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IoT Based Patient Monitoring and Future Health Estimation System using NodeMCU

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Abstract: **The Internet is a revolution in information technology. Internet of Thing plays important role in health care application.In our system, body temperature sensor , heart rate monitor sensor, ECG sensor and pulse sensor are used for collecting the vital sign of a patient. The collected information is get transmitted via NodeMCU over the internet. For the transmission and reception of a data MQTT IoT protocol is used. As a result, the doctor can examine his patient from anywhere and anytime. The system allows doctors ,nurses as well as patient easily to use the computer for checking and to save in the database. The doctor or patient can see the analyzed data on IoT web page or in Android App (Blynk App).**

Index Terms - **IoT, MQTT Protocol, Ubidots, Blynk App, NodeMCU**

I. INTRODUCTION

Internet is a global system that can be used for sharing information, providing worldwide services and communication.The main purpose of IoT devices is to generate real-time data that we can then analyze and use to create desired business outcomes. In an Internet of Things (IoT) ecosystem, two things are very important: the Internet and physical devices like sensors and actuators [1]. A health care monitoring system is necessary to constantly monitor the patients physiological parameters. The main advantage of this system is the result can be viewed at any time and place. The doctors can be notified using mobile phones messages if patient health is abnormal. The system was using both the sensors like heartbeat sensor, temperature sensor and blood pressure sensor. The system can analyze the signal to detect normal or abnormal conditions[2]. The blood pressure sensor used to ensure systolic pressure and diastolic pressure and pulse rate for a few seconds. The DS18B20 temperature sensor is used to measure the surface temperature of the skin. Heartbeat sensor is used to measure heartbeat which normally lies between 60-100bpm.The essential part of this pervasive healthcare mode is the real-time monitoring system. Satisfactory work is done in health monitoring by using IoT and NodeMCU . IoT is the interconnecting of devices and services that reduce human intervention to live a better life. [3]

II. RELATED WORK

In Review of literature we have compare various reference papers related to Healthcare monitoring. For comparison we have consider different Physiological parameters , analysis o the parameters, Sensors used for sensing the physiological parameters, different technologies and the output response.

In “Health Care System by Monitoring the Patient Health Using IoT” and GSM which was capable of detecting multiple parameters of our body such as blood pressure, temperature, heart rate, ECG and further transmitting this information on an internet of things server through 2G/3G/4G GSM technologies. The availability of low-cost single chip micro controllers and advances in wireless communication technology has encouraged engineers to design low-cost embedded systems for healthcare monitoring applications. Such systems have the ability to process real-time signals generated from biosensors and transmit the measured signals through the patient’s phone to the
medical center’s server [3].

One of the key learning platforms for IoT is the Raspberry Pi. The Raspberry Pi is a popular platform became it offers a complete Linux server in a tiny platform for a very low cost. The Raspberry Pi also
allows interfacing services and actuators through the general purpose I/O pins. The combination of Raspberry Pi and IoT becomes a new innovation technology in healthcare system. Raspberry Pi is act as a small clinic after connecting these (Temperature, Respiration, Accelerometer, Heartbeat) sensors. Raspberry Pi is works as small clinic in many places. Raspberry Pi is collect data from sensors and then it transfer wireless to IoT website. Raspberry Pi board is connected to the internet, that board MAC address is registered to the internet. After that in IoT website, add MAC address of this board. Then the sensors output is connected to the IoT Website[4].

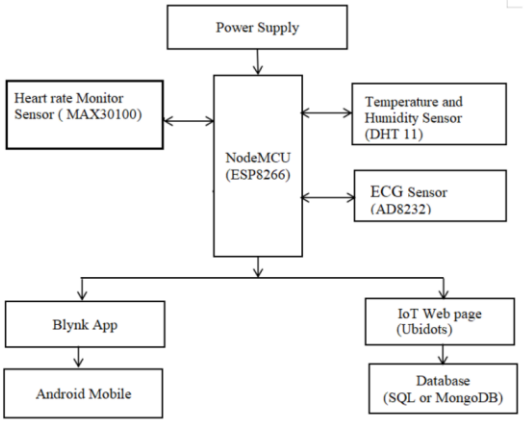
This paper explains Remote health monitoring using android app about certain physiological parameters that can be analyzed with the help of them on patients from either remote areas or urban cities. Following are the parameters, a) Temperature, b) Blood Pressure, c) Heart Beat Rate, d) ECG, e) Pedometer, f)GPS ,g)Accelerometer The sensor output is kept in track with the help of

ESP8266 Wi-Fi module, which transfers data from sensor output to an online IoT platform coined ThingSpeak. ThingSpeak software is applicable for both computers and smart phones, it is also paired with an android application called, ThingView which can be installed from Google play store. ThingView assists to help the user or the doctor to visualize the data with a smart phone. Each time it is refreshed, it shows the sensors output data at that instant [5].

Estimation and Monitoring of Vital Signs in Human Body by using Smart Device method uses NodeMCU as micro controller which is connected to Temperature Sensor, Pressure Sensor, Heartbeat Sensor. All sensors will be in sensing state to gather vital signs of the patient. Patient condition will be recorded constantly and if the data shows any if the data is above the critical value buzzer is alerted. The users can see the data of the patients by accessing to the URL of the network they have connected. Mostly this can be used for the people who stay constant at bed and for elders who are to be monitored continuously.We have arranged the model to get the values of the proposed framework. The created framework is of low effort and expends less power because of the use of NodeMCU as small scale controller. This framework is fixed and increasingly valuable for the aged people and individuals or for those whose well being is wrong and ceaselessly checked. Any place we stay we can check the qualities through web. Time is spared in this framework since Doctors can't remain at the patient's bed for checking so this framework is useful. This framework can be further increasingly adjusted by including versatile application and by not sending the every one of the information except if the signs are over the normal values [6].

III. PROPOSED WORK

Here discuss about the system architecture of our proposed system. In our proposed system we have used four sensors namely heart rate monitoring sensor (MAX30100), single lead ECG sensor (AD8232) and body temperature sensor (DS18B20). According to power requirement of a particular sensor we have separate them .All the sensor including NodeMCU they required power supply between 1.8V to 3.5V. when the power is get ON each sensor is get initialized through NodeMCU . We have design our system in such a way that the data is get monitored in real time by using above three sensors. These monitored data is then sent to a IoT web page that is on Ubidots . The communication between the NodeMCU and IoT web page is happen by using MQTT protocol. Then sensed data is get analyse in Ubidots and we get the desired output in the form of waveform. In Ubidots we have set the value between Normal to Critical condition. Further these data is get stored by using MySQL database for the future analysis. For the user friendly purpose we also created App by using Blynk application. So the patient can monitor or see the resulted data at home also and this information is send to a doctors or nurses through the cloud in web application. If there is any emergency happen doctor can co operate with patient through the Blynk app. As we know that the NodeMCU is a Wi-Fi as well as Bluetooth enabled device. So we can use our system in Indoor as well as in Outdoor applications.

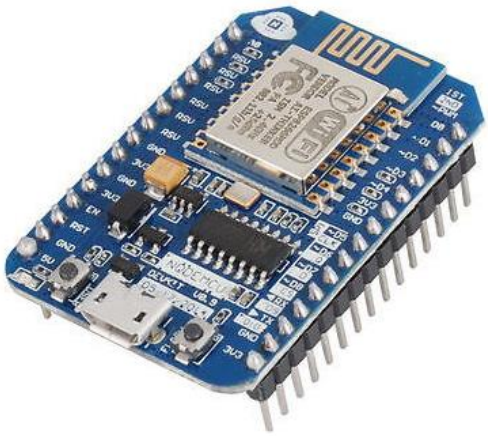


FIG[1] : PROPOSED SYSTEM

IV. HARDWARE USED

4.1 NodeMCU (ESP8266)

NodeMCU is an open source LUA based firmware developed for ESP8266 wi-fi chip. By exploring functionality with ESP8266 chip, NodeMCU firmware comes with ESP8266 Development board/kit i.e. NodeMCU Development board.
The NodeMCU is a micro controller with integrated Wi-Fi, which means that there is no need for an additional Wi-Fi chip set. The design of the SoC allows communication through the GPIOs by connecting to the Internet and transmitting data over the Internet. This is a perfect connection for the Internet of Things (IoT). It has a price of about Rs. 699 and it is depending upon retailer, with a physical size of 49 × 24.5 × 13 mm and consumes 0.00026–0.56 W of power. This is the best hardware around in terms of cost and this chip is the future of the IoT. Today, many retailers offer ESP8266 Breakout boards to facilitate our work. The NodeMCU is an easily usable board and it has a variety of pins. It has a USB connection port to connect to the computer.[7]



FIG[2]: ESP8266

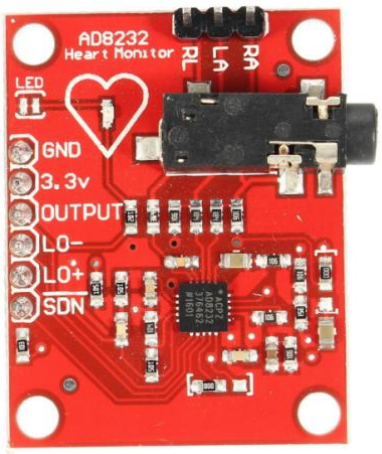
4.2 Heart rate monitor sensor (MAX30100)

The MAX30100 is an integrated pulse oximetry and heart-rate monitor sensor solution. It combines two LEDs, a photo detector, optimized optics, and low-noise analog signal processing to detect pulse oximetry and heart-rate signals. The MAX30100 operates from 1.8V and 3.3V power supplies and can be powered down through software with negligible standby current.

FIG[3]: MAX30100

4.3 ECG sensor (AD8232)

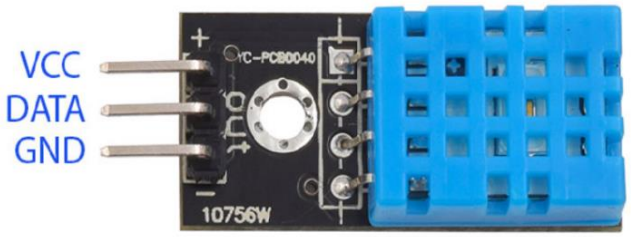
The AD8232 SparkFun Single Lead Heart Rate Monitor is a cost effective board used to measure the electrical activity of the heart. This electrical activity can be charted as an ECG or Electrocardiogram and output as an analog reading. ECGs can be extremely noisy,the AD8232 Single Lead Heart Rate Monitor acts as an op-amp to help obtain a clear signal from the PR and QT Intervals easily. The AD8232 is an integrated signal conditioning block for ECG and other bio potential measurement applications. It is designed to extract, amplify, and filter small bio potential signal sin the presence of noisy conditions, such as those created by motion or remote electro-deplacement. The AD8232 Heart Rate Monitor breaks out nine connections from the IC that solder pins, wires, or other connectors to. SDN, LO+, LO-, OUTPUT, 3.3V, GND provide essential pins for operating this monitor with an Arduino or other development board. Also provided on this board are RA (Right Arm), LA (Left Arm), and RL (Right Leg) pins to attach and use your own custom sensors. Additionally, there is an LED indicator light that will pulsate to the rhythm of a heart beat[8].



FIG[4]: AD8232

4.4 Temperature and Humidity Sensor (DHT 11)

DHT11 Temperature and Humidity Sensor features a temperature and humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature and 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 high performance 8-bit micro controller, 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 programs 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 [9].



FIG[5]: DHT 11

V. Software Used

5.1 Ubidots

A Ubidots' device is a virtual representation of a data-source or simply, an asset taking sensor data and transmitting said data through a connection protocol to Ubidots' cloud.

All devices are different, but the standard setup on any device entails:

• A library that should be installed in the device's IDE. (not required)

• Filling parameters for authentication and connection such as a TOKEN (i.e. the unique ID for each account or user), device and variable labels (i.e. devices and variables unique identifiers in Ubidots), Wi-Fi SSID and Password, depending on the device and the requirements.

• Making API request (i.e. a call from a device to the web server). Ubidots' libraries spare the need to manually make these requests. However, if you're working with a device not currently in the list of supported hardware, you can choose a connectivity protocol such as MQTT or HTTP and make a request using the API accordingly.[10]

5.2 ThingsBoard

ThingsBoard is an open-source IoT platform for data collection, processing, visualization, and device management. ThingsBoard is an open-source IoT platform that enables rapid development, management and scaling of IoT projects. The goal is to provide the out-of-the-box IoT cloud or on-premises solution that will enable server-side infrastructure for your IoT applications. It enables device connectivity via industry standard IoT protocols - MQTT, CoAP and HTTP and supports both cloud and on-premises deployments. ThingsBoard combines scalability, fault-tolerance and performance so you will never lose your data.[11]

5.3 Blynk

• Blynk is a Platform with iOS and Android apps to control Arduino, Raspberry Pi and the likes over the Internet.

• It's a digital dashboard where you can build a graphic interface for your project by simply dragging and dropping widgets.

• It's really simple to set everything up and you'll start tinkering in less than 5 mins.

• Blynk is not tied to some specific board or shield. Instead, it's supporting hardware of your choice. Whether your Arduino or Raspberry Pi is linked to the Internet over Wi-Fi, Ethernet or this new ESP8266 chip, Blynk will get you online and ready for the Internet Of Your Things.

• You can download Blynk app from below links

• Free Blynk app from IOS App store and Play Store.[12]

VI. Result And Discussion

(1)Hardware setup of our system .

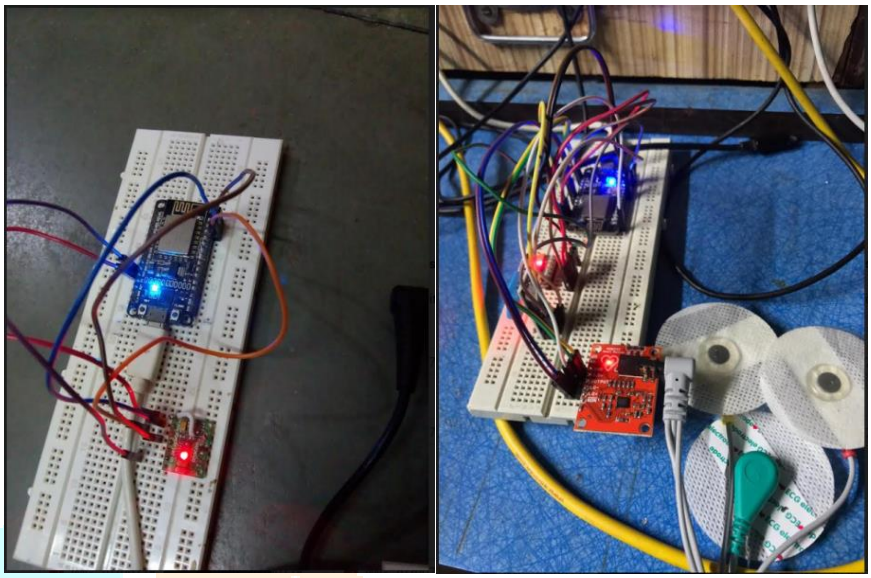
(2) Ubidots and Blynk application results. When our sensors sensed the patient vital signs such as heart rate, ECG, Body temperature, pulses these sensed data is get gathered and sent it to the IoT Web page as well to the Blynk application. These collected sensed data is passed through NodeMCU using MQTT IoT protocol.

These monitored data is get analyzed and display on the IoT web page and Blynk application. In Ubidots we have set the threshold level which is in between Normal value to Critical Value. Similarly in Blynk application,we have set the threshold levels of a conditions. We have design this system in such a way that we can see the output response on time to time basis. When the patients monitored data is analyzed , the response is shown on the IoT web page as well as on Blynk application. When the patient data is normal there i no risk or emergency found. But if the data value is above the Critical threshold then alert is get created on both IoT web page and Blynk application.

` When there is any emergency then created alert is shown or sent it to the doctor or nurses for the further process. The main advantage of blynk application is that it is a user friendly application where we have set the analyzed data on time to time basis. These

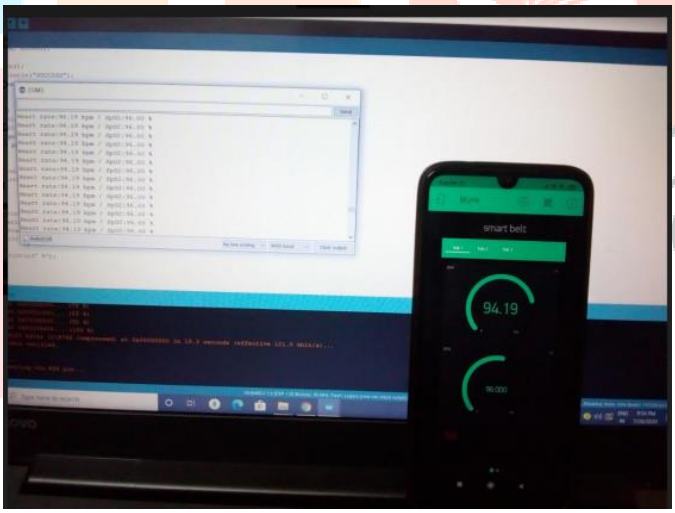
data is get stored in Database for the future health estimation of a patient. This system is used for indoor as well as for outdoor application because in our system we have used NodeMCU which is WiFi enabled device.

6.1 Hardware Setup



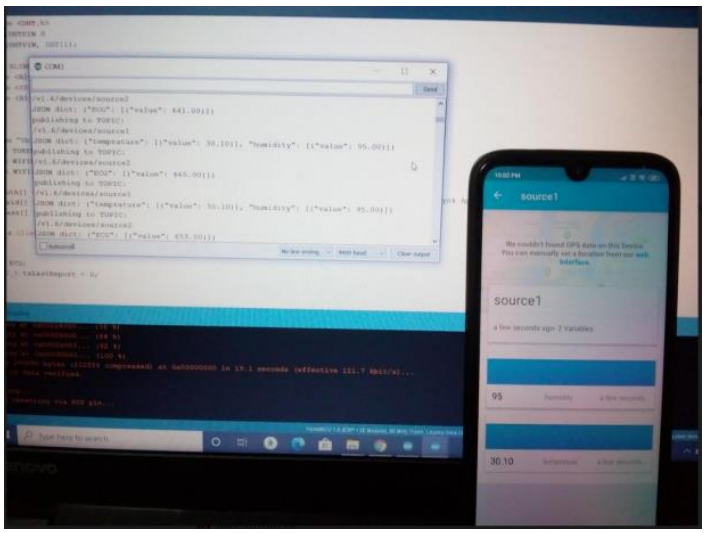
FIG[6]: Hardware Setup

6.2 Results of BPM and SpO2 on Blynk app



FIG[7]: Blynk App Result

6.3 Results of Temperature and humidity on Ubidots



FIG[8]: Ubidots Result

6.4 Comparison Result

Patient	Blynk Application		Ubidots
	BPM	SpO2	Temperature
Paitent 1	80.15 bpm	96%	37.1 *C
Paitent 2	84.87 bpm	95%	37.2 *C
Paitent 3	76.82 bpm	96%	36.7 *C
Paitent 4	71.79 bpm	96%	37.3 *C

VII. Conclusion

IoT base health care monitoring and future health estimation system is deployed.By using the system, it reduces time and hence the patient monitoring system is designed.

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