A R DIGITECH
International Journal Of Engineering, Education And Technology (ARDIJEET)
www.ardigitech.in ISSN 2320-883X,VOLUME 06 ISSUE 02,20/03/2018

E-BAND HEALTH MONITORING SYSTEM

Internet-of-Things (IOT), Cloud Based Analytics and WebApp

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***Abstract*—E-Band Health Monitoring System which sends the Heart-rate Datasets of an Individual consistently/hour to the cloud for performing "Sickness Predictive Analytics". The System which keeps running on the Backend/cloud, executes different Data Mining Techniques like Classification, produces the Analysis providing details regarding heart-rate varieties consistently. The System likewise serve the clients with constant notices of their heart condition and aides them with appropriate medicinal services. This sort of data can be of an incentive to the medicinal group. Heart Rate Variability Analysis predicts future heart ailments in people, alarming them ahead of time. On the off chance that when the patient gets lethal the beat sensor will detect the patient's heartbeat rate instantly and it will alarm his relatives by sending the patient's location through GPS co-ordinates by sending ready messages through ThingTweet. The ceaselessly checked information is put away in the cloud for encourage examination and forecast. The framework additionally gives an android application which helps in daily report generation of the patient's health status.**

***Keywords*—Pulse, Heart Beat, GPS, Wearable, Internet of Things (IOT), Heart rate variability (HRV), Beats Per Minute (BPM)**

I. INTRODUCTION

E-Band Health Monitoring System an electronic wearable contraption basically screens the prosperity of the patient by recognizing its pulse rate with the help of the gear device and pulse sensor. It similarly has an alerted system (piezo-electric ringer) which would caution the overall public about the patient's condition. The heart rate of a strong adult still is around 72 throbs each minute (bpm) and Babies at around 120 bpm, while more settled youths have heart rates at around 90 bpm. The heart rate rises relentlessly in the midst of exercises and returns continuously to the rest regard after exercise. The rate when the beat returns to conventional implies that the wellbeing of the person. Lower than run of the mill heart rates are ordinarily an indication of a condition known as bradycardia, while higher is known as tachycardia. Heart rate is essentially evaluated by putting the thumb over the subject's vein throb, and feeling, timing and including the pulsates generally a 30 second time traverse. Heart rate (bpm) of the subject is then found by expanding the gained number by2. This technique yet direct, isn't correct and can give bungles when the rate is high. Further developed procedures to measure the heart rate utilize electronic frameworks. Electro-cardiogram (ECG) is one of once in a while used technique for evaluating the heart rate. In any case, it is an expensive device. Insignificant exertion devices as wrist watches are moreover open for the quick estimation of the heart rate. Such devices can give correct estimations yet their cost is as a general rule in excess of a couple of hundred dollars, making them uneconomical. So this heart rate screen with a temperature sensor is undeniably an accommodating instrument in knowing the beat and the temperature of the subject or the patient.

II. LITERATURE REVIEW

A. Heart rate monitoring system using finger tip through arduino and processing software

[1] This framework depicts a strategy of estimating the heart rate through a fingertip and Arduino. Diverse physiological conditions, for example,

organic workload, worry at work and focus on undertakings, laziness and the dynamic condition of the autonomic sensory system can be estimated either by the ECG waveform or by detecting the beat - the cadenced development and compression of a conduit as blood is constrained through it by the customary constrictions of the heart. The beat can be felt from those territories where the corridor is near the skin. It depends on the essential of photophelthysmography (PPG) which is non-obtrusive technique for estimating the variety in blood volume in tissue utilizing a light source and identifier.

B. Evaluation of wearable consumer heart rate monitors based on photopletysmography

[2] As of late, innovations in view of heartbeat plethysmography (PPG) have turned out to be accessible for individual wellbeing administration for purchasers. Be that as it may, the precision of these screens is inadequately known which restrains their application. In this investigation, the assessed exactness of two PPG based (wrist i.e. Mio Alpha versus lower arm i.e. Schosche Rhythm) monetarily accessible HR screens amid work out. 21 sound volunteers (15 male and 6 female) finished an activity convention which included sitting, lying, strolling, running, cycling, and some day by day exercises including hand developments. HR estimation was thought about against values from the reference electrocardiogram (ECG) flag. The heart rate estimation dependability scores for <;5% precision against reference were following: mio Alpha 77,83% and Scosche Rhytm 76,29%. The assessed comes about show that execution of gadgets relies upon different parameters, including determined movement, sensor write and gadget arrangement.

C. A Review of Measurement and Analysis of Heart Rate Variability

[3] Heartbeat sensor is a standout amongst the most imperative physiological parameter that gives amend evaluation of heart work. QRS complex is a noticeable waveform in a heartbeat sensor that gives the premise to dissecting heart rate inconstancy (HRV). HRV alludes to the beat-to-thump adjustments in heart rate. To acquire important information from the Pulse sensor, a commotion free between beat interim (IBI) time arrangement is required to be removed. This is acknowledged utilizing with information securing equipment and programming. It likewise audits different time and recurrence space HRV parameters. The criticalness and importance of these diverse measures of HRV are a potential zone of research.

III. PROPOSED SYSTEM

1) Sensors: Detecting module is utilized to see the heart condition of the client by consistently detecting the heart rate information. This information incorporates BMP(Beats Per Minute), HRV(Heart Rate Variability), body temperature and oxygen level. This apparent information at that point transmitted to the breaking down unit by means of microchip.

2) Analyzing Unit: The transmitted information is consistently observed and prepared by the examining unit. The Unit recognizes sudden variety in heart state by contrasting the present heartbeat rate information and a specific edge esteem which would be set before in the gadget.

3) Alerting Unit: This unit is in charge of alarming client and his/her relative and specialist the client gets a horrendous assault, for example, heart assault or up/down in circulatory strain. Cautioning will be in two ways, one is through week by week report which will be sent to client's cell phone (Android application) by examining unit and, the other path is to send alert messages through SMS benefit on cell phone in the event of crisis.

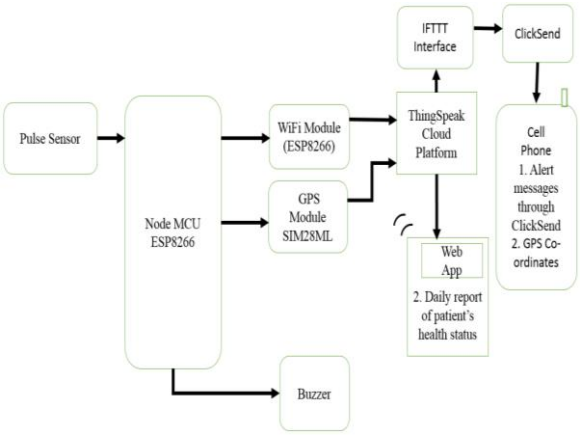


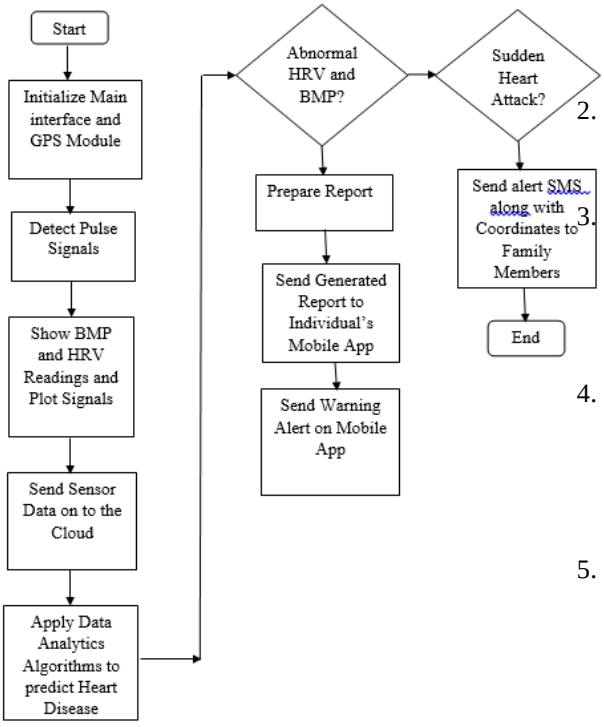
Figure-1. Overall System Block Diagram

IV. PROPOSED ALGORITHM

- The system will start by initializing all the hardware components such as sensors and GPS module.

- The pulse sensor that is embedded onto the band will detect the pulses of user.
- Calculate BPM (Beats Per Minute) and HRV (Heart Rate Variability) values using pulse rate, show these readings on processing software in the form of waves.
- Send these BPM and HRV data onto the cloud (ThingSpeak).
- Normalize the dataset, remove noisy data using algorithm and apply data analytics to predict the state of heart.
- If the heart state is abnormal, say BPM lower than 60 or above 120 then generate report and send it to user's mobile application. Also, send warning alert saying "You heart rate is not normal! Take action immediately".
- If there is sudden variation in heart rate, say heart attack, then send alert SMS to user's family member along with the GPS coordinated to identify the location.

1.



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V. ANALYSIS

To predict a heart rate for a specific point in time we use a mathematics to model heart rates and predict what it might be in 5, 15, 30 and 60 seconds. The model used is known as linear regression and in the field of statistics is expressed as:

$$\mathbf{y}=\mathbf{X}\boldsymbol{\beta}+\boldsymbol{\varepsilon} \text{ where} \qquad (1)$$

X is the regressors, or in plain english it will be 5, 15, 30 and 60 seconds time points where we want to predict your heart rate.

β is the regression coefficients. Statistical estimation and inference determines these values and are interpreted as the partial derivatives of the depend variable with respect to the independent variables. In the case of this app a sample of previous heart rate measures. There are more than one methodology to calculate these estimates, the one we use a technique as ordinary least squares (OLS) that minimise the sum of squared residuals to estimate the parameter **β** such that:

$$\boldsymbol{\beta}=(\mathbf{X}^{T}\mathbf{X})^{-1}\mathbf{X}^{T}\mathbf{y} \text{ holds} \qquad (2)$$

ε is the error term or sometimes known as noise. This variables captures things that might influence the model are not intended to take into account. Like all models there are assumptions and without going into the nitty gritty of the maths, they are:

We assume weak exogeneity. It simply means our heart rate is not random; we don't expect a heart rate of 140 bpm and then suddenly 60 bpm within 1 second.

Linearity. We assume that the average of heart rate measurement is a linear combination of the regressions coefficients and time.

Homoscedasticity. It means that within out time frame of the model (i.e. 60 seconds), all the response variables has the same variance (i.e. volatility) in regard of the predators variables (in the App time is the predictor).

Independence of errors. The model assumes that the errors in the response variables are uncorrelated. (i.e. unrelated). For example, we say that the fact that you pick up a water bottle cannot be predicted and is random.

Lack of multicollinearity. Since the prediction time is under 60 seconds this does not apply, unless your training repetition is under 60 seconds.

$$\text{BPM} = 60\sum (T[i]-T[i-1])/(m-1)\ m\ i=1$$

VI. IMPLEMENTATION

A. Node MCU

Node MCU is an eLua based firmware for the ESP8266 WiFi SOC from Espressif. The Node MCU *firmware* is a companion project to the popular NodeMCU dev kits, ready-made open source development boards with ESP8266-12E chips.

Some of the features include:

1. 10 digit Analog-Digital converter
2. On board Antenna and RF balun
3. Uses 802.11 b/g/n WiFi standards
4. Uses IPV4, HTTP, FTP, UDP & TCP network protocols
5. Operating voltages: 3-3.6V
6. Operating Frequency range: 2.4-2.6 GHz
7. On board power management modules, PLL, regulator, Power amplifier, Noise filters which makes it less external circuitry interface.
8. Configured in both Android & iOS devices

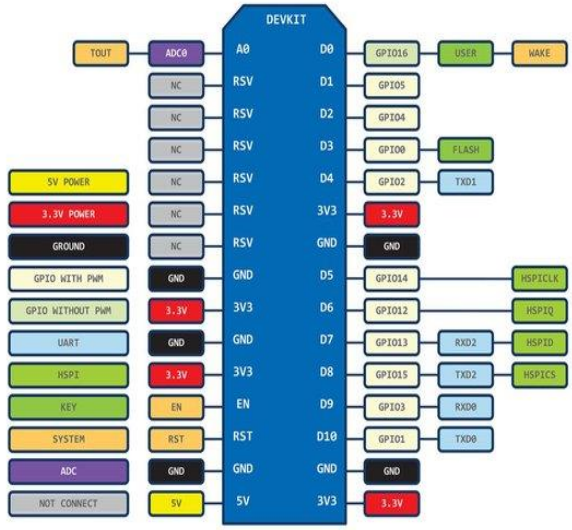

Figure 2. Pin Diagram Node MCU

B. Pulse Sensor

Table-1. Heart rate parameter for decision making

Pulse Rate Sensor(per minute)	Action Taken
60 to 100	No action
40-60 or 100-120	Inform family
40-60 or 100-120	Inform local physician
<40 or >120	Inform emergency

Pulse Sensor Amped is a plug-and-play heart-rate sensor for Arduino and Arduino compatibles. It can be used by students, artists, athletes, makers, and game & mobile developers who want to easily incorporate live heart-rate data into their projects. Pulse Sensor adds amplification and noise cancellation circuitry to the hardware. It's noticeably faster and easier to get reliable pulse readings. Pulse Sensor Amped works with either a 3V or 5V Arduino.

Specification

- Diameter = 0.625" (~16mm)
- Overall thickness = 0.125" (~3mm)
- Working Voltage = 3V to 5V
- Working Current = ~4mA at 5V

Figure 4. Pulse Sensor

C. Buzzer

Piezo ringer is an electronic gadget ordinarily used to create sound. Light weight, straightforward development and low value make it usable in different applications like auto/truck turning around pointer, PCs, call chimes and so on. Piezo bell depends on the reverse rule of piezo power found in 1880 by Jacques and Pierre Curie. It is the wonders of producing power when mechanical weight is connected to specific materials and the other way around is additionally valid. Such materials are called piezo electric materials. Piezoelectric materials are either normally accessible or synthetic.

Features

- Use of high performance piezoelectric elements to meet loud sound volume and wide frequency range needs.
- High quality achieved by integrated in-house production, from piezoelectric materials to buzzers.0

Electrical Specifications

- Sound Pressure Level: 80dB min./30cm./9VDC
- Oscillating Frequency: 2.5 ± 0.5KHz
- Current Consumption: 8mA max./9VDC
- Operating Voltage: 3 to 30VDC

D. Data Analytics

ThingSpeak is a platform providing various services exclusively targeted for building IoT applications. It offers the capabilities of real-time data collection, visualizing the collected data in the form of charts, ability to create plugins and apps for collaborating with web services, social network and other APIs. We will consider each of these features in detail below.

[5]The core element of ThingSpeak is a 'ThingSpeak Channel'. A channel stores the data that we send to ThingSpeak and comprises of the below elements:

- 8 fields for storing data of any type - These can be used to store the data from a sensor or from an embedded device.
- 3 location fields - Can be used to store the latitude, longitude and the elevation. These are very useful for tracking a moving device.
- 1 status field - A short message to describe the data stored in the channel.

E. IFTTT

[10]The information about the patient is sent to the ActOn module using IFTTT Maker applet.

The steps involved are:
Step 1: Connect through your IF app (aka IFTTT) to the new Maker channel, you will receive an unique key "YOURKEY" followed by a URL to fire the "test" event
Step 2: Paste the maker key inside our Thinghttp app of ThingSpeak with body as triggered value. SMS is received at the destination .

F. ThingSpeak Apps:

[7]ThingSpeak provides apps that allow us for an easier integration with the web services, social networks and other APIs. Below are some of the apps provided by ThingSpeak:

- **ThingTweet** - This allows you to post messages to twitter via ThingSpeak. In essence, this is a TwitterProxy which re-directs your posts to twitter.
- **ThingHTTP** - This allows you to connect to web services and supports GET, PUT, POST and DELETE methods of HTTP.
- **TweetControl** - Using this, you can monitor your Twitter feeds for a specific key word and then process the request. Once the specific keyword is found in the twitter feed, you can then use ThingHTTP to connect to a different web service or execute a specific action.
- **React** - Send a tweet or trigger a ThingHTTP request when the Channel meets a certain condition.
- **TalkBack** - Use this app to queue up commands and then allow a device to act upon these queued commands.
- **Timecontrol** - Using this app, we can do a ThingTweet, ThingHTTP or a TalkBack at a specified time in the future. We can also use this to allow these actions to happen at a specified time throughout the week.

G. Web App

As the part of the project we have implemented a web application model in order to track the heart-beat of a particular patient and monitor it correctly and give the accurate patient's health report daily.

III. APPLICATIONS

- Bradycardia
  It is a sign of a problem with the heart's electrical system, heart beats less than 60 bpm, it is slower than normal
- Cerebrovascular disease
  Very fast rates of 200 bpm or more can precipitate heart failure
- Hypertension
  Heart rate constantly ranging from 100-200.
- Tachycardia

Tachycardia, also called tachyarrhythmia, is a heart rate that exceeds the normal resting rate. In general, a resting heart rate over 100 beats per minute is accepted as tachycardia in adults.

IV. ADVANTAGES

- Quick and reliable.
- Measurements of HRV are noninvasive and profoundly reproducible.
- Assesses cardiovascular health, management of disease progression, and the effects of medication, therapies, lifestyle changes and dietary habits.

V. CONCLUSION

Cardiovascular sickness is one of the significant reasons for inauspicious passing in world, pulse readings are by a wide margin the main practical indicative apparatus that could advance early recognition of cardiovascular events. By utilizing this we can gauge ones heart rate through fingertip. This paper centre's around the heart rate observing and ready which can screen the heart beat rate state of patient. The framework decides the heart beat rate every moment and afterward sends short message benefit (SMS) through ClickSend. It is convenient and financially savvy.

[11]According to the availability of sensors or development in biomedical trend more parameter can be sensed and monitored which will drastically improve the efficiency of the wireless monitoring system in biomedical field. A graphical LCD can be used to display a graph of rate of change of health parameters over time. The whole health monitoring system which we have framed can be integrated into a microchip which will help the patients to easily carry this device with them wherever they go.

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