Development of Pulse Rate Indicator in Real Time

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***Abstract*- The death rates are increasing rapidly year by year due to heart diseases mainly in villages. In 2019, the world wide 7.57 deaths/1000 populations has increased by 0.44% from 2018 and in India 7.273 deaths/1000 populations has increased by 0.5% from 2018. Due to advancement in technology, a lot of smart medical sensors have been developed, which can continuously monitor and analyse the patients' health condition. Seeing such an increasing in deaths due to heart diseases has motivated us to develop a project "Development of Pulse Rate Indicator in Real Time". The project is designed based on the concepts of Internet of Things and Machine Learning. Here the user is made to place their index finger to obtain beats per minute (BPM) values which is then stored in ThingSpeak cloud platform. The user also needs to provide his age and gender through an app and based on their age, gender and bpm values the user's condition of whether he/she is normal or abnormal is displayed. Also ThingSpeak has a CSV file which is extracted in the Google Colab for research purpose by the admin only. The app also consists of general tips for its users to maintain their normal pulse rate. We have also restricted the location of collecting the data. Only the users between the ages 18 to 55 are eligible to use the application.**

Keywords*- *Machine Learning (ML); Internet of Things (IoT); Support Vector Machine (SVM), Progressive Web App (PWA).

I. INTRODUCTION

Now-a-days everyone is so busy in their lives that they forget to take care of their own health. By keeping this in mind, technology really proves to be an asset for an individual. With the advancement in technology, lots of smart medical sensors came into existence that continuously analyses individual patient activity before the patient feels sick. Therefore, identifying the correct sensors is important. Medical services have made large advancements in recent years. Computing and communication technologies have the potential to offer a wider variety of services for patients. Recently, the research of Human-Health monitoring systems has moved from basic reasoning of wearable sensor readings to the advanced level of data processing to give more information that is valuable to the end users either to doctor or to patient. The healthcare industry was fast to adopt the IoT as integrating IoT aspects into medical devices enhances the quality as well as the efficiency of service. This brings remarkable advantages for older people, patients with chronic conditions, and individuals needing stable management. Through in this advancement, a patient's quality of life would improve and provide a benefit to a large portion of the population. Heart disease is a grave disease that influences the heart's functionality and gives rise to complications such as infection of the coronary artery and diminished blood vessel function. Heart disease patients do not feel sick until the very last stage of the disease, and then it is too late because the damages have become irretrievable. In the past years, sensor networks for healthcare IoT have advanced quickly, so it is now possible to incorporate instantaneous health data by linking bodies and sensors. This project is developed using a NodeMCU for monitoring the pulse rate using a Wi-Fi module ESP8266.

II. LITERATURE SURVEY

Many researchers have used various methods and technologies to carry out the function of heart monitoring. Some of their important research works are reviewed below in this paper. In this research paper, the researcher designed a health monitoring system using the ATmega8 microcontroller with Wireless Body Area Sensor Network. In this work, the sensors which are used here are a Temperature sensor, a Blood pressure sensor, Heartbeat sensor. The sensors have to be placed on the human body where the health condition is monitored without disturbing any kind of schedule of the patient and the parameters which help in detecting the condition are now sent to the physician's server through long-range wireless technology GSM. The health monitoring system consists of sensors, LCD, microcontrollers, and GSM modem to transmit or receive health-related data to or from the doctor. Similarly, a hospital, the same GSM modem is used to monitor the patient's health. Hence, the GSM modem helps in the establishment of a network between the patient's server and the doctor's server. Liquid Crystal Display is providing to show instant results to the patient. [1]

In this research paper, the heart-rate signals were collected from fingers or ears using the Infrared Transmitter and Receiver pair module which was amplified in order to convert them to an observable scale. A low pass filter was used to filter the inherent noise from the system. The signals were calculated by a microcontroller module (ATmega8L) and were represented on LCD. A microcontroller is trained with a specific algorithm to execute the heart rate counting system. The results obtained using this process when compared to those obtained from the manual test involving the counting of heart rate were found satisfactory. The proposed system is applicable for family, hospital, community medical treatment, sports healthcare and other medical purposes and many more. And this also fits the adults and the paediatrics. Hence this method is already developed and requires further examination which has a great future towards healthcare. [2]

In this research paper, it mainly contains 4 parts: a heart rate sensor, a microcontroller integrated with ESP8266 (Wi-Fi module), MQTT on Raspberry pi and monitoring software. The heart rate sensor and a schematic are well built to fit on the patient's fingertips, and this reads the amount of IR light reflected by the blood circulation inside the body. When the heart pump, the blood pressure rises sharply and so the amount of infrared light from the emitter’s LED that get increased and reflected the photodetector. The photodetector passes more current when it gets more reflected light and then becomes a voltage drop. The two consecutive operational amplifiers are used to detect the signal baseline and stress the peaks and filter all the noises arising from the system. This filtered signal will be read by the analog-to-digital pin by the Arduino where this Arduino is integrated with an external Wi-Fi model i.e., ESP8266 which will help to connect other devices through the network. This provides the self-contained Wi-Fi network capability which allows the host application. It provides a complete self-contained Wi-Fi networking capabilities, allowing it to act as host applications or offload all Wi-Fi networking functions. Every minute, the Arduino will read the heart pulse rate from the sensors that are connected, and it also calculates the heart rate and then it updates to the server which is connected further to the same network. Here HTTP is not the best solution when the source information should push a change into many clients & there is no built-in support for QoS, therefore MQTT is implemented. [3]

Some of the drawbacks observed from the above literature survey are

The patient data was sent from the patient to the doctor using GSM modems instead of Wi-Fi technologies [1].

The pulse rate values will be displayed on LCD to the end-user instead of displaying the output on any kind of web pages or app [2][16].

Heart rate values are sent wirelessly to the Message Queuing Telemetry Transport broker. MQTT is unencrypted by default. This makes it natively unsecured and requires you to take additional steps and absorb some overhead to make sure is implemented. If not, any communication over MQTT, including username and password is vulnerable to hackers. Hence using HTTPS is a secured solution [3].

III. IMPLEMENTATION

1) Components:
   The various components used to carry out our work are described in the following section

A. *Heart Beat Sensor*

The heart beat sensor is used to obtain the pulse rate of the user. It consists of a light-emitting diode and a detector. The heartbeat pulses cause a variation in the flow of blood to different regions of the body. When tissue is illuminated with the light source, i.e. light emitted by the Light Emitting Diode (LED), it either reflects (a finger tissue) or transmits the light. Some of the light is absorbed by the blood and the transmitted or the reflected light is received by the light detector. The amount of light absorbed depends on the blood volume in that tissue. The detector output is in the form of the electrical signal and is proportional to the heartbeat rate. The sensor consists of three pins and the connection of sensor with Node MCU is very easy. This sensor adds amplification and noise cancellation circuitry to the hardware. It’s noticeably faster and easier to get reliable readings.

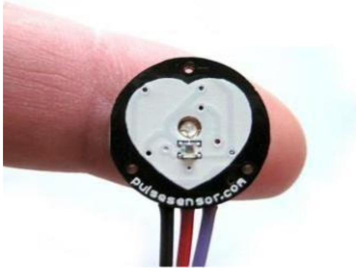

Fig. 1. Heart Beat Sensor

B. *Node MCU*

Node MCU is used to read analog output from the heart beat sensor, computes the heart beat rate in real time. It consists of ESP8266 Wi-Fi module. The storage of Node MCU is 4 Mbytes. It has storage of 128kBytes. Programming and uploading of code from any computer system through USB port to Node MCU is a very easy task as it supports variety of programming languages. We also use Arduino IDE to write and upload programs to Arduino compatible boards such as Node MCU and Arduino Board. The advantage of using Arduino IDE is that it runs on Windows, Macintosh OSX, and Linux operating systems. The Arduino IDE is easy-to-use for beginners, yet flexible enough for advanced users to take advantage of as well.

Fig. 2. Node MCU

C. *ThingSpeak*

ThingSpeak is used to store the user data such as beats per minute (bpm), Age and Gender. It acts as an IoT analytics platform that allows us to aggregate visualize and analyse live data streams in the cloud. The data is stored in channels on the ThingSpeak platform. We can send and receive data to and from ThingSpeak. ThingSpeak can also be used to create instant visualizations of live data and send alert notifications to the user's device.

Fig. 3. ThingSpeak

D. Google Colab

Colaboratory, or "Colab" for short, is a product from Google Research. Colab allows anybody to write and execute arbitrary python code through the browser, and is especially well suited to machine learning, data analysis and education. More technically, Colab is a hosted Jupyter notebook service that requires no setup to use, while providing free access to computing resources including GPUs. Colab notebooks are stored in Google Drive, or can be loaded from GitHub. Colab notebooks can be shared just as we would with Google Docs or Sheets.

Fig. 4. Google Colab

E. Progressive Web Application (PWA)

Progressive Web Application (PWA) is used to display the result to the user. The PWA is a type of application software delivered through the web and built using common web technologies. It is intended to work on any platform that uses a standard browser. The data served by PWA is safe because it uses HTTPS to prevent snooping and ensures that the content hasn't been tampered. It also allows us to use "push notifications" to maintain engagement with the user. It can be used on various output devices such as desktop, mobile and tablet. It also provides home screen icons without the use of an app store. It works for every user, regardless of browser choice, using progressive enhancement principles. It also works well in the area with low quality network.

Fig. 5. Progressive Web Application (PWA)

2) Proposed system

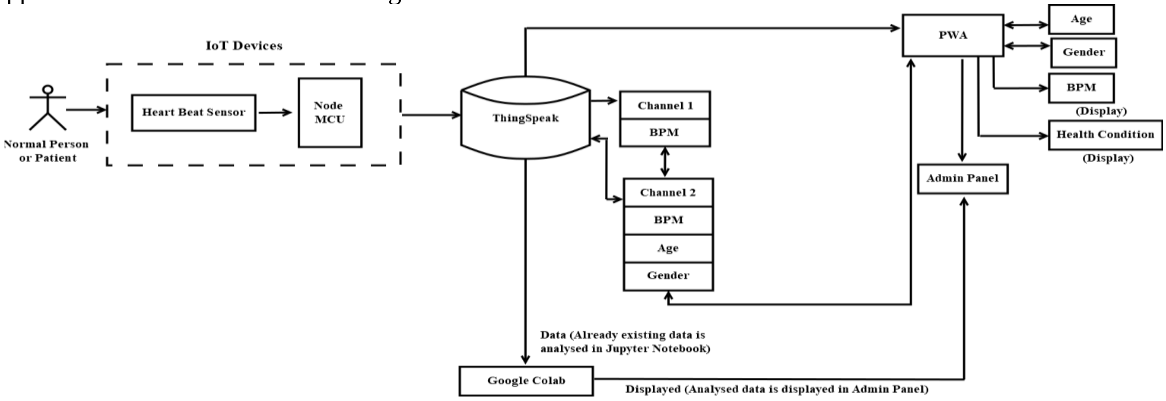

Fig. 6. Proposed System

In the project, the user is made to place the index finger on the heart beat sensor. The heart beat sensor which is connected to the Node MCU reads the analog output from the heart beat sensor and computes the heart rate (bpm) in real time, for which the code is written in embedded C language and it is run on Arduino IDE. The beats per minute (bpm) value of each user are stored in the ThingSpeak Channel which can be retrieved as a CSV file whenever needed. Progressive Web App (PWA) fetches the user data such as Age and Gender from the user. This data is again sent to the ThingSpeak Channel. The BPM, Age & Gender values are present in PWA to give users the result of their condition, while it is present in Thingspeak to have a CSV file of it for research purpose. Using the data present in PWA, logical chart sequence is applied to state the status of user's condition.

For research purpose, the values stored in a CSV file in ThingSpeak Channel are used. PWA has an admin panel which links to Online Google Colab. This CSV file is imported in Google Colab using a ThingSpeak URL. The imported CSV file is analysed with some basic operations using ML libraries and also analysed with some Machine Learning algorithms, to know the live data which is gathered by the device & then the algorithm classifies the pulse rate value as normal or abnormal condition & few other statistics of the data are formed. These results are then displayed to the admin on the PWA Admin Panel for further research.

IV. CONCLUSION

This project has been a great experience to all of us. We learnt a lot of new technologies and skills from this project. We have practically implemented the concepts of Internet of Things and Machine Learning and PWA. We have used some of the IoT devices such as Heart Beat Sensor and NodeMCU. We have worked with different software's such as Arduino IDE, Glitch Editor and Google Colab. We have worked with datasets (CSV file), also used a cloud platform called as ThingSpeak for data storage. We have also designed an application for displaying the output to the user using a Progressive Web Application (PWA). The advantage of using a PWA was that it loads faster and it can be installed without visiting the play store. Providing the user about having a normal or abnormal pulse rate by accepting the BPM from the user was one of our goals. The other goal was to perform analysis on the user data using ML algorithms which could be accessed by the admin only. At last we would conclude that, it was a great experience and writing this project has given us an opportunity to learn and understand new concepts and technologies.

V. FUTURE SCOPE

The proposed model can further be added with features such as creation of cloud storage where the list of general practitioners and cardiologists, their contact details and their clinic addresses are stored so that people in critical condition can directly contact them on emergency basis or can take an appointment. Along with detecting the pulse rate, ECG can also be integrated in the same kit. When the ECG of a particular user is abnormal the app has to display the name of the disease due to which that abnormality has occurred. Based on the ECG results the app has to suggest whether any further tests such as stress test/medical help are essential.

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