A Heath Care Monitoring IOT System Using Adafruit and IFTT

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Abstract

We all know that heart is the most essential organ in the human body. It pushes blood into blood vessels of the circulatory system. The rate of heart beat of a person per minute is known as pulse or heart rate. Although heart rate varies among individuals but normal range of heart rate for adults is 60 to 100 beats per minute. A normal heart rate of a person also depends on his age, heart condition, movement, resting position, etc. If this is known to patient and caregiver/doctor can help an individual to monitor his fitness level and it may help him in spotting a developing health problem. A prototype of pulse measurement system is built using Node mcu and pulse sensor and the data of sensor is published on Adafruit platform which make this healthcare system globally accessible and any doctor across the globe can monitor the health of his patient and can detect any heart stroke/abnormality related to heart. The system is made such that once the pulse data crosses the threshold an IFFT trigger will generate an email alert to the doctor and the doctor will get to know that the patient's health is not normal and he can check the patient once he knows that the patient is in trouble.

Keywords— pulse rate, monitor, healthcare, heart condition.

I.INTRODUCTION

The Internet of Things is gradually becoming common.Automation, voice commands and electronic interfaces can complete day to day functionality that usually require manual human labour, from vacuuming the floor, sending emails, adjusting thermostats, or using Google.[1] In 2011, before the fitness tracker and smart watch came into the commercial market, the number of internet-connected devices worldwide outnumbered the people who possessed them . By 2020, the Federal Trade Commission forecasts that there will be 50 billion internet-connected devices reaching from cars to toasters to pet monitors, cameras and many others. By2021,Tractica calculates that wearable devices will surpass 97.6 million. IOT's importance in our society is only going to rise with the increase in heart related diseases.Heart rate monitoring sensors are rapidly becoming popular and available. Research in the area of heart rate monitoring system is constantly evolving. The idea here is to view/review heart rate at any point of time and by any person (care taker etc.) out of curiosity, anxiousness to observe the changes in heart rate in case of any discomfort. With the constant evolution taking place around the world,technology is evolving and new and improved technology is developing every day. Advancement in medical science and IOT in healthcare services is becoming a new stream of research and development. An application of IOT in healthcare area allows medical centre to function more effectively and patients to obtain better treatment. The use of mobile devices in collecting health data in real-time from patients, storing it to network servers connected to Internet is referred as mobile health. These data can be used and accessed by different group of clients (e.g., hospitals, health-insurance companies,

etc.).These data is used by doctors to monitor, diagnose and treat patients. Body sensor and wearable medical devices are on rise in the mobile health. Addition of mobile health devices in the patient's environment offers capabilities to calculate health variances in real time. Mobile health technology will be the key of individual healthcare facilities in future. Recently, a number of medical devices are available in the market which is embedded with various sensors for providing vital information related to human body. This is a great revolution in healthcare sector. The industry have also forayed into healthcare sector to address issues like inconvenience created in hospitals to patients due to long waiting time for consultation and in accuracy of medical record. Internet of medical things is helping to monitor patients remotely at reduced cost by means of wearable medical devices and virtual interaction between doctor and patients. Industry and academia are also partners in various related health care devices and project. The number of heart patients is increasing day by day in the whole world. IOT applications can sense heartbeat and pulse. Pulse sensor in such an application sends this pulse rate in real time to the cloud. This real time information is then made available to the doctor's device (mobile etc.) which he can use anywhere any time. This application carries real healthcare value. [2]The Internet of Things (IOT) is a novel approach that connects even ordinary device or object to the Internet. It can also be called device to device communication. The ubiquitous sensors of the IOT are connected through microcontroller based devices which are further connected to cloud. In the near future IOT will find a number of applications in the field of smart healthcare, smart city, smart transportation, smart grid, industrial automation, smart home and much more. Among the various market domains, IOT in smart healthcare is the leading sector. Health care sector is witnessing a revolution with the medical devices being enabled with sensors and embedded systems. A patient's vital parameters like temperature, pulse rate saturation percentage of oxygen (spo2) are often recorded in hospital. However these parameters cannot be measured all the time. In case of high risk patients this data may be required in real time. IOT can help in such situations by use of wearable devices which can record these parameters of the patients and send them via cloud to the doctor/ care takers laptop or mobile .An IOT enabled health display connected to a patient will be thought-about as a virtual patient. A doctor will monitor a patient solely some times on a daily basis however essential health problems will occur at any moment. Thus 24/7 observation of health data is critical. As IOT enabled patient's data will be accessible over the net and by alternative machines, the health condition of a patient will be monitored uninterruptedly, and permit essential sickness to be detected at the precise time in order that proper actions will be taken. Also, IOT will facilitate to gather health records. Generating applied data associated with health condition will be performed by machines. It's quicker and voluminous and error free assortment of information which is very difficult. Generating statistics, police investigation, risk mapping of diseases will be done remotely. In this work a healthcare monitoring system is developed in which patient's heart rate is monitored and real time health data is sent to the patients' doctor or care taker so that they get real time data and they can handle any emergency situation. Some patients need observation from such device. Patient health can be monitored form home. Patients don't need to visit hospital every now and then. Doctors can also observe their patients from wherever they are.

II. RELATED WORK

[3] The Pulse Sensor is actually a photoplethysmograph (PPG), which may be a documented medical device used for non-invasive pulse monitoring .The out of PPG is an analog signal represented by the waveform as shown in fig1. Recent hardware version of this sensor is

pulse sensor amped which amplifies the ppg signal and normalizes the heart beat wave to mid-point in voltage (v/2).

Fig1 ppg signal

Output of pulse sensor amped changes with change in candle power. With the incident sunlight remaining constant, the signal value stays close to 512(midpoint of 10 bit of ADC range of Arduino). The instantaneous heart beat is measured in terms of inter beat interval. The heart sensor is usually attached to finger or ear lobe for measurement with every heart beat when the blood flows through the body. Pulse wave which flows through the arteries to the extreme capillary tissues like fingertips and ear lobes. Speed of blood circulation is normally less compared to that in presence of heart beat wave. In fig 1 of the heart beat wave, the growth point ”T” is also known as traditional point from where the growth or rapid upward rise of signal starts due to the pulse wave passing under the sensor and reaches a peek.The signal then falls back to the traditional point. Sometimes the dicroic Notch (downward spike) is stronger than the others but usually settles to ground noise before the arrival of next heart beat wave/pulse. Since the wave is periodic in nature any point can be chosen as the reference point for measuring the heart rate,to avoid false reading due to presence of dicoric notch if present and interrupted reading due to base line noise. Beat finding algorithms are not based on arbitrary wave phenomena. So instantaneous moment of heart beat is used for calculating bpm, heart rate variability (HRV) studies, and Pulse Transit Time (PTT) measurement.

In [4] authors have developed prototype for wireless heath monitoring system that measures patients’ vital parameters remotely. These parameters can be observed by the doctors remotely and they can provide clinical assistance /guidance /consultation to the patients. The impended model uses a raspberry pi 3 model B interfaced with sensor like pulse, temperature, fingerprint etc. The sensor data is updated every 20 sec. The collected information is first stored, analyzed for vitals over a central server. It also provides the facility to alert the care taker through SMS and voice call when measured value of sensor parameter exceeds the sensor value.

In [5] author has developed a system to identify the abnormality of the pulse rate of a patient when the system detects the abnormality, it attaches itself to nearest Wi-Fi zone and alerts the family and /or the doctor through email. It also notifies the user by sending vibration to enter the Wi-Fi zone. Health monitoring of the system continues even after entering the Wi-Fi. Use of HSF7051 is made to detect the heartbeat.

Another such health monitoring system to detect abnormality in patient heart beat followed by generation of a system alert is developed in [6]. Here authors have used esp8266 Wi-Fi model to reduce server gateway. The pulse sensor detects the center rate, converts it to beat per minute and saves this data which is observed by patients and the doctor in real time. When the pulse rate is beyond the normal values (60 bpm-100bpm) or when the patient pushes the push button an SMS alert is send to doctor and family.

Further development in this direction can be seen in [7] where authors have developed a wearable health band to sense temperature and pulse of the patients. Pulse senor and lily pad temperature sensor are interfaced to Arduino uno and sensor data through Wi-Fi model is directed to "Thingspeak an open IOT platform with MATLAB analytics", where the data can be visualized in the form of temperature and pulse rate graph. This data is directed to mobile application so that user can see the temperature and pulse rate in graphical form for better understanding of the vitals of patients. In serious condition, if the pulse rate rapidly fluctuates above or below the threshold value, then a notification will be sent to the doctor and caretaker of the patients.

In [8] author has used various sensors for observing various parameters of patients like, MEMS accelerometer for defining fall of the patient, temperature sensor is used for calculating the body temperature and potentiometers to enter the values of Systole, Diastole pressures and Heart rate. The system forwards this data to Thingspeaks cloud server for storage and visualization. In case of deviation from standard values, SMS alert is sent to doctor using GSM modem. All information about parameter, location, id and password for login is also provided. This helps doctor to continuously monitor patient's condition and in suggesting precautionary measures.

In [9], pulse rate, body temperature, spo2, body movement of patient and other parameters are measured and this measured data is uploaded to the MQTT server. This system notifies the Patient with likely preventive steps to be taken and it also proposes the patient with medical care and instructions under serious condition. This system helps the doctor to observe his patient from anywhere anytime and it also helps the patient families to view patient health condition remotely.

In [10] a prototype for diagnosing likelihood of heart attack in patients with heart disease was developed in [10]. The system consists of IOT enabled low cost wearable device which uses, heart rate, respirational rate, oxygen saturation and temperate of the paitents by repeatedly observing the parameters of patients who have had heart attack can reduce the chances of its recurrence and alerting the doctors and paitents in crisis situation. The information can be monitored through a mobile application by the doctor.

The hardware is cost effective and miniaturized and wearable on daily basis. Individual who has a history of heart attack is presented to have a continuous variation in parameters like heart rate, respiration rate and peripheral capillary oxygen saturation over a time period of 1 week or even 2 weeks. Thus the data taken from individuals is stored and analyzed using a mobile application. Using this data the chances of heart attack can be predicted and persons can be warned beforehand. Breathing rate is a new parameter which is not commonly found in wearable devices. This parameter alone can give information about an individual's health. The design of the prototype was found to be successful since it could effectively obtain and analyses the vital parameters. Previous existing devices were found to be larger in size and also not easily accessible to IOT. Thus designing a low cost wearable device has always been a challenge. This prototype when converted as an actual device can almost solve these kind of issues. Once the optimum values are known and fed into a mobile phone, it is accessible for all types of people. This will become easy since the credibility and availability of mobile phone in our society is very much high compared to any other electronic devices [11].

The growth of clod computing infrastructure is going to help manage data form wearable device, carryout information mining and analysis of medical big data. Cloud-assisted Body area sensor (CaBAS) facilitates the expansion of scalable, data-driven pervasive healthcare. The advantage of this technology in IOT will help determine energy efficient routing protocol to network smartphones, wearable sensor, incorporate activity information of paitents with clinical data to improve algorithm activity and provide better patients physician interaction.

In [12] a healthcare system using IOT is developed to recognize human action with data processing technique. This is a human action classification and recognition model. The data set comprised of 12 different physical activities carried out by 10 volunteers and fairly good accuracy was observed.

III.PROPOSED WORK

We have developed a portable IOT health care monitoring system. The block diagram in Fig. 2 shows the flow of this IOT healthcare monitoring system. The system is mainly developed for paitents and their care takers to get information of patients. Here the pulse sensor detects the pulse and sends data to micro controller. Then the micro controller will display data on Adafruit IO, which is connected to the IFTT (If This Then That) web based service and once the BPM crosses a certain range (80bpm) then the display gauge for BPM on IFTTT will become red (which is normally blue) and IFTTT will generate email alert to the patient's doctor and caretaker that bpm is exceeding the normal range. This system will generate an alert to the doctor or any registered mobile number. The various blocks of IOT healthcare monitoring system are as explained below:

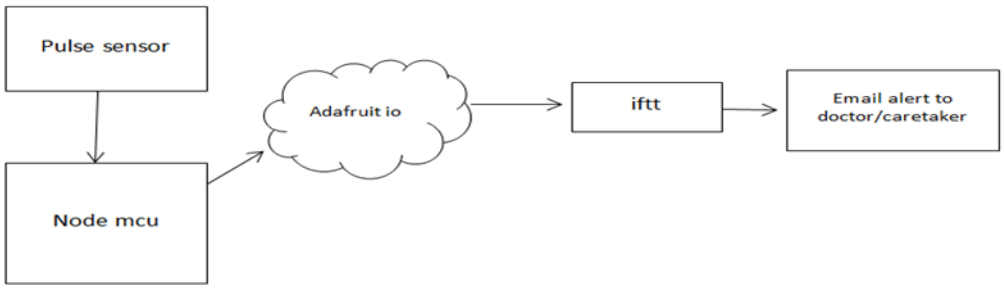

Fig 2.flow of the system

The pulse sensor is used to measure paitents' pulse. Patients keep their fingertip on it. It's a non-invasive sensor. Senor data is further sent to Node mcu through analog pins of node mcu. The node mcu is a micro controller which is the core of this healthcare system. Data collected from pulse sensor by node mcu is displayed on Adafruit IO (a cloud service). Adafruit IO is a cloud based service which monitors, stores the sensor data and connects it with other web services like webhook, IFTTT and many more. It enables and the user to connect his device with internet and use many web services likes web update and Google alexa configuration.

IV. EXPERIMENTAL SETUP

The experimental setup was implemented using a breadboard, node mcu and pulse sensor. Where pulse sensor is connected to node mcu. Node mcu is mounted on breadboard and analog pins of the node mcu are connected to readily available pulse sensor. Node mcu is powered by USB cable. The other end of which is connected to the laptop. Alternatively battery can also be used. In this system the patient's heart rate is acquired by pulse sensor when the patient keeps his/her finger on it and after calculating the bpm the results are

displayed on Adafruit IO. The connections from pulse sensor to the Node mcu are made as shown in fig 3. Implementation made use of Arduino IDE environment.

Fig 3 Healthcare monitoring system

V. RESULTS

The experimental setup was implemented using a breadboard, node mcu and pulse sensor. To see the impact of various human activities on hart rate a few individuals participated in the experiment. They were made to sit at rest, walk, and run and climb stairs. Their heart rate recorded after these activities are shown in table 1. The table depicts that rigorous activities like running and climbing stair causes significant increase in heart rate above the desired value.

Table 1: Heart rate in bps during resting and after activity

	Age	Resting heart rate	After running	After climbing stairs	After walk
1	24	68	112	100	78
2	20	60	120	110	89
3	30	69	114	115	90

After connecting Node mcu and pulse sensor the data is displayed on Adafruit IO. every 5 seconds a new pulse data will be uploaded to the Adafruit IO as shown in fig4. The data uploaded to Adafruit can be further used to analyse the health of paitents. This data can be downloaded and can be used for other studies on paitents.

Fig 4 bpm data recorded on Adafruit io

The Adafruit IO provides facility to show data of the sensor on “Adafruit feeds” in graphical form.

Fig 6 Graphical representation on sensor data

Dashboard of Adafruit IO has a gauge to display the input data coming to it, which in this case is the heart beat rate. The gauge is normally blue in colour as shown in Fig.5. However it is so programmed that the gauge colour changes to red once the pulse (heart beat) crosses the normal desired threshold (60-80 bpm) for a person. Change in colour alerts the care taker/doctor.

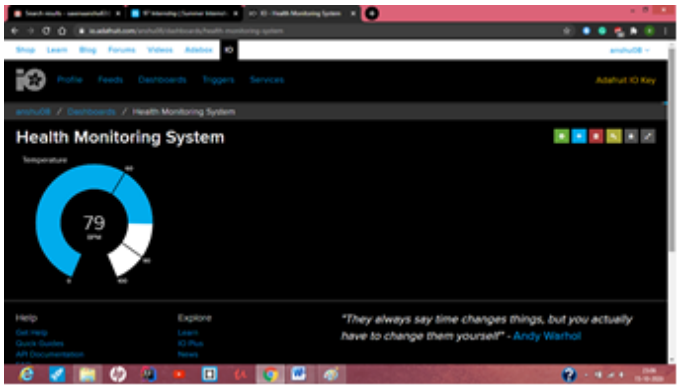

Fig 5 Dashboard displaying normal heart beat.

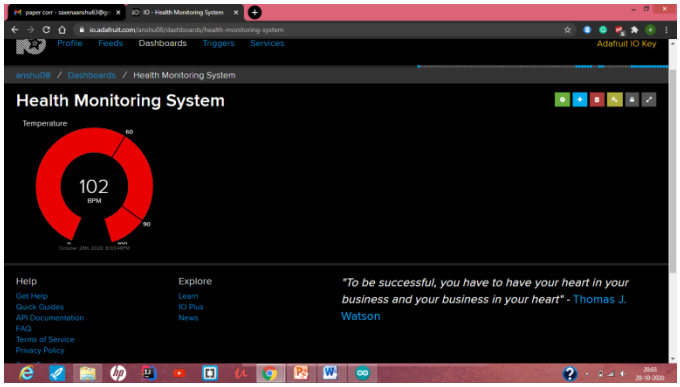

Fig. 6 displays Adafruit IO dashboard with abnormal heartbeat.

Also added feature of email notification to the care taker/ doctor is facilitated by use of IFTTT triggers when patient's pulse crosses the desired threshold. This way a double check on patient's health monitoring can be achieved.

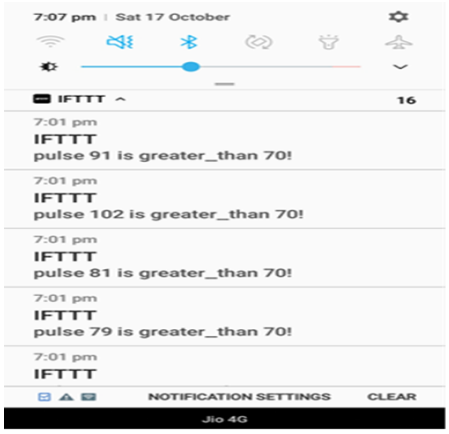

Fig 7 email notification to the doctor.

The Adafruit IO also provides this feature in which it will also give email notification if the system is not working properly and will notify the user that your system is offline and this will alert the caretaker to manually check patient on time before any problem occurs to paitents.

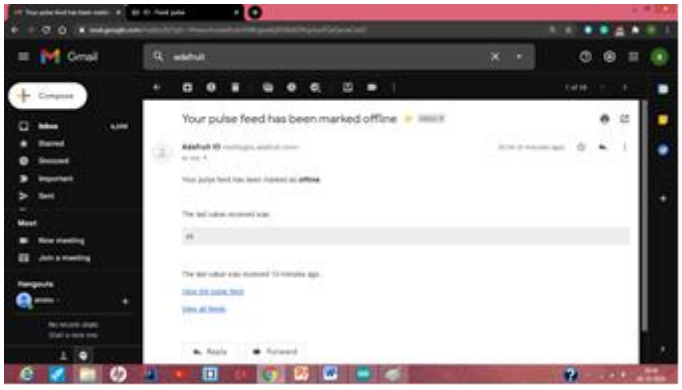

Fig 8 email notifications from Adafruit that system is offline

VI. CONCLUTION

The usage of IOT technology in healthcare not only reduces the cost of healthcare but also makes it highly accessible to all the paitents .The collected data can further be used to analyse the health of paitents. If patient data is continuously collected and sent over cloud and made available to care givers/doctors then remote health care monitoring can be useful. This will help patients consult doctors across the globe. The usage of IOT protocols enables easy integration to third party applications and devices, this system can save life of a paitents in emergency situations by informing doctor and caretaker immediately and thus reducing the delay in providing emergency help/service. In future we will add more sensors and use sensors data to detect any medical condition of paitents and that can further lead to solve more problems that are associated with remote monitoring of a paitents health.

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