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IoT Based Patient Monitoring System

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Abstract - *Domain of project is Internet of Things (IoT). This system can be used in healthcare sector. NodeMCU is used as microcontroller, other than that several sensors are used to collect data like MAX30100 Pulse oximeter, DS18b20 sensor, Dht22 sensor, AD8232 ECG sensor and Thingspeak platform is used for monitoring the patient health. With an advancement in the emerging technologies and miniaturization of sensors, efforts have been made of using new technologies in healthcare areas to improve the overall quality life. The healthcare industry is a significant field of study that has seen the introduction of technologies. It is enormously expensive for those in need of health care facilities, which is especially the case in developing countries. The health monitoring system has seen tremendous growth in hospitals and many other health centers, and portable health monitoring systems of new technologies are also being of great interest to many countries around the world. The emergence of the Internet of Things (IoT) technology makes it possible for healthcare to shift from face-to - face appointment to telemedicine. As a result, this effort is an attempt at addressing a health issue that society is currently facing. The primary aim of the project is to design a framework for remote healthcare. This project proposes an intelligent IoT healthcare system that will monitor the health related parameters of a patient and the condition inside this room where patients are presently in real time. In this framework, some sensors are used to collect the data, like heartbeat sensor, body temperature sensor, room temperature sensor, Blood oxygen sensor, ECG sensor, and Room humidity sensor from the patient and area. The status of the patients is communicated to the medical personnel through online platform, where they can process and interpret the patients' current state. The prototype will be well suited for healthcare monitoring that is proved by the effectiveness of the system. The system is very effective in the case of infectious disease including a novel coronavirus (COVID-19) treatment. The system will enhance the current healthcare infrastructure, which will protect more lives from death.*

***Key Words*: MAX30100, Thinkspeak, AD8232 ECG Sensor, DS18B20 Sensor, Healthcare, Monitoring.**

1.INTRODUCTION

The healthcare industry is a significant field of study that has seen the introduction of technologies. It is enormously expensive for those in need of health care facilities, which is especially the case in developing countries. The health monitoring system has seen tremendous growth in hospitals and many other health centers, and portable health monitoring systems of new technologies are also being of great interest to many countries around the world. The emergence of the Internet of Things (IoT) technology makes it possible for healthcare to shift from face-to - face appointment to telemedicine. As a result, this effort is an attempt at addressing a health issue that society is currently facing.

The primary aim of the project is to design a framework for remote healthcare. This project proposes an intelligent IoT healthcare system that will monitor the health related parameters of a patient and the condition inside this room where patients are presently in real time. In this framework, some sensors are used to collect the data, like heartbeat sensor, body temperature sensor, room temperature sensor, Blood oxygen sensor, ECG sensor, and Room humidity sensor from the patient and area. The status of the patients is communicated to the medical personnel through online platform, where they can process and interpret the patients' current state. The prototype will be well suited for healthcare monitoring that is proved by the effectiveness of the system. The system is very effective in the case of infectious disease including a novel coronavirus (COVID-19) treatment. The system will enhance the current healthcare infrastructure, which will protect more lives from death. As input data like Heartbeat, Body temperature, ECG, Oxygen level, Room temperature, Room humidity are taken.

Acute health conditions might lead to sudden death. Many people die suddenly around the world because of dysfunction in one or more body organs. Before that happen, these organs produce abnormal signs. These signs, which called bio-signals, can be detected and are collected via sensors. The remote healthcare systems based on IoT technology depends on microcontroller and gateway to upload data. Arduino microcontroller family is used more in this field. Some projects use NodeMCU which is ESP8266 based board . While others use Arduino UNO with ESP9266 module . Other projects make matching between one of Arduino boards and Raspberry Pi board.

There are various types of IoT platforms. Some of them are created via developers from scratch using web design skills such as Node.js server and WebSocket library also, HTTP

server and the developed web based GUI interface . On the other hand, Android Studio provides a good opportunity to mobile application developers where you can build your own Healthcare application. NodeMCU is used as microcontroller, other than that several sensors are used to collect data like MAX30100 Pulse oximeter use for heartbeats, DS18b20 sensor, Dht22 sensor is used for temperature and humidity, AD8232 ECG sensor is use for ECG graph and pulse count and Thingspeak platform and mobile application such as blynk or own developed application in android studio is used for monitoring the patient health.

2. Existing System vs Proposed System

We all are ware that in hospital, either the nurse or the doctor has to visit physically from one person to another for checkups and monitoring the conditions of patient, which is not possible to monitor their conditions continuously. Thus, any critical situations cannot be found easily unless any doctor or nurse checks the person's health at that moment. This can be a hectic for the doctors who have to take care of a lot number of patients in the hospital. Also, in case of any medical emergencies to the patient, they are often unconscious and unable to press an Emergency Alert Button or cannot ask for any help from the nurse or doctor. The data can be transferred through Hyper Text Transfer Protocol (HTTP) for general communication over Internet. However, when this technology is applied to communication in IOT, protocol overhead and resulting performance degradation is a serious problem. Moreover, IP addressing depends on physical location, which causes the problem of complexity of network control. Our proposed system continuously monitoring patient's vital signs and sense abnormalities. The monitored data is shared with the medical staff. Upon encountering any abnormalities, the system can send alerts to the medical staff about the abnormal parameter. Thus, it can reduce the need for manual monitoring which currently is done by the medical staff. Our proposed system send the data from sensors to cloud platform that is thing speak and android application. Any number of users can see the medical record recorded on the thing speak using the thing speak access key.

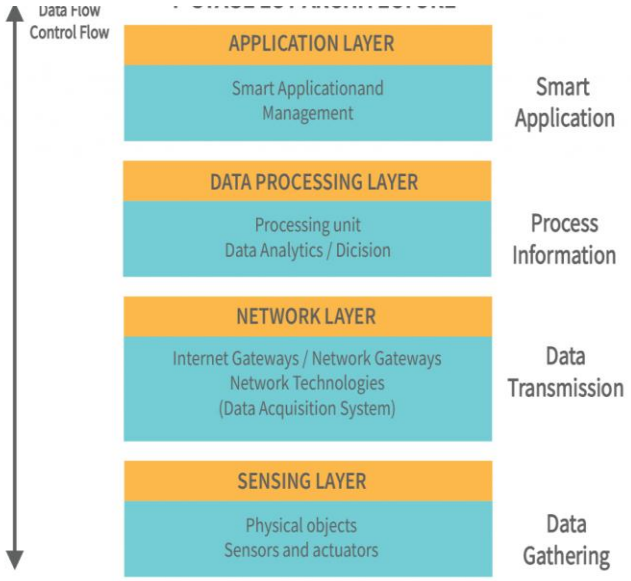

Fig -1: IoT Architecture

2.1. Advantage of Proposed System

The application of IoT in the healthcare industry enables the automation of time-consuming activities that previously allowed human mistake. For instance, many hospitals today use networked equipment to regulate the temperature and airflow in operating rooms.

1. Reduced Errors – IoT allows for the accurate collection of data, automated workflows and minimized waste, but most importantly it reduces the risk of error.

2. Decreased costs – With IoT, patient monitoring can be done in real-time, drastically cutting down the need for doctors going out and making visits. Connected home care facilities will help to reduce hospital stays and re-admissions of the patients.

3. Better patient experience – A connected healthcare system creates an environment that meets each patient's needs. Dedicated procedures, enhanced treatment options and improved diagnosis accuracy make for a better patient experience.

4. Quick proper treatment – With real-time data healthcare providers can continuously monitor patients. This means that they can spot and provide quick treatment to any of the serious patients in time

5. Homecare – Patients can be monitored in the convenience of their own homes using M2M. To the patient, sensors are attached to various medical devices, such as heart rate monitors. Data collected is sent to the hospital where a qualified member of staff analyses it for any abnormalities.

3. Software and Hardware Requirement

3.1. Software Requirement

1. Ardiuno IDE –

   The Arduino IDE (Integrated Development Environment) is used to write the computer code and upload it to the physical board. It is very simple and its simplicity is probably one of the main reason Arduino became so popular.

2. Thinkspeak –

   ThingSpeak is an IoT analytics platform service that allows us to aggregate, visualize and analyze live data streams in the cloud. It provides instant visualizations of data posted by our devices.

3. Android Studio –

   Android Studio is the official integrated development environment for Google's Android operating system, built on JetBrains' IntelliJ IDEA software and is designed specifically for Android development. It is used to develop android application which shows us all patient related data in mobile through internet.

3.2. Hardware requirement

1. Microcontroller – ESP8266 NodeMCU

   NodeMCU is an open-source Lua based firmware that runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware is based on the ESP-12 module. It can be powered using Micro USB jack and VIN pin (External Supply Pin) and supports UART, SPI, and I2C interface.

2. MAX30100 Pulse Oximeter

   A sensor solution with an integrated pulse oximeter and heart-rate monitor is called MAX30100. It is an optical sensor that obtains its readings from the red and infrared light emitted by two LEDs, then uses a photodetector to measure the absorbance of pulsing blood. This mix of LED colours is ideal for reading data with the tip of the finger. It can be entirely customised using software registers, and the device's internal 16-deep FIFO stores the digital output data. contains a digital I2C interface as well for communicating with the host microcontroller.

3. DS18B20 Temperature sensor

   The DS18B20 is a 1-wire programmable Temperature sensor with maxim integrated and is widely used to measure temperature in hard environments. The constriction of the sensor is rugged and can be purchased with a waterproof option making the mounting process easy. It measures a wide range of temperature from -55°C to +125° with a decent accuracy of ±5°C

4. DHT22 Temperature and humidity sensor

   A popular temperature and humidity sensor is the DHT22. The sensor includes a dedicated NTC for temperature measurement and an 8-bit microprocessor for serial data output of temperature and humidity information. It is straightforward to integrate with different microcontrollers and is factory calibrated. The sensor records temperature readings between -40°C and 80°C.

5. AD8232 ECG Sensor

   AD8232 ECG Module integrated with AD8232 IC from Analog Devices, is a single-chip designed to extract, amplify, and filter biopotential signals for biopotential measurement. They can be extremely noisy so that the AD8232 Single Lead Heart Rate Monitor acts as an op-amp to help obtain a clear signal from the PR and QT Intervals.

4. Flowchart and Circuit Diagram of system

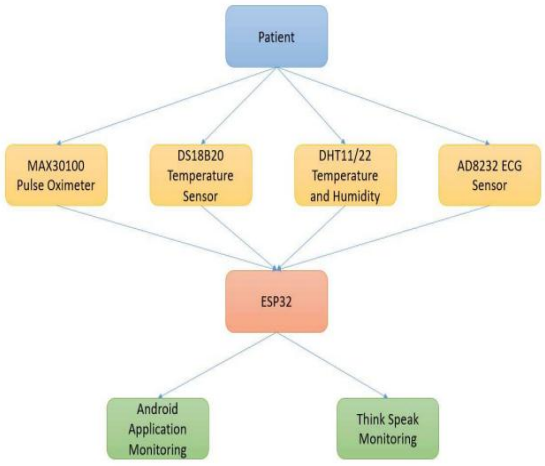

Fig -2: Flowchart of System

The flow of the system goes like firstly the patient is connected with sensors to the body like Ad8232 ECG sensor has three color cables (red, blue, black). The black color cable is attached left arm , blue color cable is attached to right arm and red color cable is attached to right leg. The DS18B20 Temperature sensor is attached to the body of patient under Left/Right arm. DHT11 is not connected to body as it is used for room temperature and room humidity. MAX30100 Pulse oximeter is attached to the finger of the patient. Now the data is collected from all the sensors and

uploaded on the cloud using ESP32 and is used by thingspeak and android app. All the monitoring of the sensor is done on ThingSpeak Platform or on the Android Application installed in the smartphone.

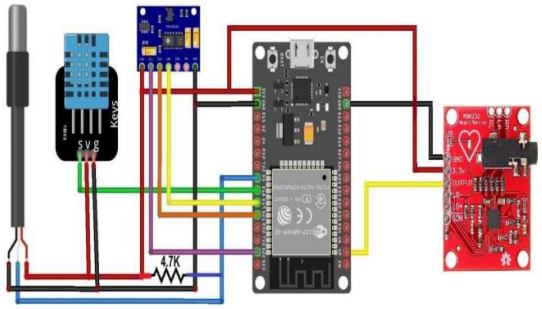

Fig -3: Circuit Diagram of System

4. Working

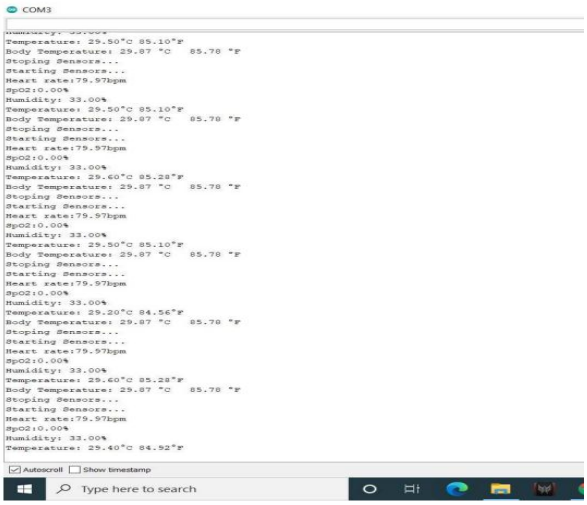

Fig -4: Sensor Data on Serial Monitor

All the sensor data output is printed on serial monitor and accuracy of the sensors are as below :

- MAX30100 Pulse Oximeter – The result is that the accuracy of the tool reaches 99.62
- DHT11 Temperature and Humidity Sensor – DHT11 humidity range is from 20 percent to 80 percent with 5 percent accuracy.
- DS18B20 Body Temperature Sensor – Measures Temperatures from -55°C to+125°C (-67°F to +257°F) with ±0.5°C Accuracy from -10°C to +85°C
- AD8232 ECG Sensor – A performance accuracy of 91.62 percent is obtained from ECG system

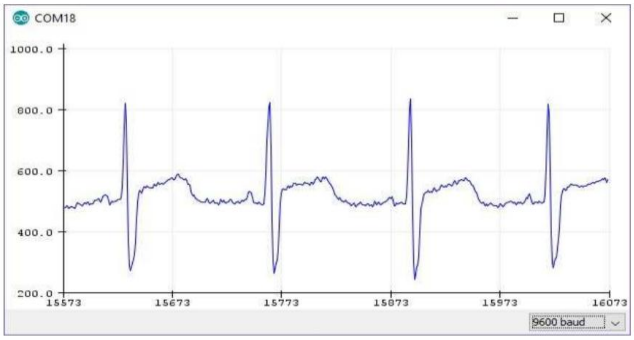

Fig -5: ECH Plot on Serial Plotter

Normal Values of Patient

1 - DHT11 Room Humidity 30 to 50 percent

2 - DHT11 Room Temperature 72 F

3 - AD8232 ECG Sensor(Heartbeat) 60 to 100 bpm

4 - DS18B20 Body Temperature 97 F to 99 F

5 - MAX30100 Pulse Oximeter Above 93 percent

Normal Values of ECG

1 - Heart rate : 60 - 100 bpm

2 - PR interval : 0.12 - 0.20 s

3 - QRS interval : less than equal to 0.12 s

4 - QT interval : less than half RR interval (males less than 0.40 s; females less than 0.44 s)

5 - P wave amplitude (in lead II) : less than equal to 3 mV (mm)

6 - P wave terminal negative deflection (in lead V1) : less than equal to 1 mV (mm)

7 - Q wave : less than 0.04 s (1 mm) and less than 1/3 of R wave amplitude in the same lead

5. Results

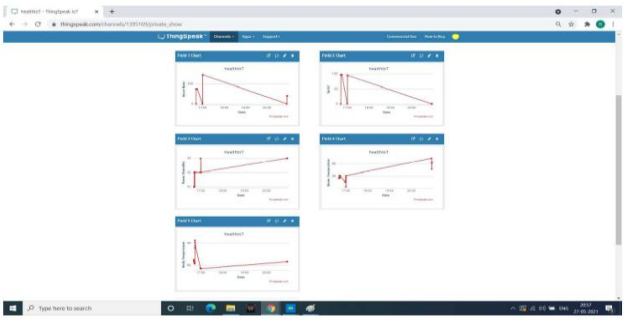

Fig -6: Thinkspeak Field Chart

Figure 6 shows five field chart on ThingSpeak platform with pulse oximeter output, body temperature output, room temperature output, room humidity output, heart rate output where data is fetched every second from the sensor and updated every second

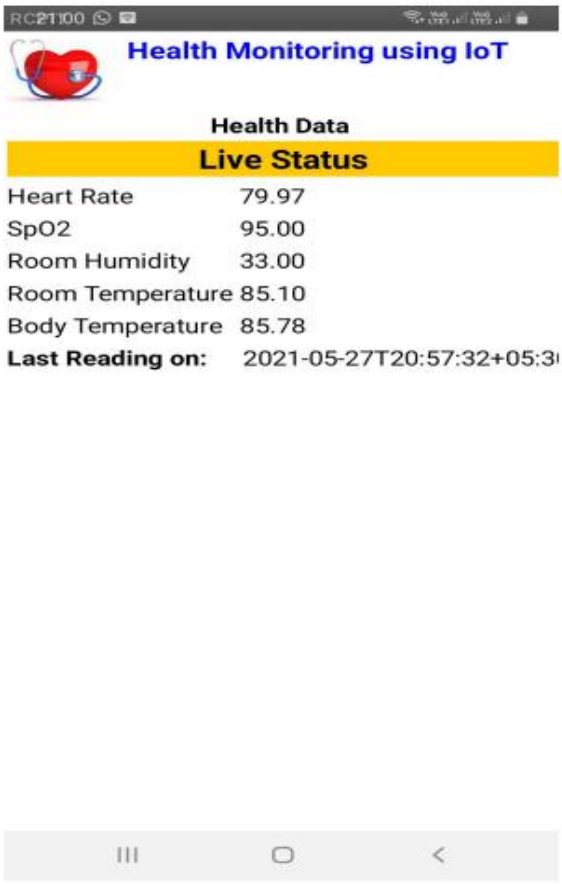

Fig -7: Android Application for Live Status

Figure 7 shows android application for live tracking or monitoring of the data fetched from the sensors and which are uploaded to ThingSpeak, This app uses http get and http response from the ThingSpeak platfrom and same data is shared in the application.

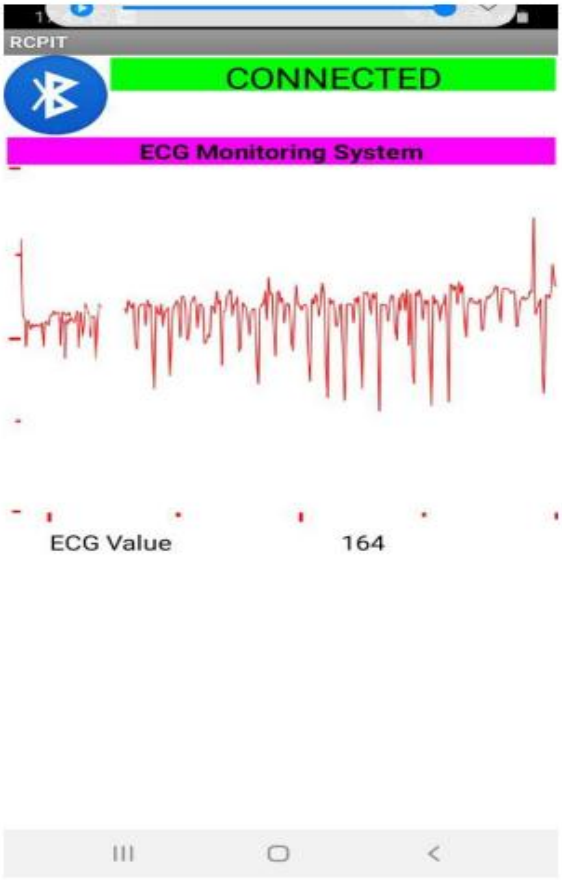

Fig -8: ECG plot on Android Application

Figure 8 shows android application for ECG Plotting from AD8232 ECG sensor and the sensors pads are attached to patients body.

5. CONCLUSION

The Internet of Things is considered 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, and stays in the hospital for conventional routine examinations. Most importantly the health can be monitored and disease be diagnosed by any doctor across the globe. This system monitors body temperature, pulse rate and room humidity and temperature using sensors. These values are then sent to a medical server using wireless communication and the data is then received on an authorized personals smart phone with IoT platform. Further, with these values the doctor then diagnoses the disease and the state of health of the patient.

There are other health parameters that can be monitored such as cuffless blood pressure, non-invasive blood glucose, respiratory rate. Additionally, machine learning technology can be considered as a vital addition to the healthcare monitoring system because it will assist doctors to diagnose

diseases faster and more accurately than the conventional diagnosing approaches. Furthermore, in case of urgent, when there is an abnormal signal produced from the patient's body, there are some approaches can be added to this project to handle this need. First, mobile calling and SMS messages sending to doctors, patients, relatives, and ambulance centers can be performed by adding SIM800L GSM Module to this project. Emails also can be sent via NodeMCU automatically to specific people's email accounts to save lives. Second, a wearable DC defibrillator can be attached to the patient body to apply DC shocks automatically when sudden VF (Ventricular Fibrillation) is happening. Finally, this system can be equipped with an automatic ventilation system to provide the oxygen automatically in case the SPO2.

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