan et al. (2018), the health care department can monitor all activities of patients, record patient's data, and send these data remotely with the presence of the Internet of Things. Secure data transmission is important to maintain this connection. To implement IoT in the healthcare department, this technology is designed properly with high-performing and multiple communication standards. To maintain information-intensive health applications a resource-based data retrieving method is introduced. To control the activities of patients this technology is combined with a smart box, which is treated as a medical system. To increase security in data transmission, Web Real-Time Communication process is implemented properly. An electronic sphygmomanometer is enabled to maintain communication via Bluetooth and other android applications. This technology is involved in the recording of any transmitted data by using mobile devices and other electrical devices. Distributed flow environment for Internet of Things healthcare is involved in real-time application. To maintain patient's information local server and communication process is implemented when a patient is under the observation of any healthcare department. To analyze electrocardiogram signals an IoT based system with embedded medical platforms is used, this system is conducted by maintaining various heart functions. In a few cases, to increase mobility of patient IoT Portable Medical devices are implemented in the healthcare system. However, use of IoT Portable Medical Devices can increase security threats and negative drawbacks. To predict various kinds of disease, lightweight IoT devices are used with existing databases. Therefore, IoT can implement a cloud-based high-performing fine-grained health information access control framework to collect information about security related issues and cloud reciprocity issues.To challenge real-world application a proxy-based approach is implemented for IoT devices. For blind people, the Internet of Things can introduce a portable electrical device with mounted ultrasonic range finders. These devices help blind people to detect any obstacle near then, by using Bluetooth headphones. To alert blind people by vibrio tactile feedback, IoT can introduce depth sensor-based den navigation systems, however, this system is consists of a limitation of database connectivity. Akhila et al. (2017) stated that, implementation of IoT is conducted by maintaining four-protocol layers. Sensors and transmitters are linked with systems in the physical layer. Signal transmission from sensors to the cloudlets is conducted through a network layer. The Middleware layer can store data in the cloud and incense availability of data. Analysis and diagnosis processes are conducted in the application layer.

1.2.4 CURRENT USE OF IOT IN HEALTHCARE SYSTEM

Satija et al. (2017), stated that there are a number of scopes for IoT in order to make a difference in the lives of patients. The devices can capture as well as monitor related data regarding patient and allows the providers to obtain the insights without bringing the patients visiting. The procedure can assist the patient results as well as preventing the possible communications for the process that involves risk. However, lack of EHR system integration is one of the major issues faced while using IoT in healthcare. Some of the EHR systems allow the patients importing data into the record. However, it remains limited to a few dominant where the EHR players as well as leaves providers unspecific of the processing data that can be helpful for the organization to use the process (Elhoseny et al. 2018). The challenges for interoperability in order to keep data in distinctive medical devices depend on the purpose and ordering physician. IoT helps to grow an interest in leading healthcare device manufacturers, dealers as well as suppliers to invest heavily in the Internet of Things. In result, they get returns in terms of real time promotions as well as efficient inventory management that helps to grow sales and reduced operational expenses. The Internet of Things is fragmented as well as the expertise referred to exist across the various parts of the value chain such as communications connectivity provider, hardware OEMs, data storage, analytics and applications (Subasi et al., 2018). The aim of this paper is to analyze the IoT opportunities for healthcare device manufactures and the limitations within the ecosystem.Nurses and technicians are responsible for inputting patient data into a centralized digital system. Accortding to Maksimović (2018), mobile industry have led to standardized qualitative care for patients and a superior healthcare professional that enhanced and garner patient’s multitude of needs. Health and fitness app help them to keep track of their daily food intake ,thus maintain proper nutrition level of all inhabitants and doesn’t led switch them to anorexia nervosa and bulimia nervosa by offering customized solutions.

The key opportunities for healthcare manufacturers are described below,

1.Infotainment: In car streaming as well as other customer services

2.Operational: such as predictive maintenance, telemetric, software updates

3.Autonomous healthcare device

Across the wide swath of industrial IoT distributions the majority of successful use cases have been in the operational area. In this area early deployments have tended to exist.

1.2.5 SECURITY ISSUES OF USING IOT IN PATIENT HEALTH MONITORING SYSTEM

The state of IoT security shows the following information in their latest research report Some other issues
of IoT that left an impact on healthcare sector are

- Cloud attacks
- Understanding IoT
- Internet Walls

There are some solutions that can be helpful to overcome the security purpose issue in IoT.

1. Use of Security Analytics
2. Ensure Communication Protection
3. Use Public Key Infrastructure
4. Secure the Network
5. Ensure Device Authentication

1.Use IoT security analytics: It can be said that the security issues as well as the vulnerabilities regarding IoT, may be reduced by implementing the security analytics. It can help IoT security providers to detect potential threats as well as bite such issues in the bud.

2. Ensure Communication Protection: The concept of IoT has an impact on connecting different devices.

Some implemented encryptions are HTTP, AES 128, AES 256 as well as a host of others (Aktas et al.,2018).

3.Use public key infrastructure: PKI secures the encryption of data through both symmetric as well as asymmetric encryption processes. Some of the IoT PKI security methods are X509 digital certificate and Cryptographic key, can be used as public or private key management, revocation and distribution.

4.Secure the network: The systems are already connected to an IoT network via the Internet. The network creates obstacles in the smooth operations of the IoT devices.

5.Ensure device authentication: There are some authentication features that play a significant role in Healthcare industry. The features are including two-factor authentication, digital certificates as well as biometric, used to ensure that no one can have illegal access to users devices.

1.2.6.OVERALL IMPACT OF IOT IN PATIENT MONITORING SYSTEM

Efficient methods to teach would be able to be applied. For example, individual needs of the patients can be catered to. This would mean that patients who need special care and attention can be given proper care and attention. This would enable patients to learn outside of the classroom with the help of various video classes they would be able to learn various topics. This will also allow patients to explore various topics. This would broaden the outlook for patients in the case of various topics. Also the interactivity of the classes with the help of smart boards would be enhanced greatly. The classes due to its interactivity would help patients to better understand the subjects. The impact of the IOT in the healthcare system is discussed in the following sections.

• Better management of facilities- The various facilities will be better managed with IOT devices. Due to the sophisticated chips and sensors which would transmit valuable data. This would help people in the better understanding of various things, how they work and how they work together. The common internet of things (IOT) platform brings the diverse information together. The internet of things also give the devices and mobile applications a common language to communicate with each other.

• Implementation of electronic attendance system – This will allow the implementation of an electronic attendance system which will greatly benefit various institutions in a great way. This include the various details of the patients being easily manageable. Also for patients whose attendance falls short of the required
percentage the electronic attendance system might also help in contacting the parents of the children along with a picture of their attendance sheets. The electronic attendance systems will be easier to manage in comparison to the normal attendance system (Muhammed et al. 2018).

1.3 HEALTH MONITORING SENSORS

Wearable devices have great importance in identifying health conditions. They allow monitoring parameters such as temperature, positioning, and electrical bio-signals as electrocardiograms (ECGs), electromyograms (EMGs), and electroencephalograms (EEGs). These are all relevant to medical analysis, personal fit of treatment plans, and monitoring of the patient acquired by the mobile health (m-health) applications.

The advancement of such devices, associated with the increase in Internet of Things (IoT) applications, converges to the concept of electronic healthcare (e-Health). E-Health is the use of electronic devices usually placed or carried next to the patient’s body for collecting and transmitting data to be accessed remotely. With the popularization of Industry 4.0, similarly, the Health 4.0 concept seeks to facilitate the progressive virtualization of individuals, medical devices, and processes for customized online health based on cloud computing. This concept can provide a solid path to the application of Industry 4.0 concepts such as the Internet of Everything (IoE), wireless communication, and cyber-physical systems (CPS) for solving healthcare problems. CPS contemplates the integration of a virtual universe with physical processes, which are feasible through embedded system monitoring and control of physical processes

1.3.1 VARIOUS HEALTH MONITORING SENSORS

The sensors used to diagnose, monitor or treat diseases in medical domain are known as medical sensors. There are functions of different types of medical sensors as described below for various applications.

- *Temperature probes*: Used for body temperature measurement. This helps in providing better medication and treatment of patients. They are called as thermometers.

- *Forbes sensors*: Used in kidney dialysis machine.

- *Airflow sensors*: Used in anesthesia delivery systems, laparoscopy, heart pumps etc.

- *Pressure sensors*: Used in infusion pumps and sleep apnoea machines. Most of the pressure sensors are integrated with embedded systems. They are used for medical diagnosis, blood pressure monitoring, infusion pumps etc.

- *Implantable pacemaker*: It is a real time embedded sensor system which delivers a synchronized rhythmic electric stimulus to the heart muscle in order to maintain effective cardiac rhythm.

- *Oximeter*: It measure the fraction of oxygen saturated haemoglobin relative to the total hemoglobin count in the blood.

- *Glucometer*: It measures approximate blood glucose concentration.

- *Magnetometer*: It specifies direction of user by examining the changes in the earth's magnetic field around the user.

    - *Electrocardiogram sensor*: It measures the electrical activity of the heart. It is called as ECG sensor

1.3.2 APPLICATIONS OF HEALTH MONITORING SYSTEM

- The wireless health monitoring system is used to transfer the data from the TX section to the RX section wirelessly.
- The proposed system mainly focuses on the situation where the doctors and patients are at the distant location and it is very important to give the entire details about the heartbeat and the temperature of the patient to the doctor.
- Besides this, if made particular changes in this project, it can also be applicable for acknowledging the students with the fastest mode of information about certain notices.

1.3.3 ADVANTAGES OF HEALTH MONITORING SYSTEM

- A wide range of communication is available (IOT).
- Easy connectivity between modules.
- Easy to implement in real time applications.
- Increases health care access.
- Enables early detection of deterioration
- Saves time
- Increases efficiency

1.3.4 DISADVANTAGES OF HEALTH MONITORING SYSTEM

- The system also needs a doctor in case of emergency.
- The accuracy of output is less.

1.4 PROBLEM STATEMENT

In the absence of the doctors, the patients cannot consult the doctors due to which emergency situation may also be created. The personal health monitoring of each individual is considered very important because of the rise in health problems in today’s world. The increasing stressful lifestyle is taking a maximum toll on public health. With the ever- increasing queues at hospitals and an increasing number of patients, the doctor fees have sky rocketed which is affecting especially those patients who cannot afford the fee or who are not suffering from major ailments but get to know so only after paying a hefty fee to the doctor.

1.5 OBJECTIVE

- To make an automated system that will help to monitor host remotely is our primary objective.
- To create an alarm or reaction system which will react whenever there is an alarming situation.
- To provide a way to remotely control the temperature, pulse, blood pressure via ESP32.
- To contribute to the field of IOT to pave the way for a future project in technological development.

CHAPTER 2

LITERATURE SURVEY

Literature survey of wearable health monitoring sensors.

Kavitha.B.C (2021) et al. presented a work in which patient’s heart rate, body temperature and body movement can be monitored. Details can also be sent to the cloud for further analysis and recording. The concept of IOT, Arduino UNO and sensors were used to develop the system. Since real time data is constantly being monitored, doctors can be alerted if any abnormality is indicated. Reliability can be further improved by the use of Raspberry Pi.

Veena Tripati (2017) et al. presented a work in which IOT in health care is aimed at empowering people to live healthier life by wearing connected devices, Health care industry has perceptually been on forefront in the adoption and utilization of information and communication technologies for the efficient health care administration. Recent development in wireless sensors, communication and information network technology (IOT). Connected health care is very important application of internet of things. The concept of connected health care system and smart medical devices bears enormous potential not just for companies, but also for the well-being of people in general. Hospitalized patients whose physiological status requires close attention can be constantly monitored using IoT- driven monitoring. This type of solution employs sensors to collect comprehensive physiological information and uses gateways and the cloud to analyse and store the information and then send the analysed data wirelessly for further analysis and review. It replaces the process of having a health professional come by at regular intervals to check the patient’s vital signs, instead providing a continuous automated flow of information. The main aim of this work is to give a comprehensive overview of this area of research and sensors used in health monitoring device, how the wearable health monitoring devices works, capture the data and generate report based on different parameters.

Vani Yeri (2020) et al. Conventional sensor based diagnosis in medial field requires more number of sensors and human efforts if it is processed in a large scale. It is a difficult task due to the shortage of medical professionals and system setup. To overcome this issue an IoT based health care application is proposed in the research work. The proposed system consists of the web and mobile application based on continuous wireless monitoring of patients. The objective is paper is to implement a low- cost system and transmit the patient vital signs in emergency situations. Sensors are being used for measuring the patient vital signs by using the wireless network. The sensors data are collected and transmitted to the cloud for storage via Wi-Fi module connected with the controller. The data is processed in the cloud and feedback steps are taken on the analysed data which can be further analysed by a doctor remotely. Remote viewing reduces burden to doctors and provides the exact health status of patients. If the patient needs urgent attention then a message is sent to the doctor.

Fan Wu (2018) et al. Presented a work There are some air pollutants in both indoor and outdoor environments, such as carbon dioxide (CO_2), carbon monoxide (CO) and particulate matter. CO_2 is a common indicator used for ventilation systems. High CO_2 levels can cause headaches, dizziness and a range of detrimental symptoms. CO istoxic to humans when the concentration is above 35 ppm. The source of CO is produced from the partial oxidation of carbon containing compounds. For example, the gas does not burn fully. Particulate matter (PM) is a mixture of small particles found in the air. Small particles with a diameter of 10 µA or less can be inhaled that causing serious health issues to lungs. Particles with a diameter less than 2.5 µm (PM2.5) can go deeper into our lungs and they can be more dangerous than bigger particles ranged between 2.5 and 10 µm (PM10).

Cecil C Nachiar (2020) et al.The present struggle with COVID 19 pandemic has necessitated strategic response in healthcare systems to decrease mortalities even with poor lab infrastructure. With improved disease surveillance, any country can handle health emergencies in a better manner. Combining wearable device technology with smartphone, self-testing can be improved and real time monitoring of various parameters such as temperature, oxygen levels and pulse rate reducing burden on healthcare and creating a vigilant environment. This also help us in contract tracing and also reduce death out of comorbidities which has caused a heavy death toll out of pandemic. Here, the components of daily use are deployed with slight modification for creating real time monitoring along with auto alarm and warning transmission to local health ministry. Data collected from sensors are stored in Arduino memory and transmitted to smartphone through Wi-Fi module. Our proposed system is used to process, analyse and display patient's collected data with auto alarm. Our proposed system has been very reliable with average delay of 14s and low power consumption with standing time of nearly 4 hr. Corona virus disease has became a pandemic causing death toll around 3 lakhs and severe economic and political vacuum in major countries around the world.

Rupali Shinde (2021) et al.Presented a work economical and wearable pulse oximeter device using sparkfun oximeter sensor and raspberry pi v2 model B. Nowadays whole world is facing COVID-19 pandemic from December 2091 and in corona patient blood oxygen level is goes down due to attack of virus on lungs. In this scenario economical and easy to use pulse oximeter is life saving device. To control pandemic; early detection of patients are important. We have presented easy to develop oximeter in this paper. We have connected sensor to Arduino uno using I2C protocol and using serial communication data is sent do raspberry pi using USB serial communication. We have achieved over 90% accuracy when result are compare with commercial health band. We also did comparative study with other sensor and we found that sparkfun sensor gives more accurate and quick results. Data visualization is implemented using python library. This device can be used as health band or for covid-19 patient monitoring using remotely.

Padmavati Kora (2021) et al. Continuous monitoring of the Heart of high-risk patients may have a major role in preventing coronary heart disease in recent decades. If any change of the health condition from their normal is observed, then it will be transmitted it to a health center for early and further analysis and preventative actions. This saves the life of the patients from Heart attacks. Keeping this in view we intend to develop a wireless wearable (coat) ECG (to be implemented in IOT) for detecting abnormal heart conditions. It uses a three wireless electrodes, a specialist framework focused on Java and a web-enabled surveillance network. The first move is to set up a portable ECG system utilizing the electrodes of the product click into the body region of the patient. Bluetooth will attach this lightweight ECG to mobile device like a cell phone. A mobile

Java device will then begin data collection and conversion. A desktop device may be enabled. In the case of emergencies, the existing program often activates a professional alert warning device. This ECG monitoring systems are very useful for elderly patients having severe heart problems. India undergoes a developmental epidemiological cycle and has an infectious disease epidemic threshold. Demographic projections suggest that coronary disease mortality has risen dramatically as life expectation is increasing and also population's ageing system is changing. In India, around one- quarter of all deaths in 2017 were caused by cardiovascular diseases (CVDs). It is critical, in particular, that people who do not access appropriate medical facilities to prevent high risk of disability or even death as a consequence of the stroke. Throughout the case of an emergency, these individuals will be supervised and given urgent medical help and treatment. The invention of the wearable ECG monitoring device is a response to this issue.

Prachi kamble (2019) et al. Measuring the Electrocardiogram (ECG) signal is an important method for the identification of Heart diseases. The ECG signal has the knowledge of the degree of how much heart perform its function. The existing devices cannot store the ECG information, which results in loss of ECG information. In this paper, using Internet-of-things (IoT) we propose a new methodology for ECG recording and monitoring. A wearable monitoring node gathers the ECG information and using Wi- Fi technology is transmitted directly to IoT cloud and is stored on SD Card for offline storage. The ECG wave is displayed through the local LCD and developed Web Interface/MobileApplication. The ECG information can be conveniently acquired using smart devices with a web browser, which has diminished the cross platform issue. The heart diseases are one of the foremost reason for unexpected deaths. Thus, various medical devices have been developed by the engineers to diagnose and scrutinize various diseases. The Healthcare has become one of the most substantial issue for both individuals and government due to brisk growth in human population and medical expenditure. Many factors such as Age, fitness activity, cholesterol level, diabetes, cardio vascular diseases, body size, body position etc. may influence the heart rate of an individual. In this way, how to recognize human sicknesses in a convenient and exact way with ease has been given careful consideration. Because of the predominance in the detection of the heart linked sicknesses, ECG wave observing and analysis has been commonly utilized in the clinics, hospitals.

Jenifer M (2022) et al. In a pandemic situation, IOT-based health care monitoring plays a critical role. It aids in the prevention of disease spread as well as the diagnosis of illnesses even when a doctor is unavailable in his work place. This paper depicts an electronic wearable device and a smart phone that are connected via Wi-Fi. Sensors are used to measure patient physical characteristics such as heart rate, temperature, blood pressure, and oxygen supply level in an IOT-based health care system. In our suggested system, health parameters are continuously screened, and patient data is collected and saved in a cloud server through Wi-Fi at a remote location. Sensors (inputs) are connected to an ARDUINO Uno microcontroller to monitor patient health care, with the results being saved on a cloud server.

Raj raorane (2020) et al. In recent years, the industries are focusing more on the safety and health of workers. The healthcare system is going through a transformation in which continuous monitoring of inhabitants is possible. There is a demand for innovative solutions that incorporate emerging technologies. Proposed system is an IOT based solutions. Wearable sensor network can detect abnormal and unforeseen situations by monitoring physiological and environmental parameters. Wearable sensors on different subjects can communicate with each other and transmit the data to gateway. They provide warnings when health parameters of individuals and environmental parameters go beyond permissible limit. A smart IOT gateway can be implemented to provide data processing, local web server and cloud connection. It can forward the data to IOT cloud for further storage, processing and visualization.

Niket patii (2017) et al. The proposed system can be mounted on the soldier's body to track their health status and current location using GPS. These information will be transmitted to the control room through IoT. The proposed system comprise of tiny wearable physiological equipment's, sensors, transmission modules. Hence, with the use of the proposed equipment ,it is possible to implement a low cost mechanism to protect the valuable human life on the battlefield.

Neel kamla (2018) et al. Wireless sensor networks (WSNs) have witnessed advancement in medical services from real-time tracking and computer-assisted machine to alert response systems. Due to a tremendous shortage of trained manpower and a huge cost for setting up state-of-the-art facilities, it is often not possible to deliver proper health care services in the rural and remote areas. Lack of accurate and timely information further adds complexity and challenges to the problem. The proposed system uses a three-tier architecture that can be generally applied to WSN based healthcare systems. The proposed model monitors the patient body temperature, heartbeat, and body position movements constantly, and sends this information to site pages and crisis centres/services from the remote location. WSNs are composed of low power consuming sensors. Raspberry pi is a credit card sized board that uses 5V power supply. The proposed and implemented system prototype uses raspberry pi that is driven by Internet of Things (IoT) connected through different sensors DS18B20, ADXL345, ADC1015 and heartbeat sensor. The framework additionally gives crisis warning to a specialist and sends the information on a web server. The framework utilizes DS18B20, heartbeat sensor, and accelerometer. The system is designed secured by providing a mechanism to authenticate the user to get access to patient data. Implemented system hardware prototype consists of two controllers that provide a mechanism to bring personal health status in the normal range in case of emergency.

Chien Khong Duc (2020) et al. develop an IoT node with an organic pressure sensor for structural health monitoring (SHM) system. A 100um-thick polyurethane film was sandwiched by top/bottom electrodes to complete the flexible pressure sensor fabrication. IoT sensor nodes using available low-cost components in the market were designed for the SHM system. Sensors collect data about the state of structural infrastructures and send information to a virtual private server through a network gateway. Also built a website on the hosting server for the purpose of SHM including monitoring signals, storing data and other administration tools. Experiment results show that the IoT node with organic pressure sensors has high potential in SHM application. The organic pressure sensor manufacturing steps and the SHM system will be described in detail in this paper.

Muhammad Irsyad Abdullah (2022) et al. Monitoring Covid-19 patients is extremely challenging due to under-resourced or risk of infection. With the increased demand for hospital beds and the difficulty of delivering care, some health centers have advised individual with milder symptoms to stay home. Hence, this paper presents a health monitoring system based on IoT that helps the medical staff to monitor blood saturation, heart rate, pulse rate and body temperature remotely. A Biosensor Module MAX3100 is used to read blood saturation level and heart rate of the patient while body temperature sensor, DS18B20 is employed to scan the body temperature. The measurement of room temperature and humidity level is done through humidity sensor. ESP32 Arduino will encode and decode all input data before execution process. The patient's fingers are connected to the sensors and the data is displayed on the smart phone or PC. The proposed system was tested and provide the intended output. Therefore, with the aid of this proposed system, medical staff can examine and keep track on several patients' status simultaneously and without the hassle of being infected by the virus as it is monitored remotely.

Arpita Das (2021) et al. Health is a primary concern of every human being. Continuous health monitoring is becoming more important nowadays. But going to the hospitals or doctors for a routine check-up can be costly and most of the time difficult for human being. Hence, a cost-effective and wireless health condition monitoring system can be an effective solution that can be monitored anytime from anywhere. Nowadays, IoT-enabled health monitoring system plays the critical role by the observation of health conditions and detecting early vital signs of diseases or ill-conditions through IoT. In this paper, we have proposed a health monitoring device on the amalgamation of Raspberry pi, and cloud IoT platform which is based on the Thingspeak server. The system monitors body temperature, heartbeat, Electrocardiogram (ECG), the variations of the electrical characteristics of the skin, motions, and blood oxygen level of every individual. The system is designed as user-friendly with low cost and potency. Experimental studies show the reliance and effectiveness of the proposed system concerning the existing models.

CHAPTER 3

INVESTIGATION

3.1 EXISTING SYSTEM

- Diagnosing with help of a doctor.
- Conventional devices that can only measure a particular parameter.
- Devices that have to be connected invasive to get measurements.
- No automated system exists.
- Smart watches are expensive and not specially for health care.

3.1.1 DRAWBACKS OF EXISTING SYSTEM

In existing system, patient needs to get hospitalised for regular monitoring of the patient. It is not possible once he/she is discharged from the hospital. This system cannot be used at home. The existing systems are measuring the health parameters of the patient and send it through zig bee, Bluetooth protocol etc., These are used for only short range communication to transfer the data. Not all the time the doctor can fetch these details.

3.2 PROPOSED SYSTEM

- In this system,24 x 7 human health monitoring is designed.
- In this system,the ESP32 board is used for collectingand processing all data.
- Wireless devices have invaded the medical area with a wide range of capabilities.
- Monitor the patient details in a periodic interval is overhead using existing technologies.
- To overcome this we have changed recent wireless sensor technologies.
- Added advanced sensors like pulse oximeter for measuring blood pressure.
- Different Sensors used for, measuring different parameters.

• All this data is uploaded to thing speak for remote analysis.

3.2.1 AIM

The system which we prefer to develop would not only help in monitoring the health of the patient when he is in bed but also when he is out of bed. The main idea of the system is to transmit the information through the webpage to continuous monitoring of the patient over internet. Such a system would continually detect the important body parameters like temperature, pulse rate and would compare it against predetermined range set and if these values cross the specific limit, it would immediately alert the doctor. In this system microcontroller is used to transmit the data. It is connected to IoT which provides information to doctor or caretaker. The data of the patients health is stored in the cloud. The doctor can easily access the patients health anytime from anywhere.

3.2.2 BLOCK DIAGRAM AND EXPLANATION

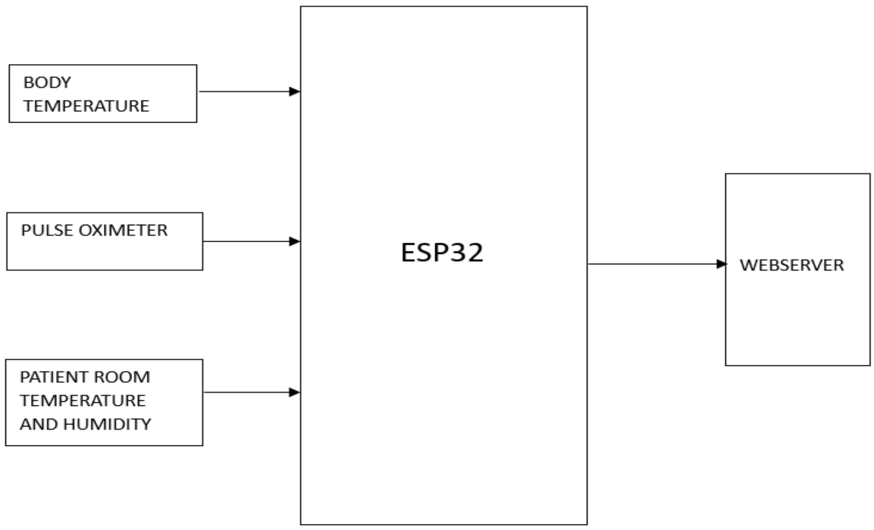

FIGURE 3.1 - BLOCK DIAGRAM OF PROPOSED METHOD

This is a simple block diagram that explain the IoT based patient health monitoring system using ESP32, Pulse oximeter (MAX30102),Body temperature (DS18B20),Patient room temperature and humidity (DHT11). From the above block diagram, 3 sensors are connected to ESP32 which gives 5 health parameters. MAX30102(Pulse-Oximeter) is connected in i2c communication protocol. The sensor is powered with 5V power supply from the ESP32. DHT11(patient room temperature and humidity). This sensor also uses i2c communication protocol. DHT11 supports 3.3V.

3.3 COMPONENTS REQUIRED

3.3.1 ESP32 MICROCONTROLLER

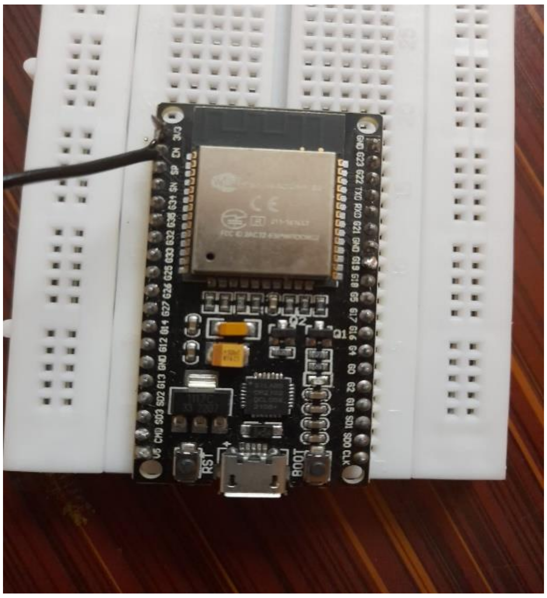

FIGURE 3.2 – ESP32 MICROCONTROLLER

ESP32 is the SoC (System on Chip) microcontroller.ESP32 is capable of functioning reliably in industrial environments, with an operating temperature ranging from –40°C to +125°C. Powered by advanced calibration circuitries, ESP32 can dynamically remove external circuit imperfections and adapt to changes in external conditions. ESP32 is highly-integrated with in-built antenna switches, RF balun, power amplifier, low-noise receive amplifier, filters, and power management modules. ESP32 adds priceless functionality and versatility to your applications with minimal Printed Circuit Board (PCB) requirements. Engineered for mobile devices, wearable electronics and

IoT applications, ESP32 achieves ultra-low power consumption with a combination of several types of proprietary software. ESP32 also includes state-of-the-art features, such as fine-grained clock gating, various power modes and dynamic power scaling. ESP32 can perform as a complete standalone system or as a slave device to a host MCU, reducing communication stack overhead on the main application processor. ESP32 can interface with other systems to provide Wi-Fi and Bluetooth functionality through its SPI / SDIO or I2C / UART interfaces.

The specifications listed below belong to the ESP32 WROOM 32 variant.−

- Integrated Crystal− 40 MHz
- Module Interfaces− UART, SPI, I2C, PWM, ADC, DAC, GPIO, pulse counter, capacitive touch sensor
- Integrated SPI flash− 4 MB
- ROM− 448 KB (for booting and core functions)
- SRAM− 520 KB
- Integrated Connectivity Protocols− WiFi, Bluetooth, BLE
- On−chip sensor− Hall sensor
- Operating temperature range− −40 − 85 degrees Celsius
- Operating Voltage− 3.3V
- Operating Current− 80 mA (average)

it is very easy to decipher the reasons for ESP32's popularity. Consider the requirements an IoT device would have from its microcontroller (μC). the major operational blocks of any IoT device are sensing, processing, storage, and transmitting. Therefore, to begin with, the μC should be able to interface with a variety of sensors. It should support all the common communication protocols required for sensor interface: UART, I2C, SPI. It should have ADC and pulse counting capabilities. ESP32 fulfills all of these requirements. On top of that, it also can interface with capacitive touch sensors. Therefore, most common sensors can interface seamlessly with ESP32.

Secondly, the μC should be able to perform basic processing of the incoming sensor data, sometimes at high speeds, and have sufficient memory to store the data. ESP32 has a max operating frequency of 40 MHz, which is sufficiently high. It has two cores, allowing parallel processing, which is a further add-on. Finally, its 520 KB SRAM is sufficiently large for processing a large array of data onboard. Many popular processes and transforms, like FFT, peak detection, RMS calculation, etc. can be performed onboard ESP32. On the storage front, ESP32 goes a step ahead of the conventional microcontrollers and provides a file system within the flash. Out of the 4 MB of onboard flash, by default, 1.5 MB is reserved as SPIFFS (SPI Flash File System). Think of it as a mini−SD Card that lies within the chip itself. You can not only store data, but also text files, images, HTML and CSS files, and a lot more within SPIFFS. People have displayed beautiful Webpages on WiFi servers created using ESP32, by storing HTML files within SPIFFS.

Finally, for transmitting data, ESP32 has integrated WiFi and Bluetooth stacks, which have proven to be a game-changer. No need to connect a separate module (like a GSM module or an LTE module) for testing cloud communication. Just have the ESP32 board and a running WiFi, and you can get started. ESP32 allows you to use WiFi in Access Point as well as Station Mode. While it supports TCP/IP, HTTP, MQTT, and other traditional communication protocols, it also supports HTTPS. Yep, you heard that right. It has a crypto−core or a crypto-accelerator, a dedicated piece of hardware whose job is to accelerate the encryption process. So you cannot only communicate with your web server, you can do so securely. BLE support is also critical for several applications. Of course, you can interface LTE or GSM or LoRa modules with ESP32. Therefore, on the 'transmitting data' front as well, ESP32 exceeds expectations.

Finally, ESP32 can be programmed using the Arduino IDE.

3.3.2 PULSE OXIMETER – MAX30102

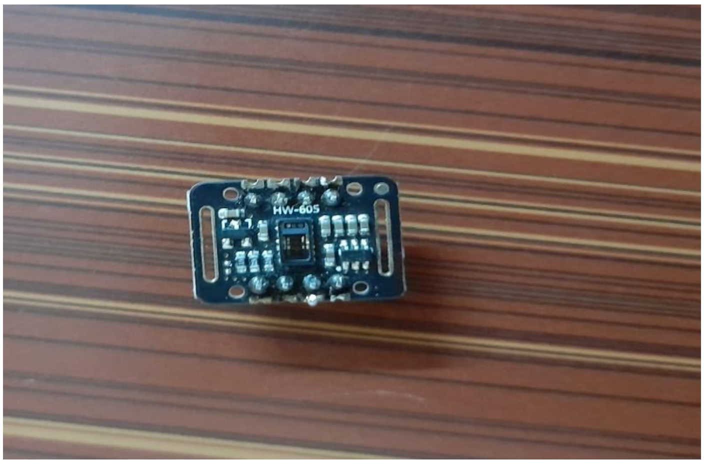

FIGURE 3.3 – PULSE OXIMETER(MAX30102)

The MAX30102 is an integrated pulse oximetry and heart-rate monitor module. It includes internal LEDs, photodetectors, optical elements, and low-noise electronics with ambient light rejection. The MAX30102 provides a complete system solution to ease the design-in process for mobile and wearable devices. The MAX30102 operates on a single 1.8V power supply and a separate 3.3V power supply for the internal LEDs. Communication is through a standard I2C-compatible interface. The module can be shut down through software with zero standby current, allowing the power rails to remain powered at all times. The MAX30102 is a complete pulse oximetry and heart-rate sensor system solution module designed for the demanding requirements of wearable devices. The device maintains a very small solution size without sacrificing optical or electrical performance. Minimal external hardware components are required for integration into a wearable system. The MAX30102 is fully adjustable through software registers, and the digital output data can be stored in a 32-deep FIFO within the IC. The FIFO allows the MAX30102 to be connected to a microcontroller or processor on a shared bus, where the data is not being read continuously from the MAX30102's registers.

SpO2 Subsystem - The SpO2 subsystem of the MAX30102 contains ambient light cancellation (ALC), a continuous-time sigma-delta ADC, and a proprietary discrete time filter. The ALC has an internal Track/Hold circuit to cancel ambient light and increase the effective dynamic range. The SpO2 ADC has programmable full-scale ranges from 2μA to 16μA. The ALC can cancel up to 200μA of ambient current. The internal ADC is a continuous time oversampling sigma-delta converter with 18-bit resolution. The ADC sampling rate is 10.24MHz. The ADC output data rate can be programmed from 50sps (samples per second) to 3200sps.

Temperature Sensor - The MAX30102 has an on-chip temperature sensor for calibrating the temperature dependence of the SpO2 subsystem. The temperature sensor has an inherent resolution of 0.0625°C. The device output data is relatively insensitive to the wavelength of the IR LED, where the Red LED's wavelength is critical to correct interpretation of the data. An SpO2 algorithm used with the MAX30102 output signal can compensate for the associated SpO2 error with ambient temperature changes.

LED Driver - The MAX30102 integrates Red and IR LED drivers to modulate LED pulses for SpO2 and HR measurements. The LED current can be programmed from 0 to 50mA with proper supply voltage. The LED pulse width can be programmed from

69µs to 411µs to allow the algorithm to optimize SpO2 and HR accuracy and power consumption based on use cases.

3.3.3 BODY TEMPERATURE (DS18B20)

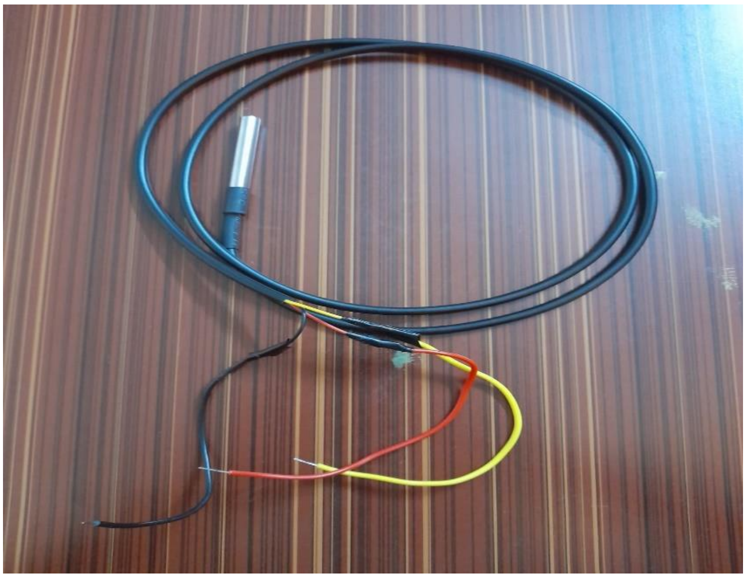

FIGURE 3.4 – BODY TEMPERATURE (DS18B20)

The DS18B20 digital thermometer provides 9-bit to 12-bit Celsius temperature measurements and has an alarm function with nonvolatile user-programmable upper and lower trigger points. The DS18B20 communicates over a 1-Wire bus that by definition requires only one data line (and ground) for communication with a central microprocessor. In addition, the DS18B20 can derive power directly from the data line ("parasite power"), eliminating the need for an external power supply. Each DS18B20 has a unique 64-bit serial code, which allows multiple DS18B20s to function on the same 1-Wire bus. Thus, it is simple to use one microprocessor to control many DS18B20s distributed over a large area. Applications that can benefit from this feature include HVAC environmental controls, temperature monitoring systems inside buildings, equipment, or machinery, and process monitoring and control systems.

- Unique 1-Wire Interface Requires Only One Port Pin for Communication
- Reduce Component Count with Integrated Temperature Sensor and EEPROM
- Measures Temperatures from -55°C to +125°C (-67°F to +257°F)
- ±0.5°C Accuracy from -10°C to +85°C
- Programmable Resolution from 9 Bits to 12 Bits
- No External Components Required

- Parasitic Power Mode Requires Only 2 Pins for Operation (DQ and GND)
- Simplifies Distributed Temperature-Sensing Applications with Multidrop Capability
- Each Device Has a Unique 64-Bit Serial Code Stored in On-Board ROM
- Flexible User-Definable Non-volatile (NV) Alarm Settings with Alarm Search Command Identifies Devices with Temperatures Outside Programmed Limits
- Available in 8-Pin SO (150 mils), 8-Pin µSOP, and 3-Pin TO-92 Packages.

The core functionality of the DS18B20 is its direct-to digital temperature sensor. The resolution of the temperature sensor is user-configurable to 9, 10, 11, or 12 bits, corresponding to increments of 0.5°C, 0.25°C, 0.125°C, and 0.0625°C, respectively. The default resolution at power-up is 12-bit. The DS18B20 powers up in a low power idle state. To initiate a temperature measurement and A-to-D conversion, the master must issue a Convert T [44h] command. Following the conversion, the resulting thermal data is stored in the 2-byte temperature register in the scratchpad memory and the DS18B20 returns to its idle state. If the DS18B20 is powered by an external supply, the master can issue "read time slots" (see the 1-Wire Bus System section) after the Convert T command and the DS18B20 will respond by transmitting 0 while the temperature conversion is in progress and 1 when the conversion is done. If the DS18B20 is powered with parasite power, this notification technique cannot be used since the bus must be pulled high by a strong pullup during the entire temperature conversion. The bus requirements for parasite power are explained in detail in the Powering the DS18B20 section.

The DS18B20 output temperature data is calibrated in degrees Celsius; for Fahrenheit applications, a lookup table or conversion routine must be used. The temperature data is stored as a 16-bit sign-extended two's complement number in the temperature register. The sign bits (S) indicate if the temperature is positive or negative: for positive numbers S = 0 and for negative numbers S = 1. If the DS18B20 is configured for 12-bit resolution, all bits in the temperature register will contain valid data. For 11-bit resolution, bit 0 is undefined. For 10-bit resolution, bits 1 and 0 are undefined, and for 9-bit resolution bits 2, 1, and 0 are undefined.

3.3.4 PATIENT ROOM TEMPERATURE AND HUMIDITY (DHT11)

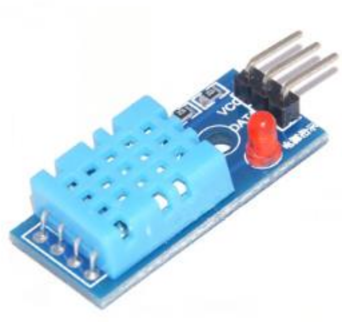

FIGURE 3.5 – DHT11

DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a highperformance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness. Each DHT11 element is strictly calibrated in the laboratory that is extremely accurate on humidity calibration. The calibration coefficients are stored as programmes in the OTP memory, which are used by the sensor's internal signal detecting process. The single-wire serial interface makes system integration quick and easy. Its small size, low power consumption and up-to-20 meter signal transmission making it the best choice for various applications, including those most demanding ones. The component is 4-pin single row pin package. It is convenient to connect and special packages can be provided according to users' request. DHT11's power supply is 3-5.5V DC. When power is supplied to the sensor, do not send any instruction to the sensor in within one second in order to pass the unstable status. One capacitor valued 100nF can be added between VDD and GND for power filtering.

- Low power consumption.
- Relative humidity and temperature measurement
- All calibration, digital output
- Excellent long-term stability

- No additional components
- Long distance signal transmission
- Ultra-low power
- 4-pin package
- Completely interchangeable

3.4 ADVANTAGES OF PROPOSED SYSTEM

- Reduce risk of disease transmission.
- Faster access to better patient data.
- Improved patient outcomes
- Cost savings
- It is easy for patients and medical professionals to use the system.

CHAPTER 4

SOURCE CODE

```
#include <WiFi.h>
#include <WebServer.h>
#include <Wire.h>
#include "MAX30100_PulseOximeter.h"
#include <OneWire.h>
#include <DallasTemperature.h>
#include <dht.h>

#define DHT11_PIN 18
#define DS18B20 5
#define REPORTING_PERIOD_MS     1000

float temperature, humidity, BPM, SpO2, bodytemperature;

const char* ssid = "ADITYA-4G";
const char* password = "Kuttima1";

dht DHT;
PulseOximeter pox;
uint32_t tsLastReport = 0;
OneWire oneWire(DS18B20);
DallasTemperature sensors(&oneWire);


WebServer server(80);

void onBeatDetected()
{
  Serial.println("Beat!");
}

void setup() {
  Serial.begin(115200);
  pinMode(19, OUTPUT);
  delay(100);

  Serial.println("Connecting to ");
  Serial.println(ssid);

  WiFi.begin(ssid, password);

  while (WiFi.status() != WL_CONNECTED) {
  delay(1000);
  Serial.print(".");
  }
```

```
  Serial.println("");
  Serial.println("WiFi connected..!");
  Serial.print("Got IP: ");  Serial.println(WiFi.localIP());

  server.on("/", handle_OnConnect);
  server.onNotFound(handle_NotFound);

  server.begin();
  Serial.println("HTTP server started");

  Serial.print("Initializing pulse oximeter..");

  if (!pox.begin()) {
    Serial.println("FAILED");
    for (;;);
  } else {
    Serial.println("SUCCESS");
    pox.setOnBeatDetectedCallback(onBeatDetected);
  }

   pox.setIRLedCurrent(MAX30100_LED_CURR_7_6MA);

}
void loop() {
  server.handleClient();
  pox.update();
  sensors.requestTemperatures();
  int chk = DHT.read11(DHT11_PIN);

  temperature = DHT.temperature;
  humidity = DHT.humidity;
  BPM = pox.getHeartRate();
  SpO2 = pox.getSpO2();
  bodytemperature = sensors.getTempCByIndex(0);


  if (millis() - tsLastReport > REPORTING_PERIOD_MS)
  {
    Serial.print("Room Temperature: ");
    Serial.print(DHT.temperature);
    Serial.println("°C");

    Serial.print("Room Humidity: ");
    Serial.print(DHT.humidity);
    Serial.println("%");

    Serial.print("BPM: ");
    Serial.println(BPM);

    Serial.print("SpO2: ");
```

```
    Serial.print(SpO2);
    Serial.println("%");

    Serial.print("Body Temperature: ");
    Serial.print(bodytemperature);
    Serial.println("°C");

    Serial.println("*********************************");
    Serial.println();

    tsLastReport = millis();
  }

}

void handle_OnConnect() {

  server.send(200, "text/html", SendHTML(temperature, humidity, BPM, SpO2,
bodytemperature));
}

void handle_NotFound(){
  server.send(404, "text/plain", "Not found");
}

  String SendHTML(float temperature,float humidity,float BPM,float SpO2, float
bodytemperature){
  String ptr = "<!DOCTYPE html>";
  ptr +="<html>";
  ptr +="<head>";
  ptr +="<title>ESP32 Patient Health Monitoring</title>";
  ptr +="<meta name='viewport' content='width=device-width, initial-scale=1.0'>";
  ptr +="<link href='https://fonts.googleapis.com/css?family=Open+Sans:300,400,600'
rel='stylesheet'>";
  ptr +="<style>";
  ptr +="html { font-family: 'Open Sans', sans-serif; display: block; margin: 0px auto;
text-align: center;color: #444444;}";
  ptr +="body{margin: 0px;} ";
  ptr +="h1 {margin: 50px auto 30px;} ";
  ptr +=".side-by-side{display: table-cell;vertical-align: middle;position: relative;}";
  ptr +=".text{font-weight: 600;font-size: 19px;width: 200px;}";
  ptr +=".reading{font-weight: 300;font-size: 50px;padding-right: 25px;}";
  ptr +=".temperature .reading{color: #F29C1F;}";
  ptr +=".humidity .reading{color: #3B97D3;}";
  ptr +=".BPM .reading{color: #FF0000;}";
  ptr +=".SpO2 .reading{color: #955BA5;}";
  ptr +=".bodytemperature .reading{color: #F29C1F;}";
  ptr +=".superscript{font-size: 17px;font-weight: 600;position: absolute;top: 10px;}";
  ptr +=".data{padding: 10px;}";
  ptr +=".container{display: table;margin: 0 auto;}";
```

```
  ptr +=".icon{width:65px}";
  ptr +="</style>";
  ptr +="</head>";
  ptr +="<body>";
  ptr +="<h1>ESP32 Patient Health Monitoring</h1>";
  ptr +="<div class='container'>";

  ptr +="<div class='data temperature'>";
  ptr +="<div class='side-by-side icon'>";
  ptr +="</div>";
  ptr +="<div class='side-by-side text'>Room Temperature</div>";
  ptr +="<div class='side-by-side reading'>";
  ptr +=(int)temperature;
  ptr +="<span class='superscript'>&deg;C</span></div>";
  ptr +="</div>";

  ptr +="<div class='data humidity'>";
  ptr +="<div class='side-by-side icon'>";

  ptr +="</div>";
  ptr +="<div class='side-by-side text'>Room Humidity</div>";
  ptr +="<div class='side-by-side reading'>";
  ptr +=(int)humidity;
  ptr +="<span class='superscript'>%</span></div>";
  ptr +="</div>";

  ptr +="<div class='data Heart Rate'>";
  ptr +="<div class='side-by-side icon'>";
  ptr +="</div>";
  ptr +="<div class='side-by-side text'>Heart Rate</div>";
  ptr +="<div class='side-by-side reading'>";
  ptr +=(int)BPM;
  ptr +="<span class='superscript'>BPM</span></div>";
  ptr +="</div>";

  ptr +="<div class='data Blood Oxygen'>";
  ptr +="<div class='side-by-side icon'>";

  ptr +="<div class='side-by-side text'>Body Temperature</div>";
  ptr +="<div class='side-by-side reading'>";
  ptr +=(int)bodytemperature;
  ptr +="<span class='superscript'>&deg;C</span></div>";
  ptr +="</div>";

  ptr +="</div>";
  ptr +="</body>";
  ptr +="</html>";
  return ptr;
}
```

CHAPTER 5

5.1 RESULT AND ANALYSIS

Interfacing of MAX30102(Pulse oximeter) with ESP32: To measure the heart rate and pulse oximetry the ESP32 is connected to the MAX30102 sensor. Moreover, we will use the Server Sent Event with ESP32 to update the Web interface. By the way, pulse oximetry is a non-invasive method to measure the oxygen concentration in our blood. In more detail, the pulse oximetry measures the oxygen saturation of the haemoglobin. Often this value is indicated as SPO2. The pulse oximeter is the tool we use to measure the pulse oximetry and it uses our finger to detect the heart-rate and the SPO2.

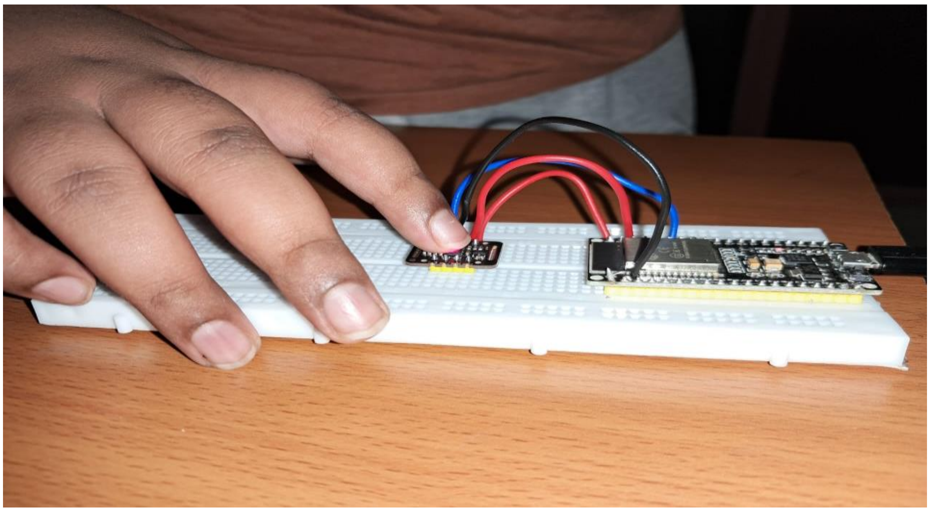

FIGURE 5.1 – TESTING PULSE OXIMETER

Pulse oximeter is successfully tested and the following are the obtained outputs.

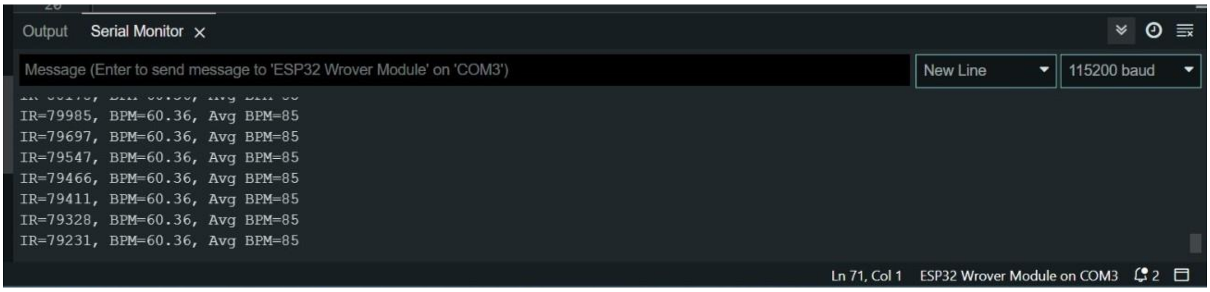

FIGURE 5.2 – OUTPUT CALCULATING HEART RATE AND OXYGEN RATE

Interfacing DHT11(Patient room temperature and humidity) with ESP32 : DHT11 is one of the commonly used temperature and humidity monitoring sensors. It is more precise in giving temperature and relative humidity. It outputs a calibrated digital signal which spits out into two different readings of temperature and humidity. It uses the digital-signal-acquisition technique that gives reliability and stability. The DHT11 sensor contains a resistive-type humidity measuring component and features a NTC temperature measuring component. Both these are integrated to an 8-bit highly efficient microcontroller which offers fast response, anti-interference ability and cost-effectiveness.

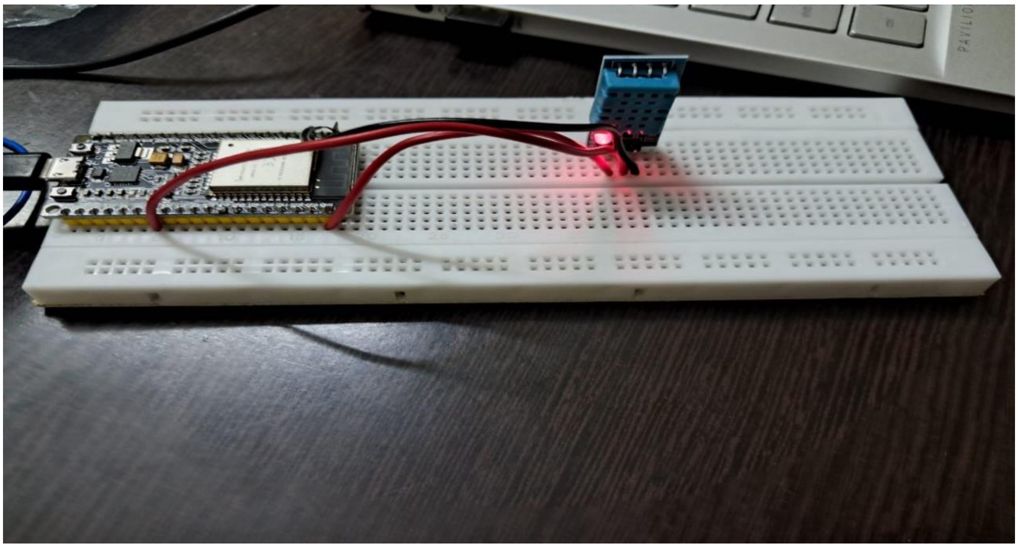

FIGURE 5.3 – TESTING DHT11 SENSOR FOR ROOM TEMPERATURE AND HUMIDITY

Patient room temperature and humidity is successfully calculated with DHT11

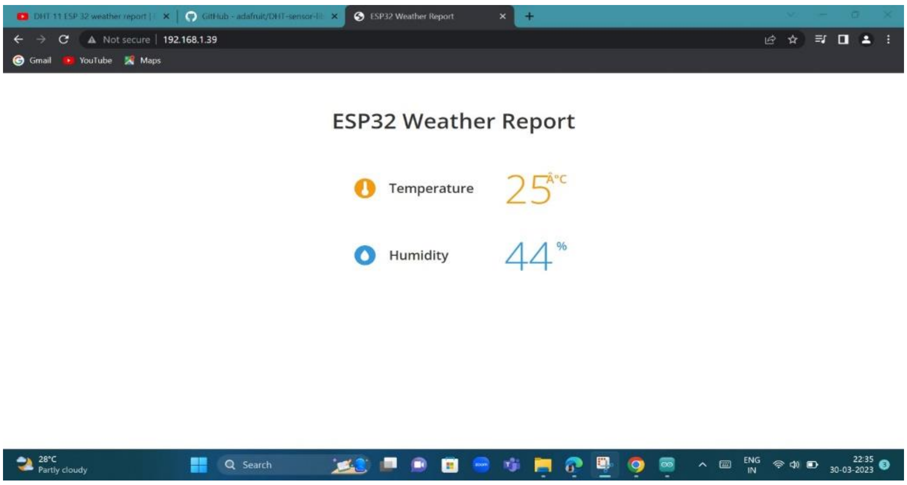

FIGURE 5.4 – OUTPUT CALCULATING PATIENT ROOM TEMPERATURE AND HUMIDITY

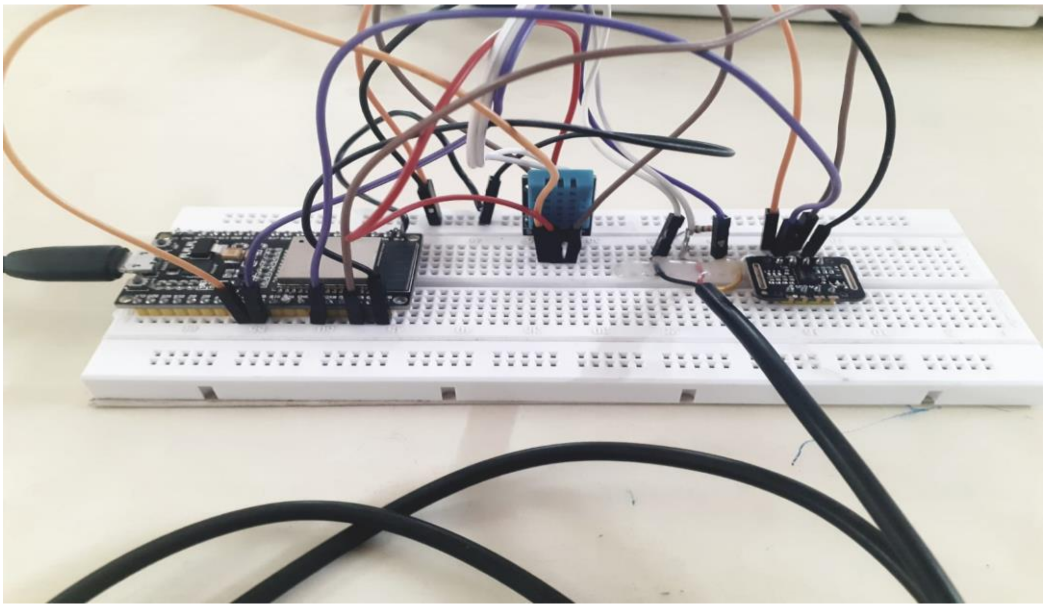

FIGURE 5.5 – HARDWARE CONNECTION OF HEALTH MONITORING SYSTEM

Hardware used for Health monitoring system are ESP32 , DHT11 , MAX30102 , DS18B20 ,Breadboard and jumper wires. All the sensor can work at 3.3V VCC. So connect their VCC to 3.3V Power Supply. Connect the GND to GND. MAX30100 is an I2C Sensor, so connect its SDA & SCL pin to GPIO21 & GPIO22. Connect its INT pin to GPIO19 of ESP32. The output pin of DHT11 is connected to GPIO18 of ESP32. Similarly, the output pin of DS18B20 is connected to GPIO5 of ESP32. A 4.7K pull-up resistor is connected between output pin & VCC pin of DS18B20.

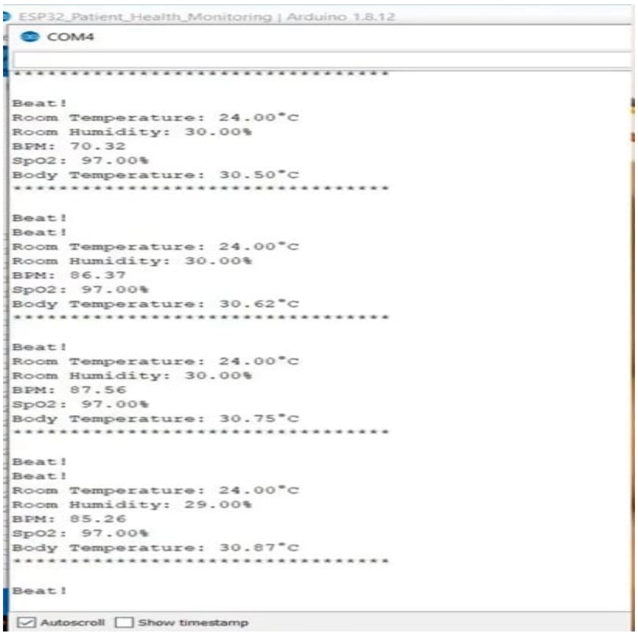

FIGURE 5.6 – Serial monitor Output

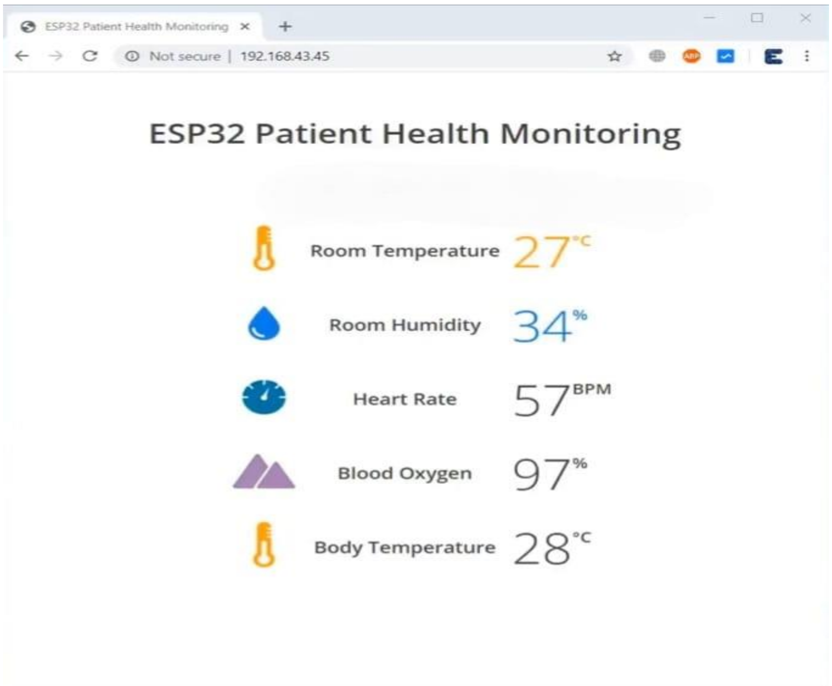

FIGURE 5.7 – FINAL OUTPUT ON WEBSERVER

This project is tested with 5 different people at different places for various outputs and the recorded values are tabulated

s.no	Room temperature (.C)	Room humidity (%)	Heart rate (BPM)	Blood oxygen (%)	Body temperature (.C)
1	$23^{.C}$	$44^{\%}$	67^{BPM}	$90^{\%}$	$29^{.C}$
2	$25^{.C}$	$32^{\%}$	70^{BPM}	$92^{\%}$	$30^{.C}$
3	$27^{.C}$	$34^{\%}$	57^{BPM}	$97^{\%}$	$28^{.C}$
4	$24^{.C}$	$29^{\%}$	65^{BPM}	$85^{\%}$	$27^{.C}$
5	$26^{.C}$	$35^{\%}$	72^{BPM}	$93^{\%}$	$26^{.C}$

TABLE 5.1 – OUTPUT RECORDED FOR 5 DIFFERENT PEOPLE

5.2 CONCLUSION

The system developed patient monitoring based on Internet of things, is an alternative that can be used to help patients with chronic diseases. Likewise with this set of solutions the aim is to improve the quality of life of patients, not just monitoring them, but also to enable direct them to improve their eating habits and workout routines. The context model developed for the system proved to be efficient when making inferences related to the context, such as recommendations for taking measures through sensors, as well as recommendations and workout routines tips to improve the eating habits of patients.

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