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Remote Health Monitoring System using Internet of Things

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Abstract - *Rising incidents of affected lives due to unprecedented heart attacks and cardiovascular diseases are one of the major concerns. Nowadays people are mostly focused on their work-life while ignoring their health life which in turn is creating a drastic effect on their health in the long run. The purpose of this study is to design a remote health monitoring system which can create a bridge between the busy lifestyle of a person along with regular health checkups remotely. Here, we have developed an E-Health Monitoring System using internet of things , comprising of a Wi-Fi module enabled microcontroller ESP8266 and wearable sensor networks which will measure different health parameters such as heart rate, the oxygen level in the blood, body temperature and ECG with reliable data and uploading them to cloud which can be remotely accessed or visualized by medical professionals on a user-friendly application from any location at any time. This study answers the idea behind creating an effective relationship between work and health life simultaneously. As a result, curbing such incidents to a greater extent can be possible soon.*

***Keywords*: Internet of Things, Remote Health Monitoring System, NodeMCU, ECG, MAX30100, AD8232, Blynk**

1. INTRODUCTION

According to the WHO statistics, the numbers of global deaths have been around 18 million lives each year among which cardiovascular diseases are the main reason for it. Eighty percent of cases are due to heart attacks, out of which thirty percent of tragic deaths occur in the age range of early fifties. One of the main reasons behind the alarming rate of the growth of the number of deaths among the patients is the unwillingness to do regular check-ups due to busy schedules, which consequently doubles the risk of a healthy person as well. The idea to visit the clinic has been very traditional and is not encouraged in this modern era due to time constraint, ultimately leading to an unresolved gap in this generation.

The advent of technology has cited its position in curbing the steep rate of death rise in the current world scenario. Different technologies have been deployed to prove its existence and hence enabling the patients to manage their health condition simultaneously while engaging with their own schedule. People at the age of early fifties and more are needed to be checked more frequently which is causing a greater threat to the existing medical system. Hence paying attention to identify diseases in quick succession with low cost devices has been the main demand.[1]
The usage of these services has provided better health outcomes, more satisfactory results, and cost-effective as compared to traditional methods.

In this paper, a prototype has been designed and implemented for real-time health monitoring using Internet of Things (IoT). This system facilitates the process of performing diagnosis and treatment of patients suffering from heart diseases. Sensors like DS18B20, MAX30100, and AD8232 are used for recording patient's health parameters like body temperature, heart rate, and ECG signals. The data gathered is transmitted to the IoT cloud which can be visualized using transmission control protocol (TCP/IP) on a mobile application. Using this system the physician and the family members themselves can use the cloud platform to diagnose patients at remote locations. The patient can access their medical records via this cloud service. These data can be analyzed by a doctor at a remote location or can be saved and retrieved later for analysis. With this design and development, we have attempted to fill the gap which was the main reason behind the growth of death rate due to cardiac diseases.

2. LITERATURE SURVEY

Compared with Bluetooth and ZigBee, a Wi-Fi employed system has a more reliable and faster approach of monitoring ECG data remotely, And the Use of non-relational database i.e. Redis is made to overcome the disadvantage of a relational database in case of storage of data analysis of data referring to the normal behavior of ECG. Both HTTP and MQTT protocols are used for a good overview of response on the web UI as compared to a mobile app and ultimately sending those data to the concerned family members and doctors to monitor and act accordingly. The ECGs are also checked for both stationary mode and motion mode to figure out the difference. [1]

Few authors presented the development of a microcontroller-based system for wireless health parameter monitoring using ZigBee. The devices are made for patients who are not in critical conditions but can be in a red zone if not taken care of properly, as a result, they are monitored periodically. Here, WSN (Wireless Sensor Network) is used i.e., a transmitter and a receiver module which is NRF24L01

to send the sensors data from the microcontroller through the transmitter to the receiver even in a very long-range, unlike ZIGBEE. Hence, introducing a very low cost as well as high-speed data transfer technology which can also be introduced in place of Wi-Fi. Finally displaying it on a visual studio platform on a PC for the doctors.[2],[3]
A low power, wearable ECG monitoring system using PSoC (programmable system-on-chip) is used to sense the ECG signal from the human body. ECG monitoring system is connected to low power, high-speed WICED (Wireless Internet Connectivity for Embedded Devices) which will transmit the data directly on to the Amazon Web Services (AWS) IoT cloud to further analyze the data and make it a web-based GUI platform for easy look after by doctors to detect any abnormality of patient's ECG. To provide convenient and timely access to ECG data, filters, peak detectors, and buffer were used to detect and receive noiseless ECG signals quickly and effectively. [4]

In another paper, a Smartphone-based remote health monitoring system using a body temperature sensor (LM35) and heartbeat sensor to continuously monitor body parameters of cardiac patients, has been proposed using the Bluetooth module from the link is established between the patient's Bluetooth enabled Mobile device with the cloud from where the doctors will open a server to get the accurate data using the mobile GPRS for continuous monitoring.[5]

The communication channel used here is Bluetooth which will, later on, a link with the server using Wi-Fi, it is consisting of a portable terminal, Smartphone, and remote server as a whole. An all in one device which has inbuilt sensors for different parameter detection is linked with it. Further data analysis is also done to ensure data reliability.[6]

In some papers, the authors have proposed an initial prototype development for wireless transmission of ECG signals using an AD8232 sensor and raspberry pi as a microcontroller. With the idea to monitor the ECG graph and heartbeat, A open based web server APACHE is used for storage and further analysis of the data which a doctor can do remotely, and hence less time is consumed and is beneficial for the patient. [7]

A paper developed a portable, low-cost ECG data acquisition system with overall less complex circuitry. Results were presented using MATLAB and Raspberry Pi.[8]

The system prototype has been developed based on the reviews of some previous work in the wireless sensor network area and the used Internet of Things in cardiac health monitoring. Different systems are available where the use of android apps are available in which the various health parameter sensor and connected to the server and doctors will treat the patient remotely. [9]

3. WORKING

TEMPERATURE SENSOR (DS18B20) – It is one-wire (Requires only one data line and GND to communicate with the microcontroller) direct-to-digital temperature sensor with the resolution being user-configurable to 9, 10, 11, and 12 bits, corresponding to increments of 0.5°C, 0.25°C, 0.125°C, and 0.0625°C, respectively. It can measure temperatures from the range -55°C to +125°C with an accuracy of ±0.5°C from -10°C to +85°C. Operates in a power supply range of 3.0V to 5.5V.

PULSE OXIMETER AND HEART RATE SENSOR (MAX30100) – It is designed to provide the digital output of heartbeat (beats per minute) and oxygen level in the blood, when it is touched. The device has two LEDs, one emitting red light, another emitting infrared light. More Oxygenated blood results in the passing of red light and absorbing infrared and vice versa. The time difference between the oxygenated and deoxygenated blood pumps determines the heart rate. Operates in a power supply range of 1.8V and 3.3V and can be powered down through software with negligible standby current.

ECG SENSOR MODULE (AD8232)- The AD8232 is a Single-Lead, cost-effective Heart Rate Monitor Sensor which when attached to the patient measures electrical activities of heart over some time. The sensor outputs can be monitored using the serial monitor or can be sent directly to the cloud with the help of a microcontroller. It has an op-amp to help obtain a clear signal from the PR and QT Intervals easily. It can extract, amplify, & filter small biopotential signals even when accompanied by noisy conditions, such as those created by motion or remote electrode placement. The AD8232 has pins-LO+, LO-,SDN, OUTPUT, 3.3V, GND along with RA (Right Arm), LA(Left Arm), and RL (Right Leg) pins through which ECG electrodes are connected to the body as shown in the figure 1.

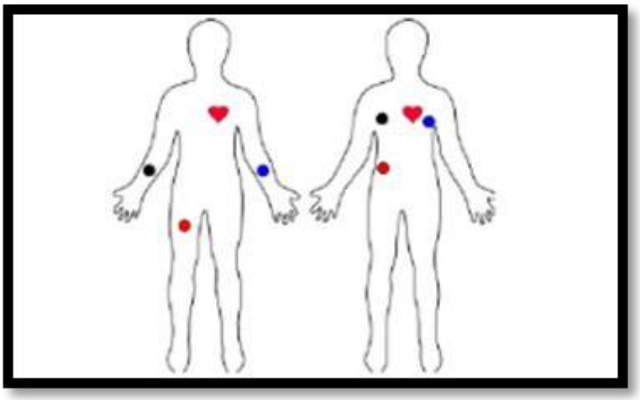
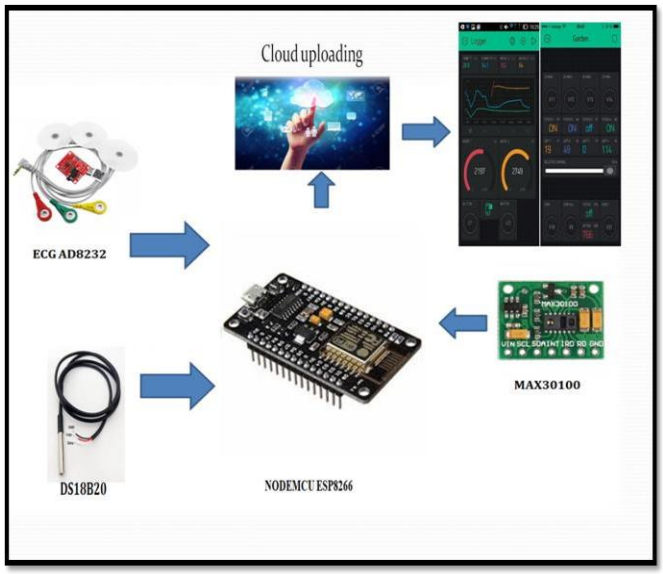


Figure 1. AD8232 electrodes placement

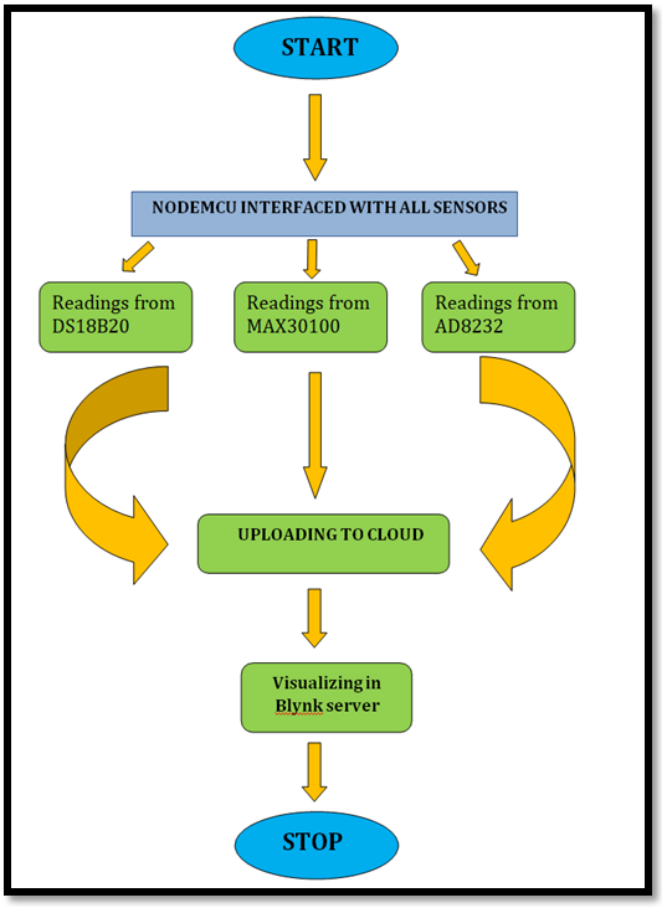
NODEMCU (ESP8266) - All the signal processing functions are implemented in a high-performance Microcontroller Unit (MCU). ESP8266, best suited for Internet of Things based applications, offers a self-standing Wi-Fi networking with TCP/IP protocol stack which provides Wi-Fi connection to any microcontroller. ESP8266 when connected on-board it has storage and processing capabilities hence can be easily connected to the sensors based on the application through its GPIOs with minimal development up-front and minimal loading during runtime. Its highly integrated on-chip architecture allows for minimal external circuitry. The main reason to use ESP8266 as Wireless Module is due to its compact size, high performance, and very economical. It uses 802.11 b/g/n protocols. Standby power consumption is less than 0.1mW.

BLYNK- It is an application which has a easy user interface and hence can prove to be useful for family members as well as doctors to monitor the data and give medication accordingly. It uses TCP/IP protocol which securely communicates with the respective authorized device and transfers the data in real-time. It has different widgets that can be used limitedly and most importantly can be used with different microcontrollers such as Arduino, NodeMCU, Raspberry pi, and so on. The interfacing of adding different widgets and creating its functionality is very simple for non-tech people as well. Moreover, at a longer period, one can also take the values in the CSV files to keep a record of the data for future references.

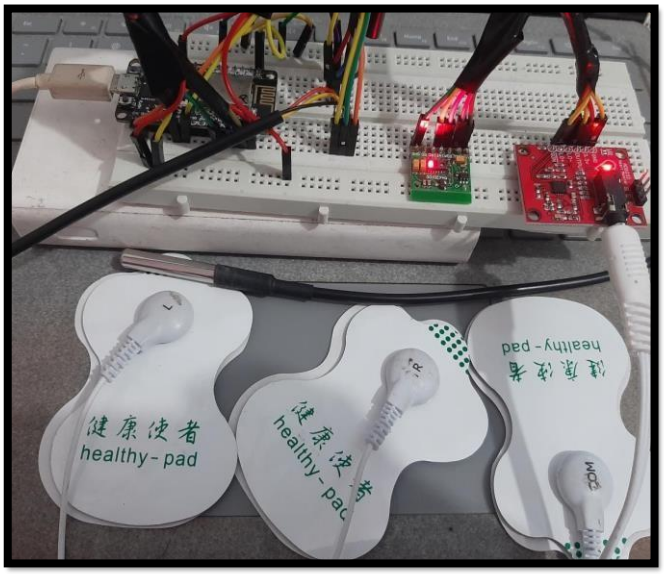
4. BLOCK DIAGRAM



5. FLOW CHART



6. HARDWARE MODEL



7. RESULTS & DISCUSSIONS

Plotting of temperature ,BPM, SpO2 , ECG on Serial Monitor & Serial Plotter-

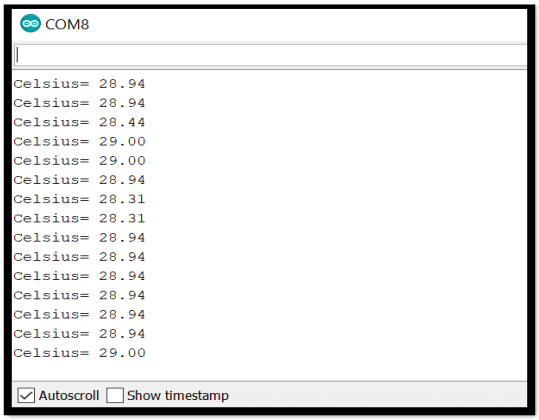


Figure 2. Temperature data

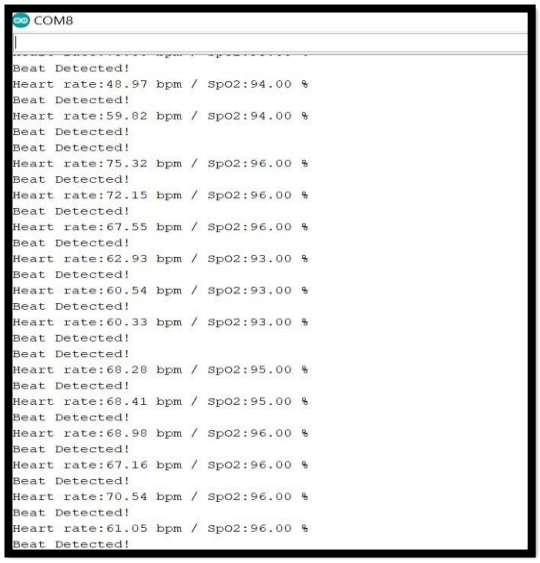


Figure 3. Heart rate and SpO2 value

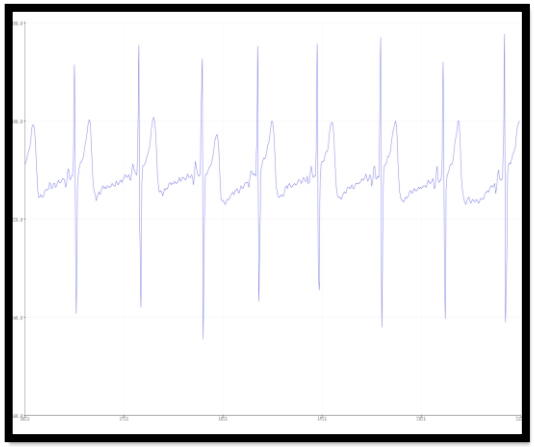


Figure 4. ECG plot

REAL TIME MONITORING ON BLYNK APPLICATION-

Figure 5. Measured body parameters displayed remotely on Blynk App

Figure 6. The ECG visualized separately on Blynk Application

Different parameters have been tested on several volunteers to check to make sure whether the data are reliable concerning the original values. According to the test data of a volunteer, with no past chronic disease the heartbeat, oxygen level, ECG intervals are very much in the normal range shown in the figures above and are simultaneously being transferred to a doctor sitting at a remote location to check the real-time data incoming of patients every single time globally. Hence, the results are satisfactory with a very cost-effective solution which further acknowledges this study on remote health monitoring systems to work on a large scale.

8. FUTURE SCOPE

The main advantage of getting real-time data on the BLYNK application is the extremely easy user interface as well as quick transformation to CSV files to store the real-time data. The real-time data can then be further analyzed using a Machine Learning algorithm to predict future conditions of a person's health. It is evident that the implementation of such a system will help in the early detection of abnormal conditions of cardiovascular diseases and the prevention of its serious consequences.

9. CONCLUSION

In this study, an E-health monitoring system using IoT is finally developed where different parameters are taken into consideration to measure and determine the current health status of a person. The use of connectivity of different sensors in a network to monitor the data remotely has solved many issues regarding the unwillingness of people to visit the clinics. In this way, people can work as per their busy lifestyles as well as receive medical care simultaneously. The doctors can prescribe the medicines based upon the monitoring of data which reduces the traffic of visiting the clinics as well. As this system size is quite small, it can be carried at various locations with ease.

In addition to that, at the end of the current ongoing pandemic, the lifestyle of people will never be the same as before, their work-life will be much busier as compared to the present-day scenario; people from every sector will be working harder to regain the economy of the country. Thus, visiting clinics and doing regular check-ups will not be seen as desirable all the more. Moreover, the doctors who are serving COVID-19 cases can also get some comfort by treating other patients from remote places as well. This remote health monitoring system will also help in maintaining social distancing by not having to visit crowded diagnostic laboratories and avoiding direct contact with others. Hence, we can say that the problems which are mentioned at the beginning of the paper can definitely be reduced to a greater extent with the help of this study.

10. ACKNOWLEDGEMENT

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