

# Development of Intelligent Wearable Device for Early Detection of Myocardial Infraction Using IOT

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**Abstract**—The purpose of this project is to design a Reliable continuous monitoring system with alarm that helps in detecting heart attack earlier using Internet of things. This involve continuously monitor vital parameter through sensors which is interfaced to a Processor that allows checking parameter readings and transmitting them over internet and detect the occurrence of heart attack as persons vital parameter goes above a certain limit, the system sends an alert to the person's mobile which then transmits this over the internet and the doctors as well as concerned users which reduce the response time and allow the person to know that he or she is about to get a heart attack in advance and send the data to medical assistant so, that they can take preventive measures and give medical attention within the first few critical hours , thus greatly improving his or her chances of survival..

## I. INTRODUCTION

### A. Overview:

The heart disease is one of the most common and serious effects in the recent year. These diseases are commonly due to aging, fatty deposits, plaque(cholesterols), emotional stress, drugs intake builds up spasm in blood vessel walls and narrow the passageway for the movement of blood The resulting condition, called atherosclerosis often leads to eventual blockage of coronary arteries and it is referred as "HEART ATTACK". The other symptoms are Anxiety, repeated cough with mild pain in chest, shortness of breath, sweating in normal condition.

According to WHO, 17 million people die from CVD which makes up to 31% of the deaths worldwide. India having a population of approximately 1.17 billion people (estimate for July, 2009), more than one sixth of the world's population, experiencing heart disease as the single largest cause of death in the country with heart attacks being responsible for one third of all deaths caused by heart diseases. Hence a method to prevent or

to help in reducing the losses of people's lives becomes essential. It is estimated that over 20 million deaths all over the world occur due to cardio vascular disorder. Several people are also disabled by cardio vascular disease. The fatal consequence occurs due to delay in providing medical assistance. The severity increases due to deployment of resources for early detection and treatment.

About one-half of those who die do so within few hours of start of symptoms and before reaching the hospital. Patients suffering from heart diseases need a earlier detection system to have a urgent treatment before it's too late.

More over some existing methodology helps in detecting heart attack using certain parameter with arduino, ultrasound, Lifesycle saving system (LCSS) with this system detecting of heart attack is only possible if the patient is under doctor or expert observation and hence it is not possible for all the cases.

To overcome the above disadvantage this system is developed which will help to provide early detection of heart attacks and eliminates delays in receiving medical treatment.

In this digitized world, various wireless communication standards have allowed the sensor to develop from traditional forms in healthcare which can be used to diagnose diseases either with the presence of patient or without patient.

The IoT allows objects to be sensed and/or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit.

By combining analytics and sensor data, reports are made that describe the early health condition of the patient. Depending on the requirement various types of sensors are being deployed. 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.

Changes in analytical structure and dearth of health and social care forces to study new modernization technique, which could be a help to these obstacles. Elderly people need to make regular visit to the doctor for their health signs test results. Observing on regular basis of essential signs is compulsory as they are main signs of well-being of one's individual health. These vital signs include Pulse rate, Body temperature, Blood pressure, respiratory level.

The goal is to develop a low power, more reliable, nonintrusive, are the essential signs monitor which gather information on the body and send the parameters through wireless technology.

In many developing countries, Human-Healthcare is frequently defined as a major problem. i.e., almost as much as 8% of the population who can has access to 20% of the country's medical resources. This inability to access proper Human Healthcare for rural populations paired with rapidly increasing cardiovascular disease rates poses a serious problem. In this paper, proposing a remote monitoring and sensing parameter of the human body which consists of pulse and temperature. The parameters that are used for sensing and observing will send the data through wireless sensors. Adding a web based observing helps to keep track of the regular health status of a patient. The sensing data will be collected in database continuously and will be used to inform patient to any unseen problem to undergo possible diagnosis.

The emerging wireless sensor technology provides the capability to continuously sense, process and transmit the required signals to a control station. This capability can be used for real-time monitoring of cardiovascular patients, which will reduce the effects of diseases. Wireless sensor nodes are constrained of their available energy and memory. This limitation can be minimized by integrating other wireless network technologies with the current wireless sensor network. Mobile phones are one of the most common devices available with each and every individual in this world. The recent mobile phones have enough available memory, energy, and processing power. So these advantages of mobile phone technology can be utilized to overcome the constraints of wireless sensor network technology for transmission,

processing, and buffering of the sensed data. This work proposes

a wireless sensor network design for real-time monitoring and detection cardiovascular disease.

This proposed system consists of a wearable wireless sensor system, control system, heterogeneous wireless network system, two phase real-time data analysis and visualization system, and the warning system.

In this system, the multiple sensors are used to detect heart attack. An analog to digital converter converts the sensed analog data into corresponding digital data. This digital data is transmitted over a cloud module. The heart of patients suffering from fatal heart failures is monitored continuously. The control system accepts and processes the monitored signal. The processed signal is then fed into alert system as an precaution or detection of heart failure to the patients. This project aims at reduction in number of deaths due to heart attack and heart related diseases. The design uses low cost-effective cloud based monitoring and alert system. The system can be used by normal persons and in hospitals and for patients who are under continuous monitoring. The heart attack detection by monitoring the heart rate, temperature, pressure, stress and ECG condition, helps to inform a person if he is about to have heart attack. The system uses transmitting and receiving parts of which the transmitter is with the patient and the receiver is with doctor or nurse. The system uses smart sensor. When the controller detects heart failure or heart attack, it sends message to cell phone contained with the doctor. This system can be used for providing enhanced healthcare services to the rural areas of the developing countries that are facing shortage of efficient specialized doctors. Thus, the cardiovascular disease causing the death of patient can be reduced immensely by the implementation of this proposed system, in both rural and urban areas.

## II. OBJECTIVES:

The objective is to develop a reliable and convenient system that can monitor an essential parameter and send through wireless automation [1]. Now a days everyone is using mobile phones. Recent mobiles are available with good processor and enough memory space. This benefit of advance technology can be used for transmitting sensed parameter through IoT (Internet of Things) which helps in measuring the multiple parameter of the subject by clipping sensors on one of the fingers

, ones the collected data are relevant to heart attack symptoms then this device gives warning alert to persons applications and immediately sends the data to doctor through GSM using cloud and through GPS signal and allow the medical assistant to reach the patient and provide medical treatment .Hence self-awareness of the patient is possible when this device is worn by the respective person.

### III. LITERATURE REVIEW

The overall literature review contains of work of different author that includes the idea of collecting and transfer some of the common data's, using different processor sensors and modules. which includes ZigBee,OTG microcontroller, service kit (the Keep in Touch) etc. using which data can be wirelessly. The collected data can be transfer through mobile app, website and internet module (Table 2.1).

Matthew et al. [1] have discussed the ECG, the rate of respiratory system, heartbeat and the temperature of the body. These sensors have been connected with a PIC16F887A micro-controller chip. Once data are collected from sensors, data are manually uploaded. This has been created an Android app and a web-based interface.

Soumya et al., 2014 [2] monitor the patient's ECG waves using AT MEGA 16L Microcontroller. The ZigBee module has been used to transfer ECG waves and data sent to the nearest ZigBee connector.

Mohammad et al, 2014 [3] oversees the OTG microcontroller in the world. Android app used to create an ECG monitoring system. The OTG micro-controller is used to connect the USB cable to the mobile phone (or) a wireless device. Once the data collected, that will be sent to the mobile application as ECG wave format.

Dohr.et al, 2010. [4] oversees the level of blood pressure using a health care service kit (the Keep in Touch). Here, the KIT is connected to the JAVA based mobile phone via communication. After KIT will gather the data and will send to the mobile phone. With the webpage will monitor the blood pressure levels of the patient.

Karandep et al. 2012 [5] is proposed to monitor the heart beat using the C8051F020 micro-controller and also the body temperature. This is use to extract the data from sensors and it would be transferred to the controller. This has been connected with the ZigBee wireless device and then transfers' data to the nearest

receiver.

S. Jassay et al, 2015 [6] discussed about the human body temperature using the Raspberry Pi platform for the cloud. In this paper, Raspberry Pi monitors the patient's body temperature and then these data have been transferred via WSN. After that, the data has been added into the cloud.

Mansor et al. 2013. [7] discussed an LM35 sensor, this sensor can monitor body temperature using an Arduino UNO board and it uses a SQL database format. The Arduino UNO board is associated with the sensor for that website. Though, can monitor body temperature.

Nithin.et.al, 2012 [8] is monitors the human body temperature, blood pressure, heartbeat. These sensors were embedded with micro-controller AT Mega 32. And this micro-controller yields a GSM. After, collection of data, diagnosis can be done. If the diagnostic value is lower than normal values, then the device can do an SMS to the doctor.

Rajeev Pyare et.al. 2013[9] were implemented for home appliances based on the Android mobile phone. The Arduino UNO board used to connect light, fan, etc. And also, it can control and monitor domestic appliances anywhere in the world using this Android app. Majdi Bsoul et al. [9] is implemented an "Apnea Med Assist" on an Android phone using support vector classifier (SVC). Which achieves F-measure 90% and 96% sensitivity after applies the efficient optimization in ECG processing.

A home-based mobile cardiac monitoring solution is described in, which incorporates a design of an integrated electrocardiogram (ECG) beat detector, supported by the PDA version of Personal Health Information Management System (PHIMS) and Facilitated Accurate Referral Management System (FARMS) through wireless network. This system is designed to use in a home environment whereas the proposed system is capable to be used for continuous monitoring of the patients at different environments such as home, hospital, work place, and practically anywhere.

A wearable cardiac monitor for continuous and real time monitoring of user's cardiac condition is introduced in. The proposed device is composed of 3 main components: a disposable electrode, a controller, and personal gateway (e.g., cellular phone, PDA, and smart phone, etc.). The ECG signal is recorded according to the surface Laplacian of the body surface

potential. WHAM shows enough feasibility and has advantages as a wearable ambulatory monitoring device in that the hardware is miniaturized enough small to integrate on a small region, thereby no wire leads need. This system is developed to monitor the ECG of the patient if the patient is not mobile. Whereas the proposed system is capable to continuously monitor patients in all states such as mobile or immobile.

Gimenez et al. 2005[10] introduces a new system for Integral community cardiac rehabilitation based on technological platforms for the LCSS's (Lifestyle Change Supporting System). The LCSS is based on a control and decision support system (tablet-PC). The system has the following characteristics: personalized cardiac rehabilitation program, automatic support in establishing and modifying care program, risk factor, monitoring access for the patients, intensive cardiac monitoring with automatic alarms, support self-care programs and continuous information of the therapy results. The system described in is developed for the cardiac rehabilitation purpose, whereas the proposed system is used for continuous monitoring and real-time warning of any cardiac problems for patients at any risk level.

Hoff et al. 2005[11] present a dedicated ultrasound system to monitor cardiac function continuously during and after cardiac surgery. The system uses miniature 10MHz transducers sutured directly to the heart surface. The ultrasound measurements are supported by synchronous ECG and pressure recordings. The system developed in uses a new method for the measurement of ECG. The proposed system uses existing method for measuring of ECG, but brings in innovative data collection and alert dissemination according to risk level each patient. This proposed system provides the capability of the doctor to prescribe medicine, by being anywhere in the world.

Romero et al. 2006[12] describe the evaluation and optimization of a beat detection algorithm that is robust against high levels of noise. An evaluation protocol is defined in order to study four different characteristics of the algorithm: non- rhythmic patterns, different levels of SNR, exact peak detection and different levels of physical activity. The proposed system is used to save human life by disseminating alerts when the cardiac problem arises. This proposed system also provides the capability to locate the patient at risk and provide the necessary health care with minimum delay.

Arduino based heart attack detection using heart rate this

system includes the hardware and software parts. For the hardware part, ECG circuits have been designed in order to interpret data from ECG simulator, which act as a patient. Then, a temperature sensor was developed to measure the temperature of human being. Both systems are controlled by Arduino Nano board, which connected to the Bluetooth module and need some programming works. For the software part As and Arduino IDE software have been used. As with most ECG topics, computer- detectable ST segment elevation has been previously studied. This section will survey existing algorithms which make use of wavelet, rule-based, artificial neural networks, time domain-based methods, use of a predetermined location of the ST segment by a cardiologist, and reference sets from an ST database.

In 2009 X. Li, et al. present ST-T complex automatic analysis using the wavelet transform. Their work focused on locating the fiducial points S, J (the start of the ST segment), and T. The wavelet transform was used at different scales to detect the different fiducial points. Although the ST fiducial points were identified in this work, the ST segments were not classified as normal or elevated.

In 2008 C. Papaloukas, et al.[13] applied a rule-based method to ST segment classification. First, they locate the QRS complex and identify fiducial points based on empirical formulas. Next a rule-based method is applied to classify the ST segments. The rules are based on the value of the ST segment after a predefined time from the R peak and the slope of the segment. The European ST database was used for testing.

In 2010 T. Stamkopoulos, et al.[14] detect ischemia using nonlinear PCA neural networks. The ST segment is classified into two groups: normal and abnormal. Abnormal groups are actually comprised of artifacts, ST elevations, and ST depressions. The radial basis function neural network is used and the algorithm is tested using the European ST database. A classification accuracy of 80% for normal beats and 90% for ischemic beats is reported.

F. Badilini, et al. 2010 [15] detect ischemia from Holter monitor recordings in. Empirical formulas are provided to create a window for locating the ST segment based on heart rate, i.e. the RR interval. Next, the resulting windowed ST segment is classified. D. Fischell, et al. patent a system for the detection of cardiac events in . Their system requires that a physician assess the location of the patient's ST segment with

respect to the QRS complex. Based on this fixed location, an algorithm then monitors the ST segment for changes in elevation. Should a change in elevation occur a warning system is triggered.

In 2010 G. Jeong and K. Yu [16] use reference sets to classify ST segments. A polynomial approximation of

the ST segment is used. First, QRS detection is performed, followed by the polynomial approximation to classify the ST shape. ST type is determined by comparing with the slope of the reference ST type. ST type by comparing The European ST database is used for testing data.

Table 2.1: - Comparison on diverse existing monitoring system

Sr.no	Title Of the Paper	Year	Technology/Work Done
1.	Wireless Medical Information System Network for Patient ECG Monitoring	2006	PIC16F887A micro-controller chip, ECG and application
2.	Short range centralized cardiac health monitoring system based on Zigbee communication	2014	AT MEGA 16L Microcontroller & Zigbee
3.	The internet of things for ambient assisted living	2010	OTG microcontroller
4.	A Zigbee-based wearable physiological parameters monitoring system	2012	JAVA based blood pressure data transmission
5.	A smart system connecting e-health sensors and the cloud	2015	C8051F020 micro-controller using body temperature
6.	Body temperature measurement for remote health monitoring system	2013	Body temperature transferred via WSN
7.	An embedded, GSM based, multiparameter, realtime patient monitoring system and control- An implementation for ICU patients	2012	Transfer of temperature Arduino UNO board
7	Internet of things: ubiquitous home control and monitoring system using android based smart phone	2013	human body temperature, blood pressure, heartbeat. These sensors were embedded with micro-controller AT Mega 32.
8.	A pda based ECG beat detector for home cardiac care	2005	The Arduino UNO
9	A novel, wearable heart activity monitor based on Laplacian potential mapping,	2005	LCSS's (Lifestyle Change Supporting System)
10.	A New System for Integral Community Cardiac Rehabilitation Based on Technological Platforms for the Lifestyle Change Supporting System	2006	ultrasound system to monitor cardiac function continuously during and after cardiac surgery
11.	Cardiac Monitoring Using Transducers Attached Directly to The Heart	2009	exact peak detection and different levels of physical activity. Using Arduino
13.	An intelligent wireless ECG patch for single-lead ECG monitoring	2006	ST segment classification
14.	An intelligent wireless ECG patch for single-lead ECG monitoring	2010	PCA neural networks
15.	A study on detect ischemia from Holter monitor recordings in .Empirical formulas are provided to create a window for locating the ST segment based on heart rate, i.e. the RR interval	2010	Holter monitor recordings, Empirical formulas are provided to create a window for locating the ST segment based on heart rate
16.	A QRS detection using polynomial approximation to classify the ST shape	2010	polynomial approximation of the ST segment is used

#### IV. PROPOSED SYSTEM

##### A. Introduction

The methodology proposes a IoT based continuously monitoring system which helps in detecting the occurrence of heart attack. The Iot based system is combined with machine learning algorithm which uses multiple computational algorithms and detects the chances of occurring heart attack in earlier stages.

With the help of cloud computing platform this system

reduce the response time and allow the person to know that he or she is about to get a heart attack by sending alert message to patient and medical assistant along with patient data who can find the location of the patient with the help of GPS. so, that they can take preventive measures and give medical attention within the first few critical hours, thus greatly improving his or her chances of survival.

The working system consist of stable monitoring

system involve three phases of working, which includes

1. Sensor or Data collecting module,
2. computational module,
3. communication module.

The Data Collecting Module includes sensors which are temperature sensor, heart b eat sensor, pressure sensor, and cardiac poded sensor which senses and collects data and sends to computational module, this

Computational Module possess machine learning algorithm which

undergo some computational process and detect occurrence of heart attack

The Communication Module consist of GSM and GPS which helps on transferring the collected data and transfer to the medical assistant, in case of emergency it sends the alert to patient and doctor and can locate the persons location and give medical treatment.

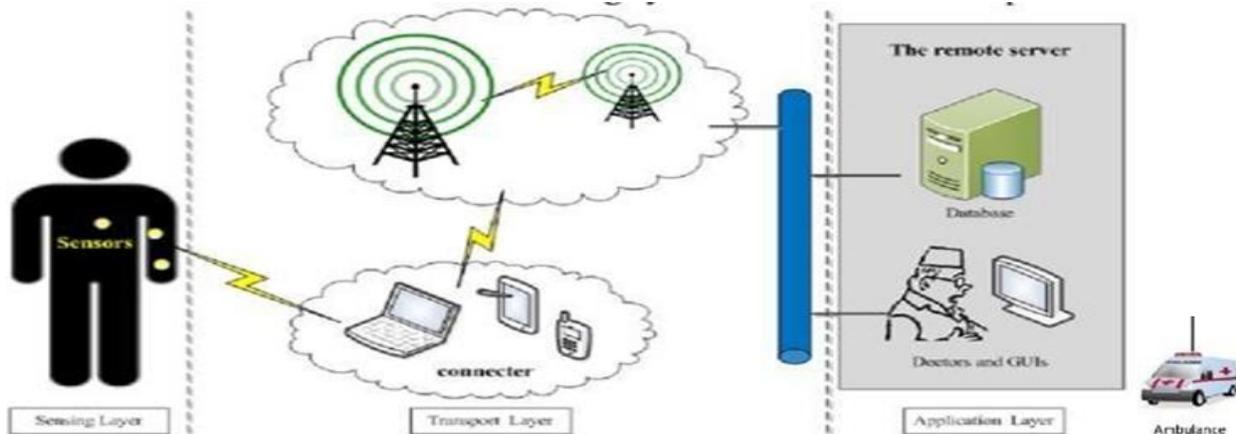


Fig. 3.1.1: System Architecture of the Proposed System

### B. Sensor or data collecting Module

This module consists of sensors. Temperature sensor, heart beat sensor, pressure sensor and cardiac poded sensor are attached to the patient's body for perceiving health data from the patient. In other words, these sensors collect the readings from the patient. The Sensors which are attached to the patient's body are then interfaced to the Raspberry Pi3.

In the sensor module, all the sensors are interfaced to the Pi3. The sensors being

- Temperature sensor
- Heart rate sensor
- Pressure sensor
- Cardiac poded sensor

### C. Temperature Sensor

LM35 is a temperature measuring device having an analog output voltage.

The LM35 device has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. The LM35 device does not require any external calibration

### D. Heart rate sensor

The Heart rate Sensor is a type of optical sensor which

consist of electronic circuit that monitors heartbeat. It essentially combines with amplification and noise cancellation circuitry making it fast and easy to get reliable pulse readings.

### E. Pressure sensor

BMP180 Sensor is an extremely precise low-cost sensor from Bosch for measuring barometric pressure and temperature.

### F. Cardiac poded

Time domain ECG signal processing is performed, which comprises the usual steps of filtering, peak detection, heartbeat waveform segmentation, and amplitude normalization, plus an additional step of time normalization.

### G. Computational Module

The Computation module involves Pi3 processor in which buzzer, GSM (RS232) interface module and GPS are connected. This main module involves in analysing the collected data to determine the condition of the patient on the symptoms of heart attack so that in case of emergency the data and location of person can be send for medical assistance.

1. Raspberry pi3: It is a low cost, credit-card sized computer that plugs into a computer monitor and uses a standard keyboard and mouse.

2. GSM (Global System for Mobile): GSM is a standard developed by the European Telecommunications Standards Institute (ETSI).

3. GPS (The Global Positioning System): They are found in most smartphones, many new automobiles, and they are used to track commerce all over the globe.

H. Communication Module

The communication module consists of following sub-modules. They are: doctor system and patient mobile. The main concern of the communication is patient data and sensor data.

- Patient sensor data
- Date and time
- Location etc.

This system allows authoritative user to communicate i.e, user data should match the data in database. This module sends the alert to person mobile in case of heart attack and helps person by sending alert and person location to doctor

.so, that the medical assistant can give early treatment to save life.

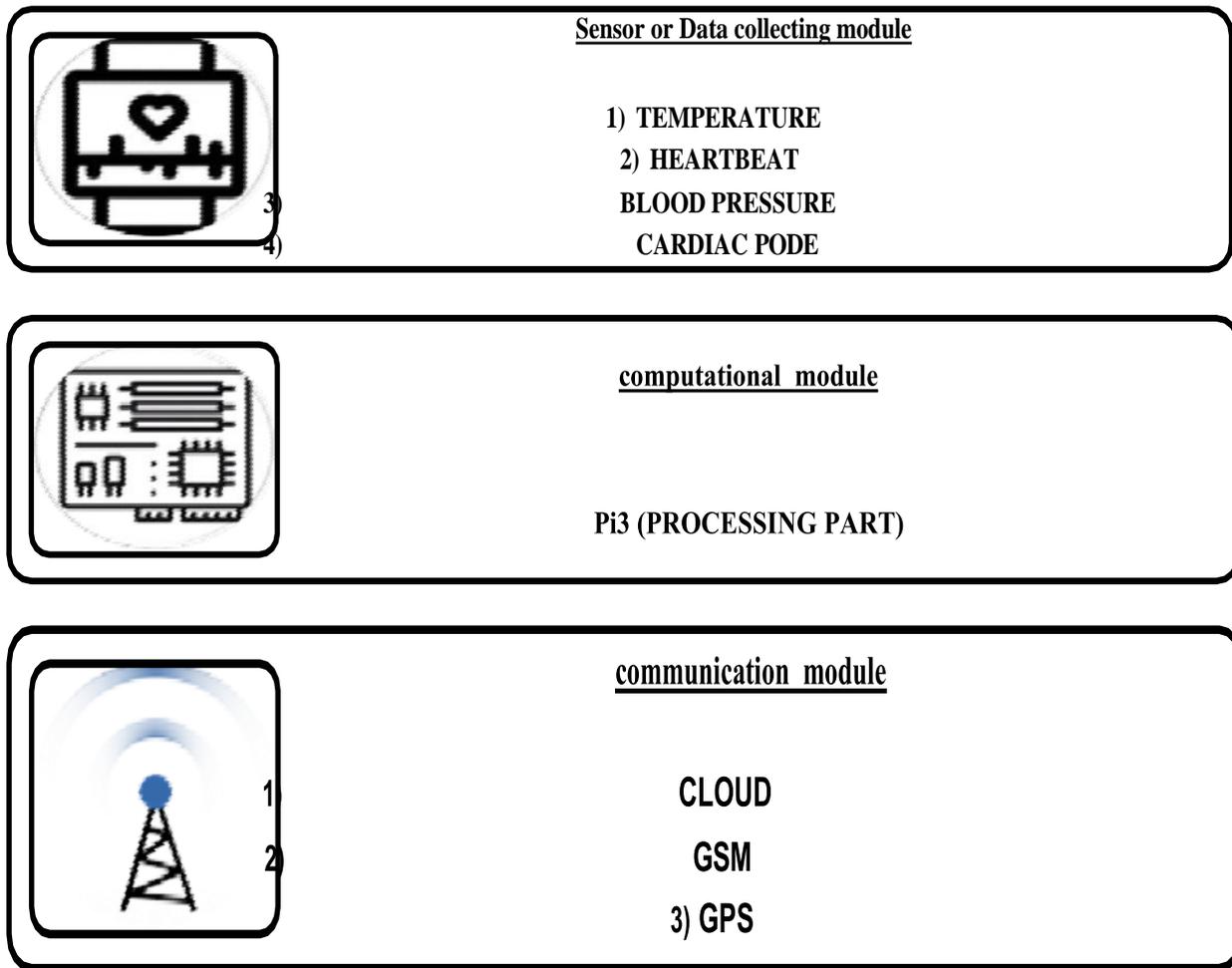


Fig 3.1.2: - Modules used in proposed system

3.1 Initially this device will detect the heart attack when the symptoms which starts in the body , ones the collected data (temperature , heart rate , blood pressure , ECG wave) are relevant to heart attack symptoms then this device gives warning alert to persons applications and immediately sends the data to doctor through GSM

using cloud and through GPS signal and allow the medical assistant to reach the patient and provide medical treatment .Hence self-awareness of the patient is possible when this device is worn by the respective person.

V. BLOCK DIAGRAM

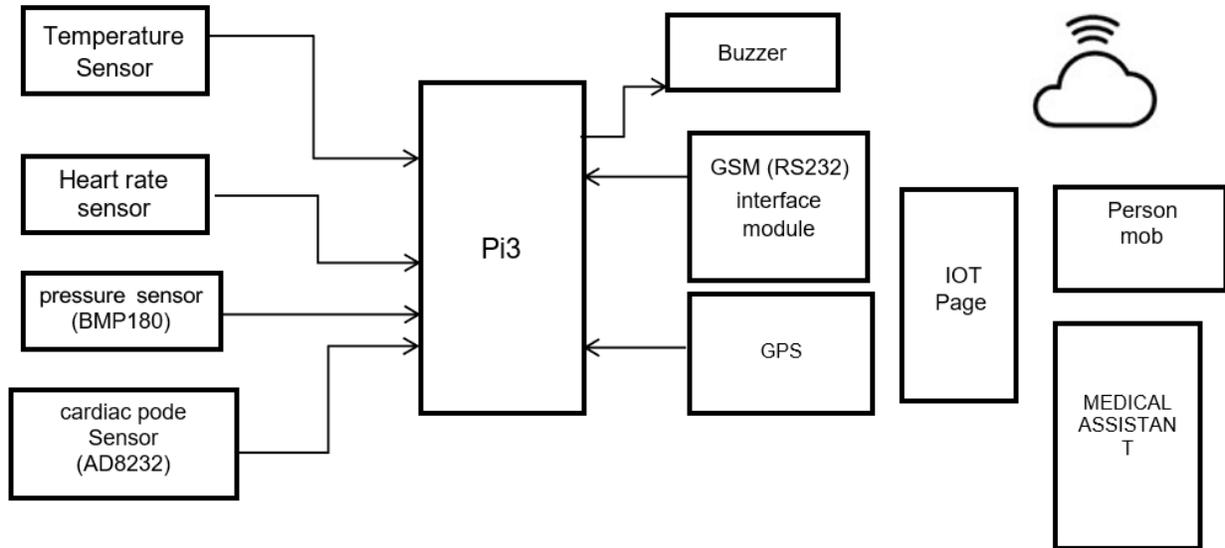


Fig .3.2.1: - Block diagram

1. Temperature Sensor

LM35 sensor is a temperature integrated analog sensor which does not require external calibration to provide typical accuracies.

2.Heart rate sensor

The Heart rate Sensor measures heart rate in beats per minute using LED light source, this LED light passes through the skin and measures the reflected light. It works on the principle of light modulation by blood flow through finger at each pulse.

3. Pressure sensor

The pressure sensor comprises piezo-resistive sensor it computes the fluctuation in blood pressure waveform from the body which is corresponding to arterial pressure waveform.

4. Cardiac pade

Cardiac biomarker is substance released into blood when the heart is damaged or stressed, it is measured to evaluate the heart function. The release of cardiac biomarker can indicate the occurrence myocardial infarction. There are several tests available to detect cardiac enzyme, one of the tests is ECG.

Thus, cardiac pade is a solitary ECG electrode helps in measuring the modulation in ECG wave

5. Raspberry pi3

The Computation module involves Pi3 processor in which buzzer, GSM (RS232) interface module and GPS

are connected. This module plays a vital role in providing accurate information about occurrence of myocardial infarction. So, that in case of emergency the data and location of person can be send for medical assistance.

Raspberry pi3: The Raspberry Pi works like a computer. It enables the software program to run. Her the software will be installed which consist of different algorithm that helps in detecting the occurrence of heart attack accurately.

6. GSM (Global System for Mobile)

GSM (Global System for Mobile):-A GSM is an modem which comprise sim and manipulates in data transmitting service. Here it helps in transfers measured parameter and person condition to person mobile and doctor.

7. GPS (The Global Positioning System)

GPS (The Global Positioning System):- They are found in most smartphones ,and they are used to track commerce all over the globe. Here it helps to detect the location of person in emergency.

8. Process involves

Here temperature sensor, heart rate sensor, pressure sensor, stress sensor and cardiac pade sensor are places in wrist or finger.

The above sensor are collected and sent to pi3, where the data undergo multiple process that is feature selection, classification, computational operation,

prediction, valuation and accuracy testing. Once the prediction is done based on the condition it sends the data to iot page through cloud module and GSM where one can see all the reading and store it. If the the person is having abnormal condition it sends the alert message to mobile and medical assistance. The medical assistance reaches the person through GPS signal and provide medical treatment.

A. Working algorithm:

1. Machine learning

The algorithm plays an imperative role in accomplishing accurate output for collected input. Algorithm assist in computing occurrence of heart attack in advance by undergoing arithmetical computation with respect to

giveninput. Machine learning involves following process  
 a. Preprocessing of dataset  
 b. Feature selection  
 c. Machine learning classifiers  
 d. Cross-validation method  
 e. Classifiers’ performance evaluation method.

2. Preprocessing of dataset

The preprocessing of data is necessary for efficient representation of data and machine learning classifier which should be trained and tested in an effective manner. Based on WHO here, Machine learning –heart attack dataset are preprocessed which involve

- Number of records :300
- Number features used :12(Table :3.3.1 Feature used)

Feature used		
S.no	Feature used	Description
1.	Age	(age in years)
2.	Gender	(1=male ; 0= female)
3.	cp	chest pain type
4.	trestbps	resting blood pressure (in mm Hg on admission to the hospital)
5.	chol	serum cholesterol in mg/dl)
6.	fbs	fasting blood sugar > 120mg/dl)(1= true ; 0= false)
7.	restecg	Resting electrocardiographic results
8.	thalach	maximum heart rate achieved
9.	exang	exercise induced angina (1=yes ; 0= no)
10.	oldpeak	ST depression induced exercise relative rest
11.	slope	the slope of the peak exercise ST segment
12.	ca	number of major vessel (0-3) coloured by fluoroscopy
13.	thal	3= normal; 6=fixed defect; 7= reversible defect
14.	Target	1=0

Table :3.3.1 Feature used

Feature selection

Feature selection is necessary for the machine learning process because sometimes irrelevant features affect the classification performance of the machine learning classifier. Feature selection improves the classification accuracy and reduces the model execution time. For feature selection in our system, three well-known Feature selection algorithms is used and these algorithms select important features.

For feature selection following algorithm are used

- i) Relief Feature Selection Algorithm
- ii) Minimal-Redundancy-Maximal-Relevance Feature Selection Algorithm
- iii) Least Absolute Shrinkage and Selection Operator
- i) Relief Feature Selection Algorithm

Relief is used to extract the feature from the given input from the dataset. Relief- based algorithms (RBAs), a unique family of filter-style feature selection algorithms that have gained appeal by striking an effective balance between these objectives while flexibly adapting to various data characteristics. First, this work broadly examines types of feature selection and defines the context.

ii) Minimal-Redundancy-Maximal-Relevance Feature Selection Algorithm

The mRMR is use to avoid the redundancy and gives relevent data. The mRMR chooses those features that are related to the target label. These selected features might be redundant variables which must be handled. The Heuristic search method is used in mRMR and selects optimum features that have maximum relevance

and minimum redundancy. It checks one feature at a cycle and computes pairwise redundancy. In this algorithm, main computation of mutual information (MI) between two features is computed. This function is calculated between each pair of features instead of many pairs of features; being irrelevant to the last result, mRMR is not suitable for large domain feature selection problems.

iii) Least Absolute Shrinkage and Selection Operator

Least absolute shrinkage and selection operator select features are based on updating the absolute value of features coefficient. Some coefficients values of features become zero, and these zero coefficients' features are eliminated from features subset. The LASSO performs excellently with low coefficients feature values. The features having high values of coefficients will be included in selected feature subsets. In LASSO, some irrelevant features may be selected and include a subset of selected feature

b. Machine learning classifiers

In order to classify the condition of person (normal or abnormal), machine learning classification algorithms are used.

Here, three algorithms are used

i. Support Vector Machine

ii. Naive Bayes

iii. Decision Tree Classifier

K-Nearest Neighbor (it is used only when different data are collected)

i. Support Vector Machine

The SVM is a machine learning classification algorithm which has been mostly used for classification problems. SVM used a maximum margin strategy that transformed into solving a complex quadratic programming problem. Due to the high performance of SVM in classification, various applications widely applied it.

ii. Naive Bayes

The NB is a classification supervised learning algorithm. It is based on conditional probability theorem to determine the class of a new feature vector. The NB uses the training dataset to find out the conditional

probability value of vectors for a given class. After computing the probability conditional value of each vector, the new vectors class is computed based on its conditionality probability. NB is used for text-concerned problem classification

iii. Decision Tree Classifier

A decision tree is a supervised machine learning algorithm. A decision tree shape is just a tree where every node is a leaf node or decision node. The techniques of the decision tree are simple and easily understandable for how to take the decision. A decision tree contained internal and external nodes linked with each other. The internal nodes are the decision-making part that makes a decision and the child node to visit the next nodes. The leaf node on the other hand has no child nodes and is associated with a label.

K-Nearest Neighbor

K-NN is a supervised learning classification algorithm. K-NN algorithm [35] predicts the class label of a new input; K-NN utilizes the similarity(nearest value) of new input to its inputs samples in the training set.

c. Cross-validation method

K-fold cross-validation (CV) method is used for performance evaluation.

i. K-Fold Cross-Validation

In k-fold cross-validation, used for checking outperformance in each step. The process of validation is repeated k times. The classifier performance is computed based on k results.

d. Performance evaluation method.

Here, confusion matrix, it checks whether the predicted value is correct or not. It is  $2 \times 2$  matrix because there are 2 repose classes shown in table 3.1.2 where 1 shows that positive case means diseased, and 0 shows that a negative case means healthy.

Classification accuracy: accuracy shows the overall performance of the classification system as follows:

Classification accuracy = \_\_

Classification error: it is the overall incorrect classification of the classification model which is calculated as follows:

Classification error = \_\_

Confusion matrix			
<i>Predicted value</i>	<i>Actual value</i>	<i>Result</i>	<i>Description</i>
Positive (1) <sup>a</sup>	Positive (1)	True positive (TP)	The system has predicted the person do have heart attack, which is correct and the person have heart attack.

Negative (0) <sup>b</sup>	Negative (0)	True negative (TN)	The system has predicted the person is healthy, which is correct and the person is healthy.
Negative (0)	Positive (1)	False positive (FP) (type error 1)	The system has predicted that the person is healthy which is incorrect but the person do have heart attack
Positive (1)	Negative (0)	False negative (FN) (type error 2)	The system has predicted that the person do have heart attack which is incorrect but the person is healthy.

Table 3.3.2: - Confusion Matrix

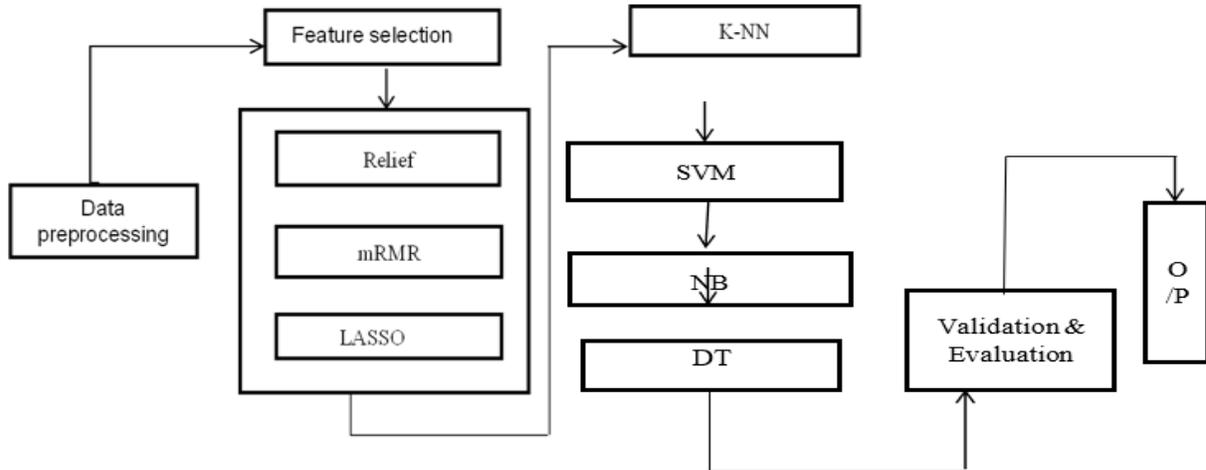


Fig .3.3.3: - Machine learning training process

Working process

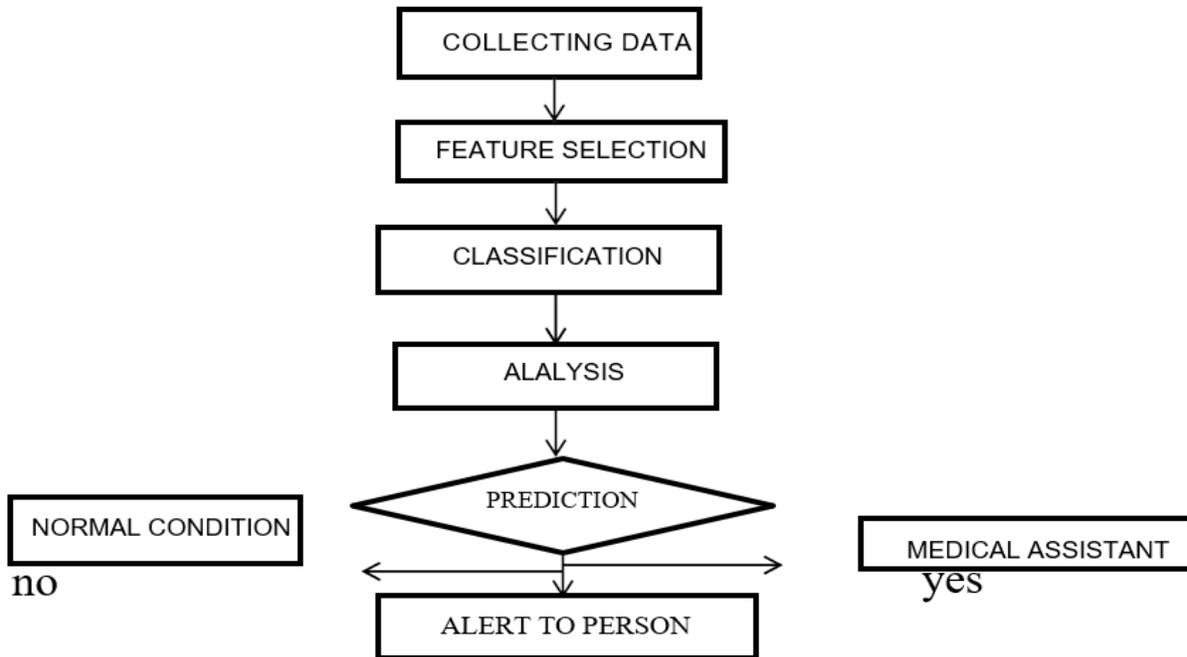


Fig 3.3.4: - working process

The working process involves

- 1) collecting of data from the multiple sensor
- 2) feature selection process
- 3) classification of sensor data
- 4) the analysis involves computation operation through which it decides whether it is normal type or abnormal
- 5) if the prediction is yes means it sends message to



4) Cardiac pod sensor

Cardiac pod sensor, that uses signals collected at the fingers or wrist, through a minimally intrusive 1-lead electrodes without gel as interface with the skin. The collected signal is significantly, motivating the application of feature extraction and signal processing techniques to the problem.

5) Raspberry pi3

Raspberry pi3 is a processor which acts as an CPU which stores the data or programming. The pi had a single –core 700MHZ CPU and just 256MB RAM, and the latest model has a quad-core 1.4GHz CPU with 1GB RAM



Figure 3.5.5: - Raspberry pi3

Here are the various components on the Raspberry Pi board:

- ARM CPU, GPIO, RCA, Audio out, LEDs, USB, HDMI, Power, SD card slot, Ethernet

6) Global System for Mobile Communications (GSM)

GSM is a mobile communication modem; it stands for global system for mobile communication (GSM). GSM is an open and digital cellular technology used for transmitting mobile voice and data services operates at the 850MHz, 900MHz, 1800MHz and 1900MHz frequencybands.



Figure 3.5.6: - GSM

7) Global Positioning System (GPS)

GPS receivers are generally used in smartphones, fleet management system, military etc. for tracking or finding location. GPS is also known as Navigation System with

Time and Ranging (NAVSTAR) GPS.



Figure 3.5.7: - GPS connected with pi3

8) Buzzer:

A buzzer is a device which makes a buzzing or beeping noise. There are several kinds; the most basic is a piezoelectric buzzer, which is just a flat piece of piezoelectric material with two electrodes.

3.3 SOFTWARE REQUIREMENT Arduino IDE

Arduino ide is a 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 Linus. In this project connect an Arduino UNO to a Raspberry Pi and program Arduino IDE in Raspbian. To achieve this, RasPiArduino framework is used. That will allow us to compile the Arduino code into binaries which can run on Raspberry Pi.

It is a special software running on your system that allows you to write sketches (synonym for program in Arduino language) for different boards. The Arduino programming language is based on a very simple hardware programming language called processing, which is similar to the c language.

Php (Hypertext Preprocessor)

PHP (recursive acronym for PHP: Hypertext Preprocessor) is a widely-used open-source general-purpose scripting language that is especially suited for web development and can be embedded into HTML.

It is used to develop Static websites or Dynamic websites or Web applications. PHP stands for Hypertext Pre-processor, that earlier stood for Personal Home Pages. PHP scripts can only be interpreted on a server that has PHP installed.

Here the php is used to design IoT page and transmission of data. As a request- response protocol, HTTP gives users a way to interact with web resources such as HTML files by transmitting hypertext messages between clients and servers. HTTP clients generally use Transmission Control Protocol (TCP) connections to communicate with servers.

## VII. EXPERIMENTAL RESULT AND DISCUSSION

The results are to illustrate that all the modules are operating correctly without any data loss and each sub-module in all modules are performing their function. The Pulse Sensor and Temperature Sensor of sensing module should extract the accurate readings and should be able to send the data to the pi3. The cloud module which is also a part of the sensing module must send the values to the server without any delay and without any data loss. The Server must store all the data sent by the cloud module and display the same on the Web Server. The system is evaluated and investigated its performance. The evaluation is done with extensive experiments. In this section, experiment done and analyzed is explained in two parts which includes how the data is analyzed for each component and analyze the performance of system in predicting the healthy and unhealthy subjects.

### 4.1 Experimental Analyze for Each Component

#### 4.1.1 Heart Rate Sensor

After checking all the pin connections and adding the library to the arduino IDE and uploading the source code, run the code. IOT display will be turned on to display the Human-Human Heart rate reading obtained by the Pulse Sensor. Place your index finger on the front side of the pulse sensor, you should see when you place your finger on the sensor. Place your finger on the sensor lightly till you get a read on the IOT page and the data is already transmitted. You will be able to get the reading IOT page.



Fig 4.1: - heart rate sensor

Working of the Heart rate Sensor The different test cases have been considered for the Human-Heart rate of a patient are

- ❖ When the person is sitting idle
- ❖ When the person is a sleep
- ❖ When the person is running
- ❖ Also, when a person has undergone an abnormal Human-Heartbeat

#### 4.1.2 Temperature Sensor

LM35 is an analog temperature sensor which outputs an analog signal. Pi3 don't accept analog signals as their input directly. Thus, need to convert analog output signal to digital before feeding to a microcontroller's input. For this reason, use an ADC. Modern day boards like Pi3 and most modern-day micro controllers come with inbuilt ADC. Pi3 has an in-built 10-bit ADC (6 channel). Make use of this in-built Pi3 to convert the analog output of LM35 to digital output. Since Pi3 has a 6channel inbuilt ADC, there are 6 analog input pins numbered from A0 to A5. Connect analog out of LM35 to any of these analog input pins of Pi3. After checking all the pin connections and adding the library to the Arduino IDE and uploading the source code, run the code. The LCD screen will display the temperature in Celsius.



Fig 4.2: - Temperature graph with time

#### 4.1.3 Cardiac podes

Cardiac podes is proposed for ecg condition identification, that recurs to a minimally intrusive 1-lead setup for signal acquisition at the fingers. Our apparatus uses this electrode without gel as interface with the skin, further improving its usability. This work relies on time domain processing of the signal. Due to the inherent heartbeat waveform variability, normalization must be performed in order to obtain amplitude and time invariant characteristics applicable for biometric purposes. The typical steps consist of filtering, peak detection, heartbeat waveform segmentation, and

amplitude normalization; our approach further improves on prior work by adding an additional step of time normalization of the features.

4.1.4 Pressure sensor

A total 300 record were recruited in this study years. Among them, eight subjects had hypertension (mean SBP greater than 140 mmHg or mean DBP greater than 90 mmHg over three-time BP collection via oscillometric technique) and 10 subjects had hypotensive (mean SBP less than 90 mmHg or mean DBP less than 60 mmHg over three-time BP collection via the oscillometric technique). None had taken antihypertensive drugs recently before the study was conducted. The ECG signals were acquired in this experiment for calculating the Pressure. The sampling frequency was set to 2500 Hz.. Sensor is based on piezoelectric sensitive elements was pressed on the radial artery of the

left wrist to obtain Pressure signals. The HK-2000B is a medical pulse sensor that integrates pressure-sensitive devices (PVDF piezoelectric membrane), sensitivity temperature compensation components, a temperature sensing element, and signal adjustment circuits, and it has been recognized by some research institutions.

4.2. Performance Evaluation Of A System (Predicting The Healthy And Unhealthy Subject)

4.2.1 Healthy Test Subject

The results shown are for one test subject in the different scenarios. Different parameter had collected form each subject which includes temperature, heart-beat, blood pressure and cardiac condition , using this parameter the results of the prediction algorithm for each sample is shown. Below healthy persons data has been checked using the system

Subject	Gender	Age	Scenario	Parameter collected				System prediction
				Heart beat	Pressure	ECG	temp	
1	Female	25	(i) Sitting (ii) Walking (iii) Climbing Upstairs	(i) 84 (ii) 108 (iii) 135	(i) 122/83 (ii) 134/89 (iii) 133/87	1. normal wave 2. (2%) increase from the normal 3. beats increases to 4%	36.5c	Normal
2	Male	54	(i) Sitting (ii) doing exercise (iii) Low BP	(i) 86 (ii) 112 (iii) 79	(i) 121/85 (ii) 130/88 (iii) 112/75	1. normal wave 2. (6%) increase from the normal 3. normal	37.3c	Normal
3	male	37	(i) Sitting (ii) Running (iii) sleeping	(i) 79 (ii) 115 (iii) 79	(i) 120/82 (ii) 135/89 (iii) 119/81	1. Normal wave 2. (5%) increase from the normal 3. normal	35.5c	Normal
4	female	41	(i) Sitting (ii) cycling (iii) climbing stairs	(i) 80 (ii) 109 (iii) 111	(i) 122/83 (ii) 131/89 (iii) 129/86	1. Normal wave 2. (3%) increase from the normal 3. 3% increase than 4. normal	36.9c	Normal

Table 4.2.2.1: System Prediction On Healthy Subject

The above table shows the results of the healthy persons data result. The system has predicted the healthy person has normal case.

The ECG signal while walking is considered as a normal and, therefore, no warning will trigger. The ECG signal while walking also consider as normal. hence the changes due to walking and exercise can be differentiate from the ECG during heart attack by the system using the prediction algorithms. the table shows increase in ECG level in 4 stages one while walking, exercise, climbing strains and running the system does not consider it as an heart attack it has predicted correctly the person is healthy. Therefore, there was no need to warn the user since it was a false error.

4.2.2 Unhealthy Test Subjects

The heart attack datasets are downloaded from a database online that has records of patients who suffered from sudden cardiac deaths. Already the algorithm as been ran on our 20 healthy test subjects and the results validated that the algorithm works with a high accuracy for the healthy test subjects. Table 4.2.2.2 shows the information of each test of unhealthy subject.

subject	Gender	Age	History	Medication	Underlying Cardiac Rhythm	System prediction
1	Male	43	Unknown	Unknown	Sinus	Abnormal
2	Female	72	Heart Failure	Digoxin; Quinidine gluconate	Sinus	Abnormal
3	Female	30	Unknown	Unknown	Sinus	Abnormal
4	Female	72	Mitral valve replacement	Digoxin	Atrial fibrillation	Abnormal
5	Male	75	Cardiac surgery	Digoxin; Quinidine	Atrial fibrillation	Abnormal
6	Male	34	Unknown	Unknown	Sinus	Abnormal
7	Female	89	Unknown	Unknown	Atrial fibrillation	Abnormal
8	Male	66	Acute myelogenous leukemia	Digoxin; Quinidine	Sinus	Abnormal
9	Female	82	Heart failure	None listed	Sinus	Abnormal
10	Male	68	History of ventricular ectopy	Digoxin; Quinidine Gluconate	Sinus	Abnormal

Table: 4.2.2.2 System Prediction for Unhealthy Subject

Therefore, 10 heart attack datasets from a database online that has temperature, heart rate, pressure and ECG of the patients that suffered from sudden cardiac deaths. The data collected moments before the subject passed away.

The algorithm as been tested with all the subjects shown in Table 4.2.2.2 shown 10 data and the results were accurate as expected. The algorithm’s results have been explained using subject 5 from Table4.2.2.2.

Before showing the prediction algorithm results, explanation of the results from the algorithm to show why the algorithm triggered warnings is given below.

The subject 5 has an atrial fibrillation initially the system will collect the data from the patient and undergo feature extraction , in machine classifier it finds out the probability that whether the person have heart attack or not, k fold Cross-validation method checks whether the performance of the system is correctly following up , Classifiers performance evaluation method checks whether the produced result is correct or there is any error in prediction , if there’s an error it will eliminate the error and gives an accurate result.

- 1) For subject 5 it shows warning level 1 one in classifier
- 2) During in cross validation Warning level 2 occur where the R-R Intervals had very high fluctuations which explain why the heart rate jumped from 71.94 to 131.89 in just one second. → Warning level 2
- 3) During in confuse matrix it shows Warning level 3 , the ST segment voltage values were also fluctuating in an abnormal fashion and produce result that he is abnormal →Warning level 3

4.3 Overall Connection and Output

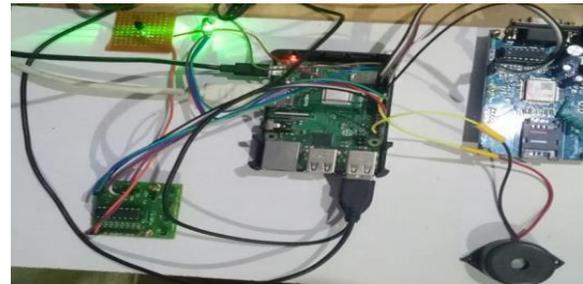


Fig 4.3.1:- Complete Connection

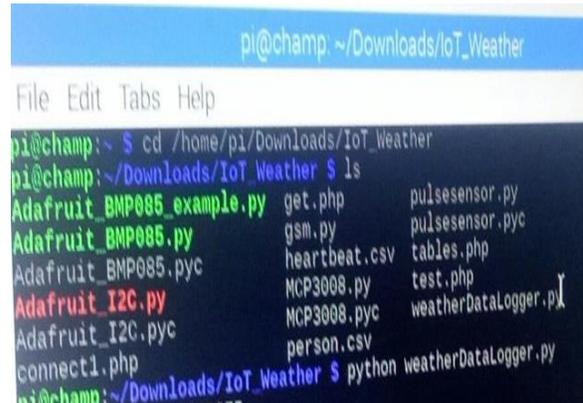


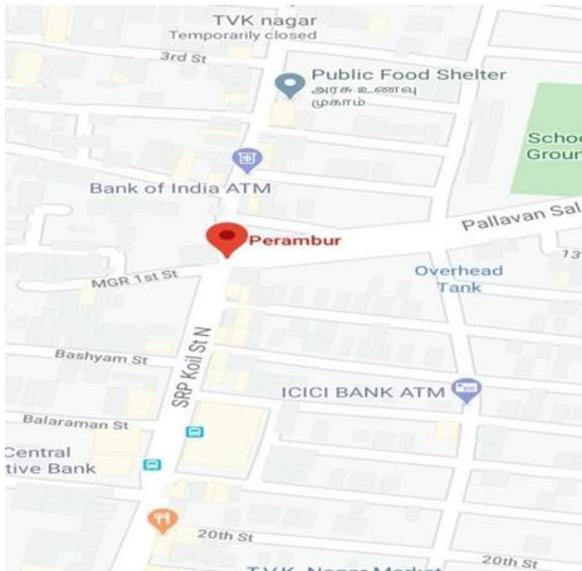
Fig4.3.2: Processing the Sensor Data

S.NO	TEMPERATURE	PRESSURE VALUE	HEARTBEAT VALUE	ECG VALUE	DATE	TIME
1	35.5 C	119/75	80	Normal	2019/11/09	02:00:21
2	37.5 C	150/76	70	Normal	2019/11/09	02:00:19
3	35.8 C	121/80	72	Normal	2019/11/09	02:00:17
4	36.3 C	140/112	51	Abnormal	2019/11/09	02:00:15
5	36.2 C	125/79	56	Normal	2019/11/09	02:00:13
6	35.6 C	180/115	51	Abnormal	2019/11/09	02:00:11
7	36.1 C	122/77	74	Normal	2019/11/09	02:00:09
8	45.3 C	151/100	51	Abnormal	2019/11/09	02:00:07
9	36.2 C	120/79	70	Normal	2019/11/09	02:00:05
10	38.4 C	125/82	75	Normal	2019/11/09	02:00:03
11	36.1 C	121/81	71	Normal	2019/11/09	02:00:01

(a)



(b)



(c) Fig 4.3.3 (a) Doctor's Web Data, (B) Alert Message & (C) Tracked Location Through GPS

### VIII. CONCLUSION

The key objective of developing this project with the help of IOT Open-Source platform is to immediately alert Medical Emergency and the patient's emergency contacts about the health condition of patient.

A prototype application was developed using the continuous monitoring of parameters to detect and predict the heart attack and generate an alert. The alert is

given to mobile when the person exceeds the normal level. This objective is met with measuring the heart rate, body temperature, Blood pressure, stress and ECG condition. It is helpful where continuous monitoring is required under critical condition. In addition, it is very usable device due to its portability which means the patients can carry it with him therefore no need to stay at hospitals.

Along with that, web page application was developed that allows both doctors and patients to interact with each other, records the data received from the device via cloud as well as enable access to these records by the doctor.

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