

Wearable Heart Attack Detector using IoT

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Abstract— Life is precious. Many people among us lose their life due to heart attack. This is because of their unbalanced diet, age, less physical activity and many other factors. Today, the leading cause of death in the world is heart attack. Heart attack is not easy to detect and symptoms of heart attack varies from male to female. To overcome and help our society from heart diseases and attack, we are developing such a system which will help to decrease the death rate and detection of heart attack through a wearable device.

I. INTRODUCTION

The National Heart, Lung, and Blood Institute states that “more than a million people in the U.S.A have heart attack and about half (515,000) of them die each year. About one-half of those who die do so within 1 hour of the start of symptoms and before reaching the hospital. After heart attack, the few hours are critical in saving much of the dying heart muscle which are starving due to lack of oxygen supply and preventing permanent heart damage. The symptoms vary from individual to individual and most common reason for critical delays in medical treatment is patient’s unawareness and lack of early warnings.

To overcome from this we are developing a system which will help to decrease the death rate due to heart attack by detection of heart attack. In our system we will be using wearable device. This wearable device will continuously monitor ECG (Electrocardiogram) of a user. When the ST segment in the ECG of a user elevates and leads to myocardial infarction, another monitor will get notified with an alert message and exact location of the user. The wearable device and the monitoring system will be connected to the cloud and will alert the doctors as well as guardian.

II. BACKGROUND STUDIES

The heart is a muscular organ that acts like a pump to continuously send blood throughout your body. The heart is at the center of the circulatory system. This system consists of a network of blood vessels, such as arteries, veins, and capillaries. These blood vessels carry blood to and from all areas of the body.

An electrical system regulates the heart and uses electrical signals to contract the heart's walls. A system of inlet and outlet valves in the heart chambers work to ensure that blood flows in the right direction. The heart is vital to your health and nearly everything that goes on in the body. Without the heart's pumping action, blood can't circulate within the body.

Blood carries the oxygen and nutrients that your organs need to work normally. Blood also carries carbon

dioxide, a waste product, to your lungs to be passed out of the body and into the air. A healthy heart supplies the areas of the body with the right amount of blood at the rate needed to work normally. If disease or injury weakens the heart, the body's organs won't receive enough blood to work normally.

Numerous works in literature related with heart disease diagnosis using data mining techniques have motivated our work. We have studies several paper based on the heart attack detection where they have taken the parameter like heart rate, pulse rate, pressure. Heart rate is used to find out average distance between adjacent peaks which helps in the heart attack detection. Because of the heart sound and heart rate are not only for heart attack. It could be for another heart disease. We also found that Microsoft band is a smart band with smart watch and activity tracker/fitness tracker features, created and developed by Microsoft. The Microsoft band incorporates fitness tracking and health oriented capabilities and integrates with windows phone, ios, and android smart phones through Bluetooth connections. But the main drawback of this is connectivity. Since Bluetooth works only within 100mtrs it fails to locate the user if the user is far from the smart phone. To find the heart attack the main parameter is ECG itself. Hence in our proposed method we are using ECG as one of the parameter for more accuracy purpose. Along with ECG we are using Google device manager for tracking system which work more precisely than the Bluetooth. Also cloud system for continuous recording of the user data.

The two types of ECG recordings are the 12-lead ECG and a rhythm strip. Both types give valuable information about heart function.

A 12-lead ECG records information from 12 different views of the heart and provides a complete picture of electrical activity. These 12 views are obtained by placing electrodes on the patient’s limbs and chest. The limb leads and the chest, or precordial, leads reflect information from the different planes of the heart.

Different leads provide different information. The six limb leads—I, II, III, augmented vector right (aVR), augmented vector left (aVL), and augmented vector foot (aVF)—provide information about the heart’s frontal (vertical) plane. Leads I, II, and III require a negative and positive electrode for monitoring, which makes those leads bipolar. The augmented leads record information from one lead and are called *unipolar*.

The six precordial or V leads—V1, V2, V3, V4, V5, and V6—provide information about the heart’s horizontal

plane. Like the augmented leads, the precordial leads are also unipolar, requiring only a single electrode. The opposing pole of those leads is the center of the heart as calculated by the ECG.

The six unipolar precordial leads are placed in sequence across the chest and provide a view of the heart's horizontal plane. These leads include:

- **Lead V1**—the precordial lead V1 electrode is placed on the right side of the sternum at the fourth intercostal rib space. This lead corresponds to the modified chest lead MCL1 and shows the P wave, QRS complex and ST segment particularly well. It helps to distinguish between right and left ventricular ectopic beats that result from myocardial irritation or other cardiac stimulation outside the normal conduction system. Lead V1 is also useful in monitoring ventricular arrhythmias, ST-segment changes, and bundle-branch blocks.
- **Lead V2**—Lead V2 is placed at the left of the sternum at the fourth intercostal rib space.
- **Lead V3**—Lead V3 goes between V2 and V4. Leads V1, V2, and V3 are biphasic, with both positive and negative deflections. Leads V2 and V3 can be used to detect ST-segment elevation.
- **Lead V4**—Lead V4 is placed at the fifth intercostal space at the midclavicular line and produces a biphasic waveform.
- **Lead V5**—Lead V5 is placed at the fifth intercostal space at the anterior axillary line. It produces a positive deflection on the ECG and, along with V4, can show changes in the ST segment or T wave.
- **Lead V6**—Lead V6, the last of the precordial leads, is placed level with V4 at the midaxillary line. This lead produces a positive deflection on the ECG.

An ECG complex represents the electrical events occurring in one cardiac cycle. A complex consists of five waveforms labeled with the letters P, Q, R, S, and T. The middle three letters —Q, R, and S—are referred to as a unit, the QRS complex. ECG tracings represent the conduction of electrical impulses from the atria to the ventricles.

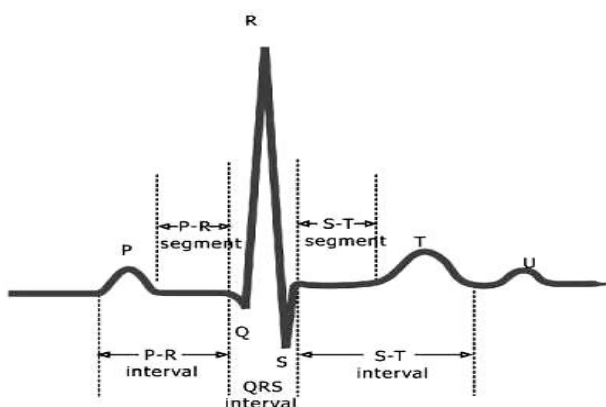


Fig 2: Typical ECG

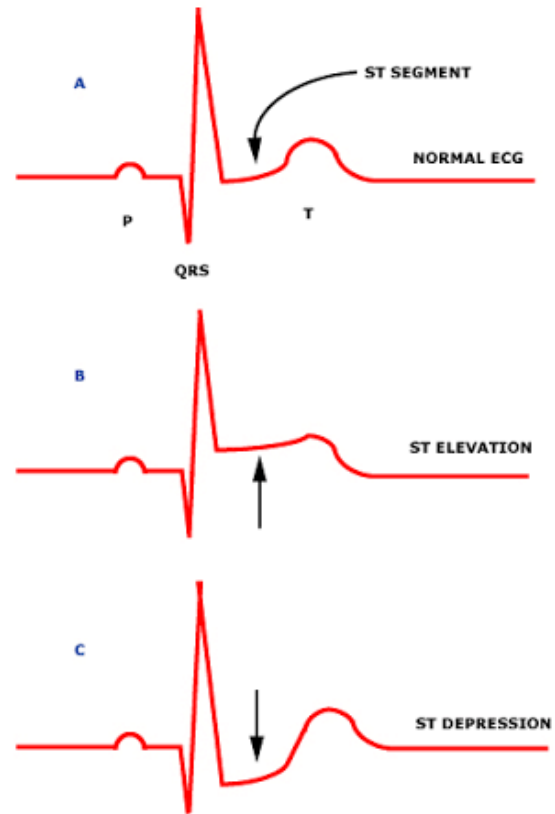


Fig 3: Abnormal ECG

III. PROPOSED SYSTEM

The wearable device will be worn by the user. This device will acquire the user ECG and processed. This will be stored in the cloud through internet gateway. If any abnormal condition occurs then the device will send alert message with location to the monitoring system.

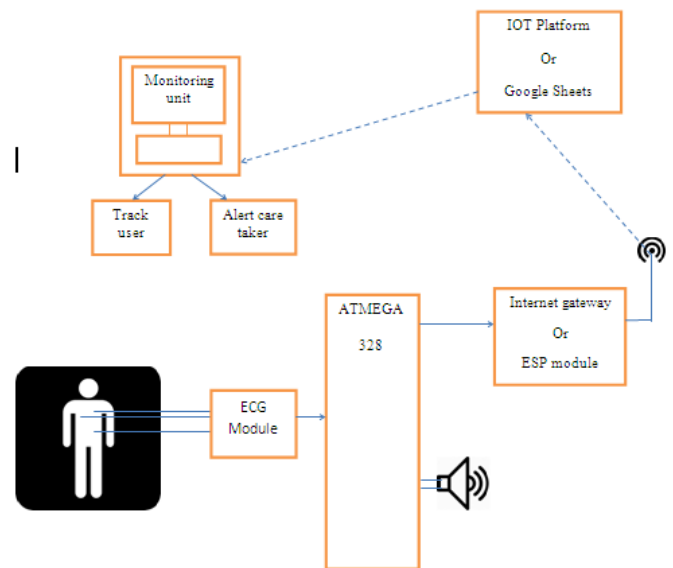


Fig 4: Block Diagram of Wearable Heart Attack Detector

ECG Sensor: AD8232

This ECG sensor is suitable to acquire the ECG of the patient through 3 leads. It has AD8232 an integrated signal conditioning block for ECG and other bio potential measurement applications. It is designed to extract, amplify, and filter small bio potential signals in the presence of noisy conditions, such as those created by motion or remote electrode placement. This design allows for an ultralow power analog-to-digital converter (ADC) or an embedded microcontroller to acquire the output signal easily.

Microcontroller: ATMEGA 328P

Arduino/Genuino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

"Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

Voice Output

To make the patients surroundings attentive if he/she got heart attack this voice output is used in the model. The voice is stored in a micro SD card and interfaced with a memory card adapter namely catalex.

Adapter combines a SD card slot with a 3.3V – 5V level shifter and a 3.3V voltage regulator. This enables direct hookup to the Arduino SPI pins.

Internet Gateway

An internet gateway is a horizontally scaled, redundant and highly available VPC (Virtual Private Cloud) component that allows communication between instances in VPC and internet. It therefore imposes no availability risks or bandwidth constraints on the network traffic.

An internet gateway serves two purposes: to provide a target in VPC route tables for internet routable traffic and to perform network address translation (NAT) for instances that have been assigned.

Internet Platform

The Internet of things (IoT) is the inter-networking of physical devices, vehicles (also referred to as "connected devices" and "smart devices"), buildings, and other items—embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data.

The IoT platform is a suite of components that enable: Deployment of applications that monitor, manage, and control connected devices. Remote data collection from connected devices. Independent and secure connectivity between devices. Device/sensor management.

Monitoring Unit

This monitoring unit is used to get the alert and precise location of the patient if he/she got heart attack.

Track the user

If any abnormalities shown in the ST segment then the location can be tracked using a Google device manager to get the precise location of the patient.

Alert the care taker

Also message will be sent to the care taker of the patient to inform about the health status of the patient.

Wearable devices

The user will be wearing a device. The ECG module will acquire the ECG of the user. The ECG will be continuously processing through this device. This will be stored in cloud through the internet gateway. We are mainly concentrating on the abnormalities in the ST segment of ECG.

Symptoms of STEMI-

ST segment represent the interval between ventricular depolarization and re-polarization. The most important cause of ST segment abnormality (elevation or depression) is myocardial ischaemia or infarction. The ST segment is flat isoelectric section of ECG between the end of the S wave and beginning of the T wave. Classically a STEMI (ST Segment Elevation in Myocardial Infarction) is the cause of acute myocardial infarction, coronary vasospasm, pericarditis, raised intracranial pressure. The main symptoms for this are discomfort in left arm, jaw, breathlessness, chest pain.

If the ST Segment in the ECG of the user is altered when compared to pre-stored values of ECG then the device will send the alert to the monitoring system using the internet gateway. Here we are also using voice message to alert the surroundings.

Cloud Monitor

After receiving data from internet gateway the cloud will store the data as a history. The information in the history will be used for further usage.

Monitoring System

If any elevation occurs in the ST segment then the abnormal condition will be occurred. Then the monitoring system will get an alert message. From this monitoring system we can also get the location of the user at the abnormal condition. Here we are using the Google device manager for the precise location of the user.

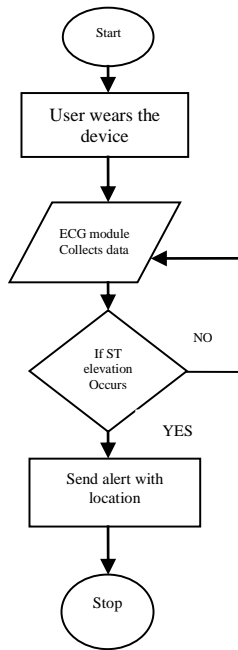


Fig 5: Flow Diagram

IV. CONCLUSION

Numerous heart attack detection techniques have been introduced so far, but they are very expensive and time consuming. Since this modern age is the era of smart phone, the proposed technique can reach to the doorsteps of people of every level in the society. Alternative modalities to detect heart attack may fail while others will provide the accurate outcome.

This application is efficient and suitable from other non-medical application. There are many researchers, who dedicated their whole life to find out the latest technology for medical applications. The only way out of this is implementing telecare solutions that will manage to increase

the quality of delivered health care. It will maintain low installation and low running cost. Old health services delivery is now shifting to modern technology gradually.

Health services delivery is about to change, but it is the nature of the service itself that will gradually shift from reactive treatment of conditions to pre-emptive health care. Avoiding health risks can be more efficient than sustaining patients with chronic conditions that could have been avoided. This is where health monitoring and cognitive therapy comes to offer new possibilities, to provide the users with information.

So to overcome difficulties of early detection of heart attack this wearable device is been proposed. This device will help to decrease the death rate due to heart attack. In this system a wearable device is being proposed. This wearable device will continuously monitor ECG (Electrocardiogram) of a user. When the ST segment in the ECG of a user elevates it leads to sudden myocardial infarction. This will get notified with a voice output and exact location of the user can be found. The wearable device and the monitoring system will be connected by IOT

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