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Smart Jacket for Wearer's Healthcare and Safety

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Abstract
The country's healthcare infrastructure may not be enough in the face of an epidemic, especially COVID-19. Patients need to be monitored constantly, 24 hours a day which is very difficult to do either at hospitals or at home. This system tries to ease this problem through automatic monitoring of some basic parameters that governs a patient's health condition. The parameters that this system monitors are temperature of the body using temperature sensor, heartbeat count and blood oxidation level using oxidation sensor. The readings are then pushed to the database using a Wi-Fi module, the values are then fetched using MQTT protocol on the front-end web application. A web application using ReactJS is developed to give a live analysis of a patient's condition and to check the condition of multiple patients with a graphical representation of their heart rate, oxidation and body temperature levels. The data of each patient can be viewed by the doctor. When the condition of a patient is at an abnormal level, the doctor is immediately alerted through an indication in the web application and at the same time an SMS alert is sent to the patient's family member. Thus, this project prevents the doctor from coming in direct contact with the patients.

Keywords: Bio-Medical engineering, WI-FI module, Graphical representation, IoT.

1. Introduction

The device is designed to monitor patient at any instant for a remote location. This device is equipped with sensor units like MAX30102, AD8232 and LM35 which will be used to sense some of the human vitals like SpO2 level, Heart pulse rate, body temperature and ECG. All these sensors will be integrated with a microprocessor and a gateway module. The sensors, microcontroller and the gateway module together are called a sensing unit and it will be fabricated on a vest. This sensing unit will be to the monitoring system on a wireless basis. The monitoring system is divided into two units 1. patient monitoring unit 2. nurse's office monitoring unit (remote location). Patient monitoring unit is a dedicated system given to the patient (i.e.) in ward monitoring unit, this unit will collect the data from the sensing unit through Wi-fi and stream the data to all other monitoring unit through the internet. The data transfer is done using MQTT protocol. MQTT protocol allows data fetching at the front level of the web page. This system doesn't need any dedicated fixed, immobile devices for patient monitoring which allows the patients to move freely wherever they want without any inconvenience. The proposed system is an ideal solution for the current requirement of the modern healthcare system to provide complete and support to ICU patients

2. Technologies Used

An embedded system is part of a larger operating system that is designed to perform one or two specific tasks. In the healthcare field, embedded system is often used for data storage. Since healthcare applications may be used in rugged operating conditions with temperature fluctuations and exposure to shock and vibrations, it is usually necessary to choose industrial grade embedded system. Industrial grade products are designed for use in those demanding conditions and can withstand them without any loss of functionality. Most embedded systems are small in size and have low power demands. Embedded systems can be based on microcontrollers or microprocessors.

Most people interact with embedded system daily, even if they don't realize it. Traffic lights, digital watches, MRIs, and avionics are all examples of devices that use embedded systems. The use of embedded systems in healthcare has empowered doctors and patients alike. Through embedded systems, doctors can use imaging tools to diagnose health problems without having to perform exploratory surgery, and they can use those same imaging tools to track treatment progress. The use of embedded systems in healthcare also makes tracking vital signs virtually instantaneous. For patients, embedded systems have made managing conditions at home easier.

A. Internet of Things

Today the Internet has become ubiquitous, has touched almost every corner of the globe, and is affecting human life in unimaginable ways. We are now entering an era of even more pervasive connectivity where a very wide variety of appliances will be connected to the web. The Internet of Things as simply an interaction between the physical and digital worlds. The digital world interacts with the physical world using a plethora of sensors and actuators.

Internet of Things "provides an integration approach for all these physical objects that contain embedded technologies to be coherently connected and enables them to communicate and sense or interact with the physical world, and also among themselves". The Internet of Things (IoT) is a concept that reflects a "connected set of anyone, anything, anytime, anyplace, any service, and any network". One of the most attractive applications fields for IoT is the Healthcare, giving to us the possibility of many medical applications such as remote health monitoring, fitness programs, chronic diseases, and elderly care. An IoT ecosystem consists of web-enabled smart devices that use embedded 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 analysed or analysed 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 connectivity, networking and communication protocols used with these web-enabled devices largely depend on the specific IoT applications deployed.

B. Project Objective

The objective of this work is to design a system which helps in the health monitoring system by providing the feature of continuously monitoring multiple patient's health status through the web application, without direct contact with the doctor and the system will alert the doctor as well as the patient's family members in case of any emergency.

C. State of the Art

Assumpta Nantume [1] *et al*. (2018) presented a moderate level of agreement for measurement of SpO2, PR, and RR, with>80% of subject means falling within the predefined acceptability limits. However, there was also notable variation in accuracy between subjects, with large standard deviations observed for measurement of all four parameters. While the level of agreement for measurement of temperature was low, this is partly explained by limitations in the comparison method.

Arnob [2] *et al*. (2018) presented a framework that uses sensors to track patient health information and web technology to notify the family members and friends.

Chao [3] *et al*. (2017) presented a real-time pervasive patient monitoring system that transmits sensed physical sings (parameters) to a remote medical application. The proposed system integrates two parts, namely, data acquisition and data transmission. The data acquisition part of the system is responsible for monitoring of the system's parameters and the number of each parameter in the system. This is designed based on the knowledge gathered from medical experts. The second part includes parameters that are designed to be measured at different time rates, these include the blood pressure; heart rate; pulse rate; blood fat; glucose and patient's location. The authors presented an easy-to-use prototype to demonstrate the workability of the proposed system.

Mohammad [9] *et al*. (2019) presented an IoT-based health monitoring system employing the use of the My Signals development shield, and a low power long range (LoRa) wireless technology. Several sensor components were used. These include body temperature sensor, pulse rate and oxygen saturation sensors.

Reshma [10] *et al*. (2019) proposed a system that integrates an infrared based heartbeat sensor and Arduino Uno microcontroller. The system possesses the capabilities to detect the body temperature and heart pulse respectively. The heart beat sensor was used for detecting the heart pulse. The system allows its users to measure their mean blood vessel weight (MAP), and measure the body temperature to be displayed on the android screen for viewing. Furthermore, the system can be used to measure important parameters such as heart rate and body temperature.

D. System Analysis

System analysis is the first and foremost step performed in developing the software to solve a particular problem. In the analysis part, a software developer examines the requirements. Carrying out preliminary investigation identifies these requirements. Analysis consists of two sub phases namely,

- Planning.
- Requirement.

Planning: During the planning phase, cost estimates and work schedules will be planned.

Requirement: Requirement definition is a specification that describes the processing environment, the required software functions, performance constraints (size, speed, machine configuration) and exception handling.

3. Existing System and Drawbacks of Existing System

The existing RPMS allow providers to monitor, report, and analyze their patient's acute or chronic conditions from outside the hospital or clinic setting. They enable real-time understanding of a patient's disease state, enabling the provider to make proactive clinical decisions. But these systems have separate module for pulse-meter, oximetry, heart rate, weight scale, etc. These essential vitals will be measured by conventional sensors or miniature wearable sensors like bands and chips. The existing RPMS has a dedicated routed path for the data transfer between the sensing module and monitoring system. And the interlink of the system will be done through a PLC controlled data bus. The drawbacks are listed as follows

- A little inconvenience for the patients and minimal movement radius.
- Pure through-wire data transfer to the monitoring system.
- Require base router for every group/series of sensors.
- Large amount of clerical time is required.
- The record maintainability is difficult.
- Accessibility of accurate information from the past record is difficult.
- There is always delay in information search and retrieval. It requires
- Lot of human resources is required.
- Data reliability and maintainability is difficult.
- Lot number of records need much place to save.
- The paper works have to be taken care.
- The patient entry form may miss.
- The doctor appointment cannot be maintained in properly

E. Proposed System

This system is designed to monitor the patient's vital al all time and send the vital details to any remote monitoring system which has access to those patients' sensing device. The system developed for the first phase has equipped with MAX30102 sensor on the sensory unit and interfaced with GSM module. This sensory unit will sense the spO2 level in percentage and heartrate in beats per minute of a patient and send those signals to a nearby monitoring device (mobile application) through Wi-Fi. Interfacing of the sensory unit and mobile application is done through a dedicated webpage. This webpage provides a platform to connect any nearby device with it and enable us to control and monitor its activity and store the vital values as the website's cache memory. The block diagrammatic representation of proposed system is shown in figure 1.

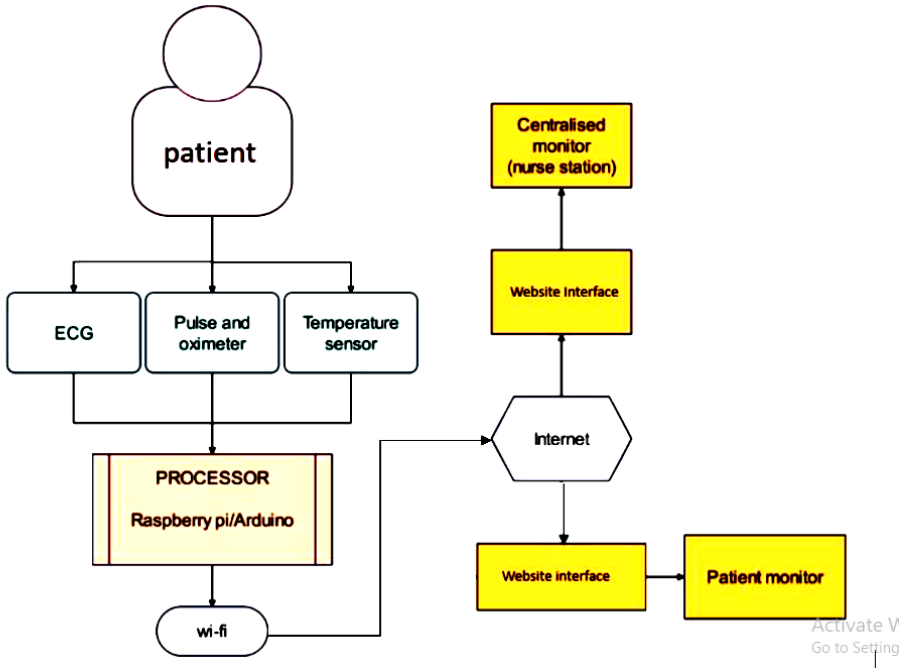

Fig 1: Block Diagram of proposed system

F. Modelling

In order to propose a new system, modelling has to be done in order to check whether the design of the proposed system is unique from previously proposed system. Here, Modelling of proposed system is done with the help of the data flow diagram which helps us to understand the working flow of our proposed system.

4. Data Flow Diagram

Data Flow Diagram is a design tool constructed to show how data within the system. It is designed from the data which is collected during data collection phase. A data flow diagram shows the way information flows through a process or system. It includes data inputs and outputs, data stores, and the various sub-processes the data moves through.

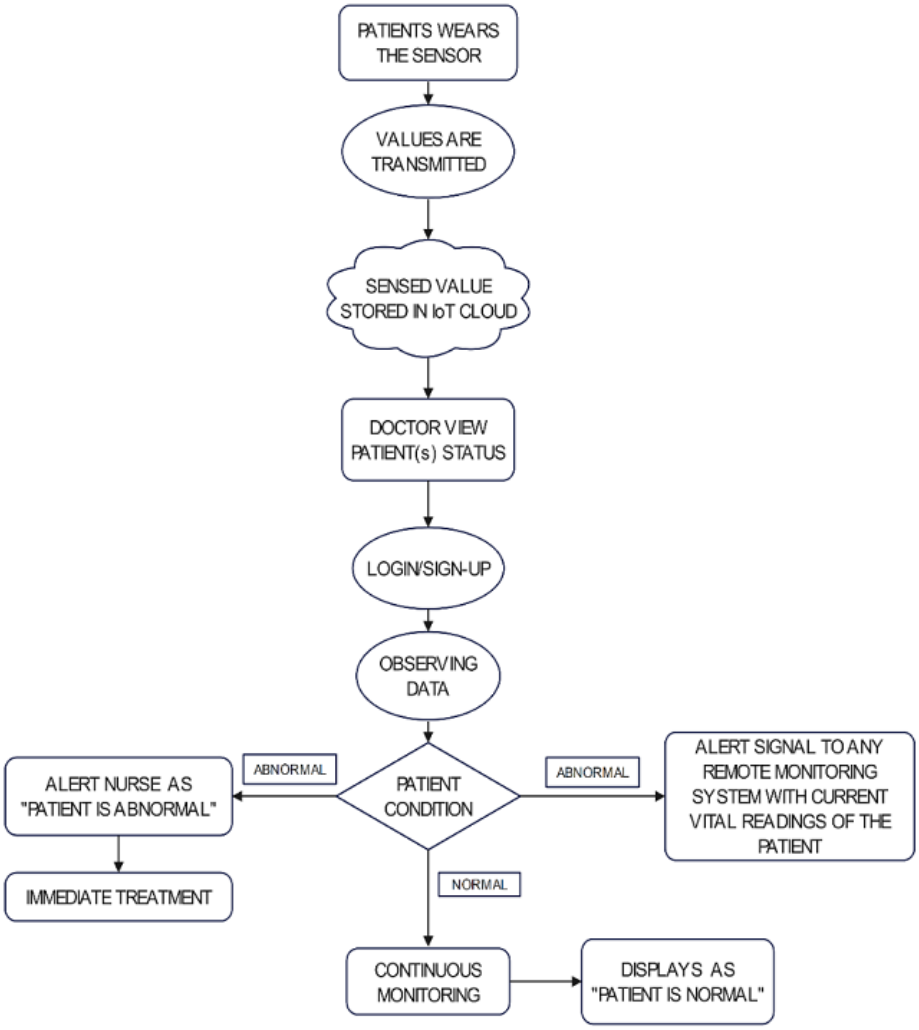

Fig 2: Data Flow Diagram

5. Hardware and its Implementation

The hardware of the proposed system has sensors, a micro controller unit, GSM module and a power source. Each component serves a unique purpose in the system to make it fully functional. A block diagrammatic representation is shown in the figure 3.

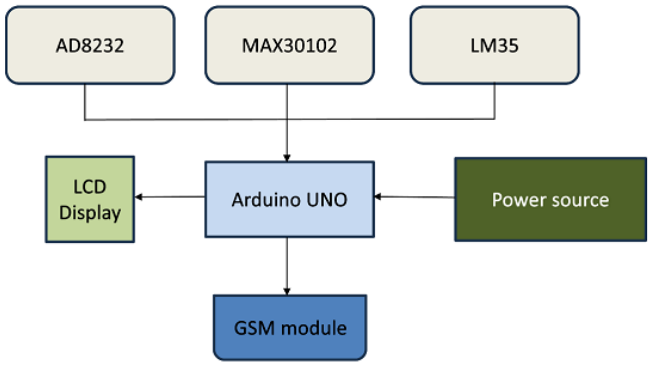

Fig 3: Block diagram

This circuit diagram is designed for sensing human vitals like spO2 and heartrate and display it through Arduino UNO. This circuit consists of two sensors AD8232 and MAX30102. AD8232 is sensor that converts analogue signals to digital signals. AD8232 is used to measure ECG of a person. MAX30102 is an optical sensor which is used to measure the SpO2 level and heartrate of a person. These two sensors are connected to Arduino UNO which will get the info from the sensors and process it to perform it dedicated work. These sensors will tap the vitals and send that signal to the processor. Then the processor will analyse the received signals from the sensor to check any abnormality, if there are any abnormality then the device will send a distress signal to the healthcare assist through message. If all the sensed vitals are normal it will continue to do its work without any interruption. The hardware of the proposed system is shown in the figure 4.

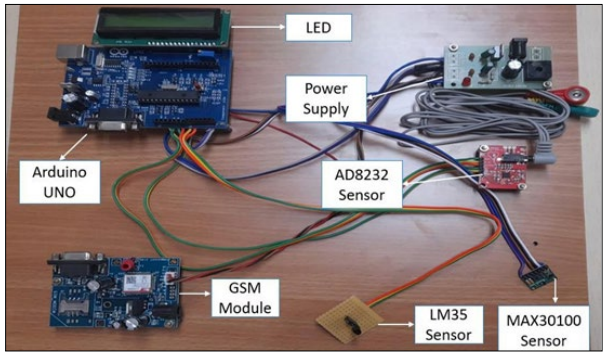

Fig 4: Hardware of the proposed system

Output was obtained as graphical form of ECG using AD8232 which is shown in the figure 5. This graphical waveform illustrates the electrical activity of the heart during the cardiac cycle with waves and bumps
(PQRST).

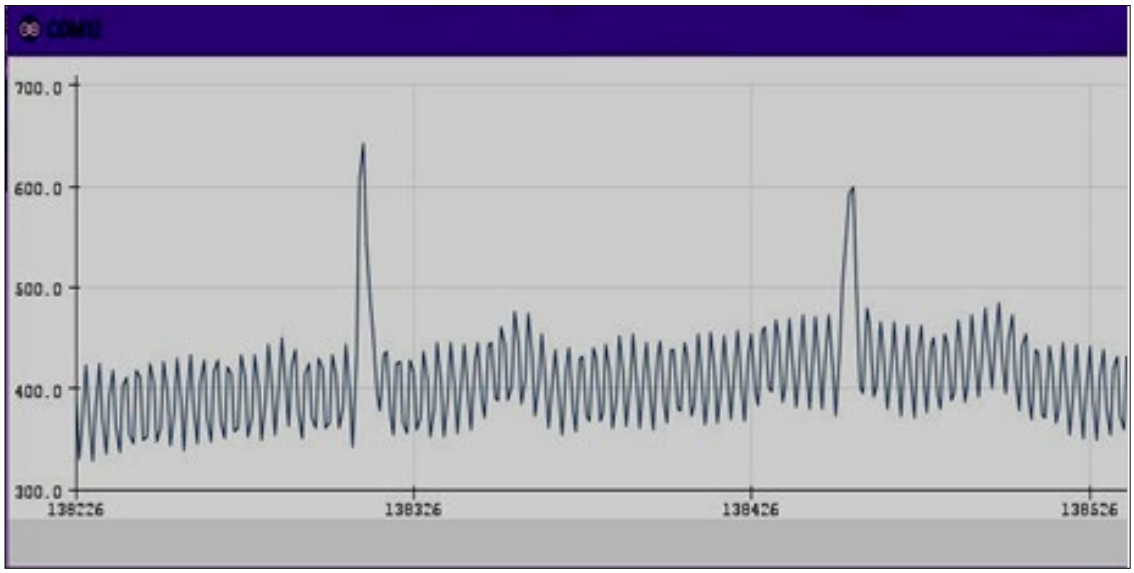

Fig 5: ECG Output using AD8232

By observing the output waveform we obtained, it has a little tolerable distortion which will not be a problem as the distorted value is very low. The output obtained is the graphical representation of initial stage of sensing by MAX30102 when the patient places their finger on the sensor. The readings shown here is the representation of before contact and after contact of the sensor with the patient. The graphical representation is given in figures 6 and 7.

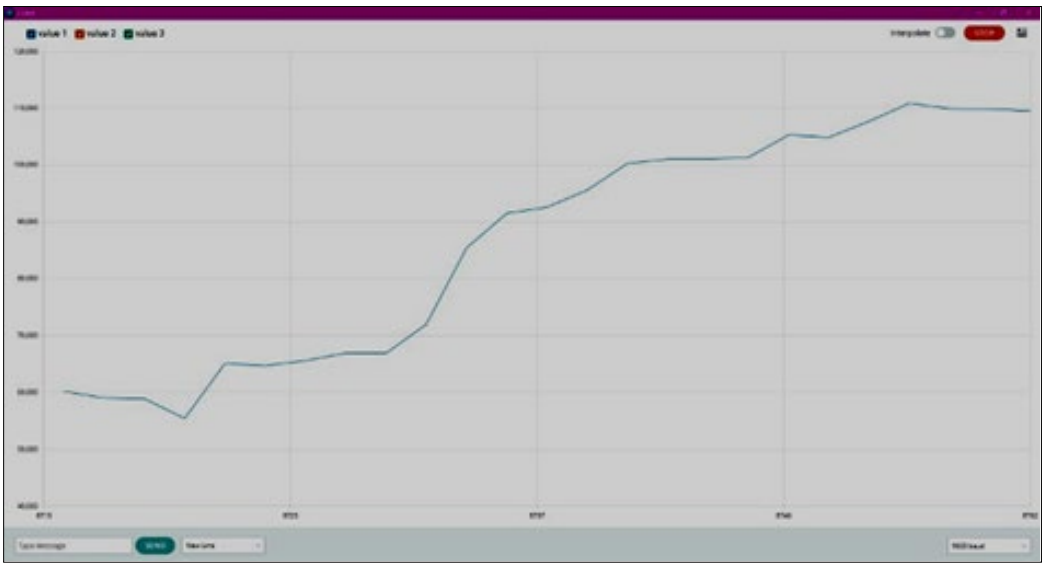

Fig 6: SpO2 Output using MAX30102

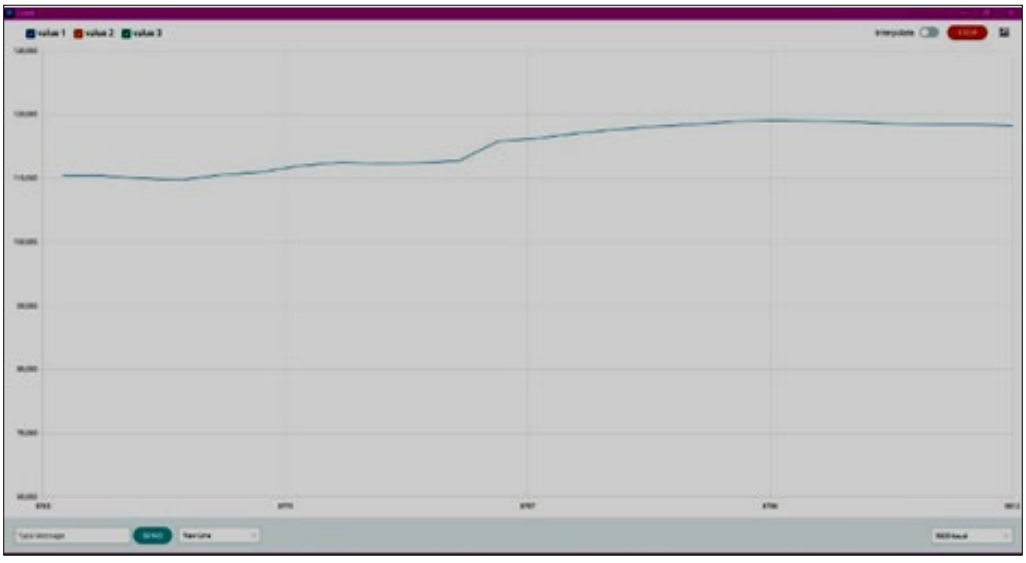

Fig 7: SpO2 Output using MAX30102

The output obtained is the graphical representation of heart rate in a pulse wave form. Each pulse in this waveform indicates a heart pulse. The pulse wave form is shown in figure 8

Fig 7: Output wave form of heart pulse using MAX30102

The monitoring device displays the vitals of patient in a tabular form. In here the details of patient's vitals will be displayed with the time indication. Figure 8 shows the table which displays the vitals with it respective time.

S.No	Date	Heart Rate (HB)	Blood Oxygen Saturation (SPO2)	Temperature (Temp)	Electroencephalogram (EEG)
1	2024/03/20 11:27:25am	72.05	90	33.5	2.47
2	2024/03/20 11:32:51am	0.	0	39	0
3	2024/03/21 12:24:13pm	72.05	90	32.5	2.47
4	2024/03/21 06:11:57pm	20.37	0	30.30	0
5	2024/03/21 06:12:57pm	20.37	0	51.81	4
6	2024/03/21 06:14:42pm	107.54	93	32.79	3
7	2024/03/21 06:16:15pm	141.59	93	30.30	0
8	2024/04/05 01:07:02pm	0.00	0	27.37	0
9	2024/04/05 01:08:03pm	0.00	0	28.84	4

Fig 8: Face of monitoring device

From the table it is observed that the device is capable of reading the vitals in a precise way and the distortion in the displayed value is under tolerance rate. This website is designed as if it can store the patient's vitals as website's cache memory in the device itself, this helps in eliminating the use of any external IoT cloud.

Conclusion

This work presents a design and implementation of health monitoring system, within the context of IoT environment. This system will provide a constant health monitoring facilities for the patients who are in the ICU or bedridden at home remotely from any place. Oxidation sensor and temperature sensor are the two sensors that have been used to allow real-time monitoring of SpO2, Heart beat count and temperature of the patient. Moreover, the data are continuously updated to the cloud at a regular time interval. This helps the doctors and relatives of the patient to monitor the health condition of the patient and also helps to take any action at the appropriate time. The system also sends an automated notification via text to the doctors or the relatives if the SpO2 value, heart beat count and the temperature reading go above or below the threshold value. It will help doctors in many ways and will enhance the efficiency of monitoring and treatment for patients. This system comes with an advantage that, it is cost effective as compared to the device available in the market for determining the SpO2value, heart beat count. These devices show the value whenever the person uses it and there is no facility to store the sensed value which can be used later to analyse the health status. The developed project overcomes this disadvantage by providing the facility to store and maintain the sensed values.

References

1. Assumpta Nantume, Noah Kiwanuka, Asad Muyinda, Teresa Cauvel, Sona Shah. Accuracy and reliability of a wireless vital signs monitor for hospitalized patients in a low-resource setting, 2022.
2. Arnob S, Akash M, Nilay S, Abhishek KK, Binanda KM, Souvik C. An IOT based Portable Health Monitoring Kit, Int. Journal for Research in Applied Science & Eng. Tech. (IJRASET). 2018; 6(VIII):701-708.
3. Chao L, Xiangpei H, Lili Z. "The IoT-based heart disease monitoring system for pervasive healthcare service", International Conference on Knowledge Based and Intelligent Information and Engineering Systems, KES2017, Marseille, France, Procedia Computer Science. 2017; 112:2328-2334.
4. Charu Krishna, Dinesh Kumar, Dharmender Singh Kushwaha A Comprehensive Survey on Pandemic Patient Monitoring System: Enabling Technologies, Opportunities, and Research Challenges, 2023.
5. Femke L Becking-Verhaar 1, Robin PH. Verweij 1, Marjan de Vries 1, Hester Vermeulen 2, Harry van Goor 1 and Getty J. Huisman-de Waal. Continuous Vital Signs Monitoring with a Wireless Device on a General Ward: A Survey to Explore Nurse's Experiences in a Post-Implementation Period, 2023, xlviii.
6. Jorge G, Oviedo B, Zhuma E. "Patient monitoring system based on internet of things," Procedia Computer Science. 2016; 83:90-97.
7. Ju-Yu Wu, Yuhling Wang, Congo Tak Shing Ching, Hui-Min David Wang and Lun De Liao IoT-based wearable health monitoring device and its validation for potential critical and emergency applications, 2023.
8. Kegomoditswe Boikanyo, Adamu Murtala Zungeru, Boyce Sigweni, Abid Yahya, Caspar Lebekwe. Remote patient monitoring systems: Applications, architecture, and challenges, 2023.
9. Mohammad SI, Mohammad TI, Ali FA, Gan KB, Norbahiah M, Nowshad Amin. Monitoring of the Human Body Signal through the Internet of Things (IoT) Based LoRa Wireless Network System, Appl. Sci. 2019; 9:1884. doi:10.3390/app9091884.
10. Reshma SPT, JaiSurya Y, Sri LM. Heart Rate Monitoring System using Heart Rate Sensor and Arduino Uno with Web Application, Int. Journal of Eng. and Advanced Technology (IJEAT). 2019; 8(4):xlix.