IoT based H-E-T Monitoring & Alerting System

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Abstract:

When considering health, one of the most important parameter to be seen is the state of heart. The heart is the main element in a human body which is muscular organ about the size of a closed fist that functions as the body's circulatory pump. It takes in deoxygenated blood through the veins and delivers it to the lungs for oxygenation before pumping it into various arteries. There exists a project which can measure ECG (Electrocardiogram), temperature and heartbeat rate and the base of working was using Bluetooth (802.15.1), which passed the readings of the system to the Android and desktop application. The current project masks all the inabilities of the previous systems which it was supposed to cover. The current project is very synchronized version of the previous system created. It is compact, easy to use and cost friendly. This project will be working on Internet of Things (IoT), which uses Wi-Fi (802.11) for passing the readings of the system to the Android and desktop application. Wi-Fi enables the project's abilities and the productivity to magnify at a high level.

Keywords: ECG, Heartbeat Rate, Temperature, Wi-Fi, IoT

1. Introduction

This paper is based on the revised version of an existing project which used to measure ECG (Electrocardiogram), temperature and heartbeat rate and also send alerts to the respective doctor(s), if there are any issues born in the patient's ECG, temperature or even heartbeat rate. The existing project used Bluetooth (802.15.1) for communication with the applications residing in any Android phone or desktop. The issue with this was, Bluetooth had limited connectivity in terms of geographical range. The maximum limit of a Bluetooth connectivity is 100 metres (approx.), which happens to be a humongous limitation of this project. As we see advancements in Science & Technology and their applications, we need to take efforts and use these new technologies for further advancements in pre-existing systems. The new concept of Internet of Things (IoT) is in trend and therefore, we decided to implement this new technology and create a new project, most likely to be a finished product, to overcome and mask all the limitations of the previous system.

2. Literature Review

ECG happens to be one of the most essential report, through which, a doctor can identify, what are the conditions and situations which are occurring and will occur with the patients' hearts. ECG becomes a major result of someone's life and death, so it's accuracy has to be maintained. Doctors have given reviews that, long ECG stripes are very tedious and difficult to handle. Thus, they need something handy to examine the ECG results of the patient. Thus, by seeing the difficulty of the doctors, this system is getting designed, so that, doctors can always get updated about the whereabouts of the patients' cardiac health, although they are standing at any geographical location on the globe, because what they need with them is just an application and an active Internet connection. Doctors have also prescribed that, using such methods for health care can help in providing the best remedy within no time for patient at any time possible.
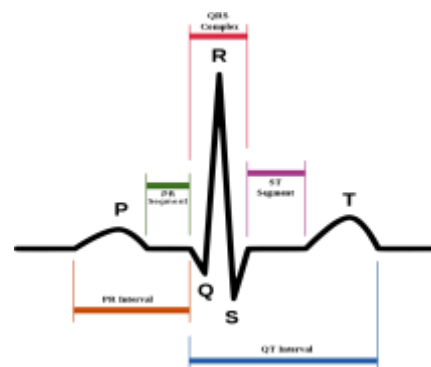
➢ Definition of ECG

Fig1: Electrocardiogram (ECG) Structure

Electrocardiography (ECG or EKG) is the process of recording the electrical activity of the heart over a period of time using electrodes placed on the skin. These electrodes detect the tiny electrical changes on the skin that arise from the heart muscle's electrophysiologic pattern of depolarizing and repolarizing during each heartbeat. It is a very commonly performed cardiology test. The overall goal of performing electrocardiography is to obtain information about the structure and function of the heart. Medical uses for this information are varied and generally relate to having a need for knowledge of the structure and/or function. [1][4][11]

➢ Definition of Heartbeat Rate

By the name itself, heartbeat rate means the number of times the heart pumps within a given unit of time. For better consideration,

heartbeat rate is calculated by considering the base as minutes. Heartbeat rate is calculated in a standard format of BPM (Beats Per Minute) and thus shows, how much blood the heart is pumping or how many times the heart is expanding and contracting.

Factors affecting Heartbeat Rate:

- Air temperature: When temperatures (and the humidity) soar, the heart pumps a little more blood, so your pulse rate may increase, but usually no more than five to 10 beats a minute.
- Body position: Resting, sitting or standing, your pulse is usually the same. Sometimes as you stand for the first 15 to 20 seconds, your pulse may go up a little bit, but after a couple of minutes it should settle down.
- Emotions: If you're stressed, anxious or "extraordinarily happy or sad" your emotions can raise your pulse.
- Body size: Body size usually doesn't change pulse. If you're very obese, you might see a higher resting pulse than normal, but usually not more than 100.
- Medication use: Meds that block your adrenaline (beta blockers) tend to slow your pulse, while too much thyroid medication or too high of a dosage will raise it.[12][3]

➢ Definition of Temperature

Temperature is a physical quantity that expresses the subjective perceptions of hot and cold. Temperature is measured with a thermometer, historically calibrated in various temperature scales and units of measurement. The most commonly used scales are the Celsius scale, denoted in °C (informally, degrees centigrade), the Fahrenheit scale (°F), and the Kelvin scale. The kelvin (K) is the unit of temperature in the International System of Units (SI), in which temperature is one of the seven fundamental base units. As temperature is important in all fields of natural science including physics, geology, chemistry, atmospheric sciences, medicine and biology as well as most aspects of daily life, the project team has included this factor of including the temperature module in the project.[5][6]

3. Comparitive Study

➢ Existing Systems:

- Existing System 1- ECG monitoring using Android mobile phone and Bluetooth:

This paperwork describes the development and test of circuitry and software to enable the use of Android mobile phones equipped with Bluetooth to receive the incoming electrocardiogram (ECG) signal from a user and show it in real-time on the cell phone screen. The system comprises three distinct subsystems. The first one is dedicated to condition the analog ECG signal, preparing it for conversion to the digital world. The second one consists of a microcontroller and a Bluetooth module. This unit samples the ECG, serializes the samples and transmits them via the Bluetooth module to the Android cell phone. The third subsystem is the cell phone itself. An application program written to the cell phone receives the ECG samples and suitably charts the ECG signal on the screen for analysis. The good quality of the ECG signal allows for identification of arrhythmias. [1][2]

- Existing System 2- Android Application for measuring ECG, Temperature, Heart rate and Sending Alerts to Family Doctor:

The hardware of the system has been interfaced with the ARM-7 Microcontroller through Amplifier part. The circuit senses the parameters related to the human body such as Body Temperature, Heartbeat and ECG. The system is designed with the help of different sensors available in the market and suitable signal conditioning circuits are designed with the help of well-known circuits. The parameters of temperature sensor and heartbeat are displayed on the LCD display. Considering the parameters of all the techniques we discussed till now we come to conclusion that these techniques are the best for authentication purpose but there is common drawback for all the above stated system that right person may get authentication But, it may not be at right situation. That is the unauthorized person may force or harm the authorized person to get access to the system. [6]

Fig 2: Existing System 2

➢ Proposed System (Block Diagram):

In the block diagram, we can see that each module is connected to another. Information flows from the user to the NodeMCU to the other two modules i.e. DHT11 and AD8232 used for temperature and heartbeat rate purpose respectively.

The design described in the diagram, is way too compact and is very effective with respect to accuracy. This project, can be encased very easily, so that it looks like a product. A very simple solution to a very critical issue is thus, accomplished very well.
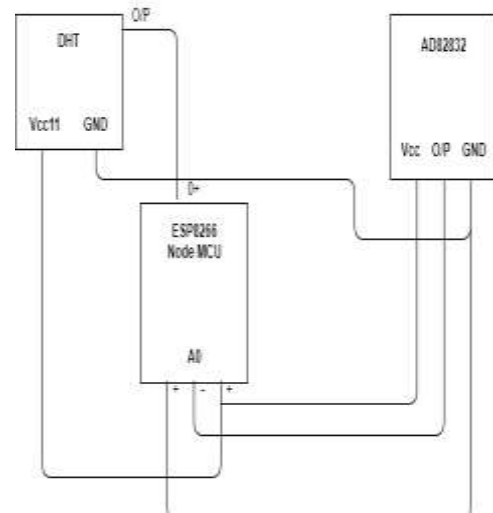

Fig. 3: Block Diagram of IoT Based H-E-T Monitoring & Alerting System

➢ Comparison:

Factors	Existing System 1	Existing System 2	Proposed System
Project made for measuring:	ECG.	ECG, Heartbeat rate and temperature.	ECG, Heartbeat rate and temperature.
Displaying of result	Android Application	Android Application and portal.	Widget in Android phones.
Connectivity	Bluetooth based	Bluetooth based	Wi-Fi based
Range	Approx 10 meters	Approx 10 meters	Approx 32 meters
Model	Fragile	Little Fragile	Not Fragile
Maintenance	Hard	Not so Hard	Easy
Complexity	Very Complex	Complex	Not Complex
Application Space Used:	As it is an android application, approx size of the same will be in MB	As it is an android application, approx size of the same will be in MB	As it is a widget, approx size of the same will be in KB
Cost of the system	Not so Affordable	Not so Affordable	Affordable

➢ Summary of the comparison:

The proposed system is designed by using the updated and new version of the components, also the size of the system is very small and is compact as compared to the previous systems. The application used for displaying the graph and other data is a widget which is smaller than that of the android application. This system is not complex and is feasible enough for the common man to buy and use it. Also this proposed system is IoT based which is a new technology and the data could be accessed from anywhere. So this system is less costly and made for common man use which could be accessed by the doctor for regular updates of the patient's health.

4. Methodology, Techniques and Algorithms

➢ Overview of how and why ECG reading is it taken:
An electrocardiogram is a simple, painless test that measures your heart's electrical activity. It's also known as an ECG or EKG. Every heartbeat is triggered by an electrical signal that starts at the top of your heart and travels to the bottom. Heart problems often affect the electrical activity of your heart. Your doctor may recommend an EKG if you're experiencing symptoms or signs that may suggest a heart problem, including:

- pain in your chest

- trouble breathing

- feeling tired or weak

- pounding, racing or fluttering of your heart

- a feeling that your heart is beating unevenly

- detection of unusual sounds when your doctor listens to your heart

To take ECG readings is an easy job and does not require high expertise. The following figure shows the vital points, on which, the sensors are glued with. The following figure shows the vital points, which the project is going to use. [4][11][12]
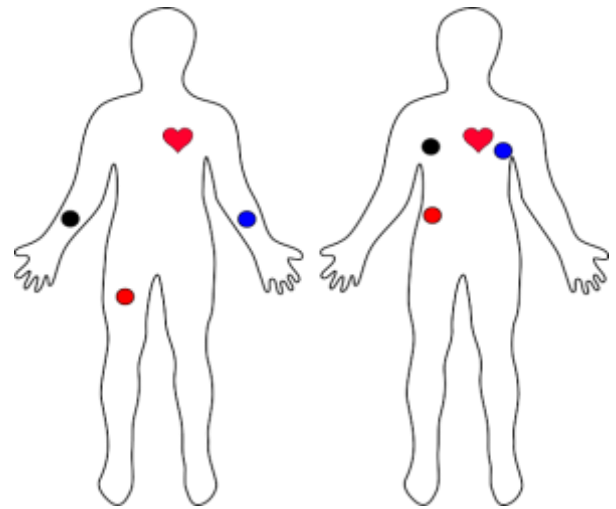

Fig 4: Vital points for attaching the sensors to the body for accurate readings.

➢ Heartbeat rate readings:

Taking heartbeat as an output in the project, displays the complete movement of the heart and its health. The heartbeat rate can be read from the following body points:

- wrists
- inside of your elbow
- side of your neck
- top of the foot

In this project, we are using AD8232 module for this purpose which gives accurate readings as the literature review performed. [7][8][3]

➢ Temperature readings

For a typical adult, body temperature can be anywhere from 97 F to 99 F. Babies and children have a little higher range: 97.9 F to 100.4 F. Your temperature doesn't stay same all day, and it will vary throughout your lifetime, too. Some things that cause your temperature to move around during the day include:

- How active you are
- What time of day it is
- Your age and gender
- What you've eaten or had to drink
- Where you are in your menstrual cycle (If you're a woman)

The vital spots of checking body temperature are:

- Mouth
- Armpit

The temperature, as a parameter of this project, is accomplished through DHT11 sensor attached to the ESP8266 NodeMCU. This sensor provides precise readings of the same. [5][6]

➢ Adafruit:

For getting current status of the patients' ECG, heartbeat rate and temperature, the project will be using Adafruit's IDE as a medium. By using this IDE, we will create widgets, which are lighter and faster than a whole application. These widgets will be providing all the needed data about any given patient(s). On top of that, it will also provide alerts in case of emergencies about patients' cardiac status. Also, Adafruit is going to be used for saving the

records on a cloud server under the name "adafruit.io", where, the records can be easily seen and manipulated as well.[10]

Fig 5: Adafruit Logo

➤ Arduino IDE

Fig 6: Arduino Logo

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software. This software can be used with any Arduino board or any given board other than Arduino. The code will be written in C# which will be understandable and easy to use. [9]

5. Conclusion:

Human race is developing new technologies day by day, for many purposes such as entertainment, health care, engineering and many more. Contribution of science and technology is remarkably great towards health care services. Since we say, necessity is the mother of invention, our project can be considered as a necessity, because of the services it provides for reacting faster towards curing the patients' problems within no time. Our project is a step forward towards health care and related services, which focuses fundamentally on heart's issues and their remedies. This project is the perfect combination of service provision, health care and IoT. This project can be further created in the form of a finished product which would be very cost friendly and easy to use for people who cannot afford separate ECG tests. This will not only be helping doctors for keeping a regular check on patients' status, but also will help them to react at the right time and provide the perfect solution possible.

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