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E-Health Diagnosis System using IoT and Machine Learning

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Abstract: IOT is the induced structure foundation of openness, transportation and advancement. IOT sharp contraptions can understand the work environments of remote thriving viewing and additionally crisis see structure. It has clear utilization of sharp therapeutic organizations framework. In the human organizations structure the featured techniques and systems that assistance to the masters and investigators and specialists who make stunning contraption which is the up-degree to the present improvement. Undoubtedly, even information mining strategies and ML tally expect a basic work around there. The specialists vivifying their experts work to make programming with the assistance of AI check which can help aces with taking choice concerning both gauge and diagnosing of coronary sickness. The genuine objective of this examination paper is envisioning the coronary disease of a patient using ML estimations and web of web of things.

Keywords: Blood pressure sensor, ESP8266 Wi-Fi module, Health monitoring systems, Heartbeat sensor, Internet of Things(IoT), Machine learning, Smart devices, Temperature sensor.

I. INTRODUCTION

The increasing trend of ageing populations all over the world in recent years [1], [2] has led to complex health issues, including the increase in chronic diseases and rise in hospital and clinical services expenditures [3], [4], [5].

Health monitoring is playing an important role in maintaining health for individuals, in particular for the elderly or people with chronic diseases because it can reduce hospitalization and increase the quality of life [6]. Traditional health mon- itoring models are time-consuming and inconvenient for all involved [7]. These models will be insufficient to meet the need of medical services in our ageing society. There has been a demand for developing efficient healthcare solutions which help to decrease the pressure on hospital systems and healthcare providers, improve the quality of care as well as have a part in reducing healthcare costs by keeping patients out of hospitals for routine care.

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Innovation has dependably been there to rearrange and makes human life a lot simpler. It influenced the different everyday issues; the restorative field is one of them. It profits by the innovation in various ways; presently it is simpler to analyze inside maladies utilizing some advanced gadgets. The therapeutic administrations part is encountering a tremendous change with electronic limits changing how authorities coordinate with their patients. These days, patients have the apparatuses to see their key vitals themselves and help specialists to have prompt access to persistent information in a hurry. In a type of wearable gadgets, for example, Apple watches [1].In any case, we note that these contraptions are all around expensive and it is difficult to find these devices used by destitute people, who are standing up to the best bit of diseases load. Also, by far most of the current restorative gadgets are still need a few examinations once it goes to the idea of the Internet of Things. The possibility of IOT includes the utilization of electronic devices that catch or screen data and are related with a private or open cloud, engaging them to thusly trigger certain events with helpful data, for instance, heartbeat and heartbeat are accumulated by sensors on periphery contraptions; this information are sent to human administrations providers or untouchables by methods for remote media transmission devices.. The information is assessed for potential issues by applying ML calculations and wellbeing suppliers are quickly alarmed if an issue is identified [2].

Rest of the paper is organized as follows, Section I contains the introduction about the proposed technique. Section II contains the Literature review. Section III contains the Problem Statement. Section IV describes Related Work. Section V contains our Proposed Work. Section VI describes the result of our project and Section VIII concludes our work.

II. LITERATURE REVIEW

In Oana Frunza.et.al, "**A Machine Learning Approach For Identifying Disease-Treatment Relations In Short Texts**" It includes programmed extraction of connection between medicinal ideas. A word reference of medicinal terms is utilized for sentence arrangement. The sentences are naturally parsed utilizing semantic parser. In the wake of applying semantic extraction a lot of extraction, change, approval rules are connected to recognize the real semantic connection to be separated however issue is that because of utilized of just a single calculation of Navie Bayes may not get great exactness of yield [3].

In Ms. Shinde Sayali P.1, Ms. Phalle Vaibhavi N. 2, " **A Survey Paper on IoT based Healthcare System**", this paper states how the IOT interrelate to different framework including the savvy human services. The paper incorporates the framework which experiences the shrewd wellbeing malady reconnaissance. Here, the Health care framework has limited confusion and multifaceted nature with the earth of IOT. Every one of the forecasts that they got from the review of the entire therapeutic framework is un-prosperous upkeep and unutilized innovation [4].

In Ahmed Abdulkadir Ibrahim*, Wang Zhuopeng **, "**IOT Patient Health Monitoring Patient**", their venture was to structure a wellbeing checking framework to screen patient's body whenever utilizing the web. The capacity of the body is to quantify some natural parameters of the patient's body. After the sensors will gather and store the information into the IOT cloud stage. The planned framework gives low intricacy, low power use for social insurance observing of patients[5].

Pravin Shinde RVIOT Kharghar Navi Mumbai. Prof.Sanjay Jadhav Saraswati College Of Engineering, Kharghar Navi Mumbai," Health Analysis utilizing Machine Learning", This paper present social insurance conclusion treatment and counteractive action of sickness, ailment, damage in human. The space naturally gets familiar with some undertaking of the Health care data, restorative administration, Patient wellbeing data and so forth. The proposed method can be incorporated with any therapeutic administration framework to settle on better restorative choice and in patient administration framework can naturally mining biomedical data from advanced vaults[6].

Sanjay Kumar Sen Asst. Teacher, Computer Science and Engg. ,"**Foreseeing and Diagnosing of Heart Disease Using Machine Learning Algorithms**" In this paper, they completed an investigation to locate the prescient execution of various classifiers. They chose four mainstream classifiers thinking about their subjective execution for the analysis [7].

III. PROBLEM STATEMENT

The E-Health framework venture gives an administration arranged stage which assembles all information sources applicable for the arrangement of individualized individual E-Health administrations.

IV. RELATED WORK

As indicated by the Literature Survey of over 5 papers, a portion of the papers have highlights with that they likewise have a few issues. Along these lines, in the paper of Ms. Shinde Sayali P.1 , Ms. Phalle Vaibhavi N. 2, " **A Survey Paper on Internet of Things based Healthcare System**", we have seen that they have incorporated the webbed human services framework in their paper which experiences the wellbeing infection observation. They have for the most part utilized IOT gadgets to which serve the component of distributed computing and principle servers at the clinic. The disadvantage of this framework is that

they need a ton of speculation to be made for the brilliant gadget to be introduced in the medical clinic. Another paper of Ahmed Abdulkadir Ibrahim*, Wang Zhuopeng **, "IOT Patient Health Monitoring Patient" , they have actualized this task where they can screen patients remotely and they can verify their lives by giving crisis alert continuously. The downside of their proposed framework is that the association between the modules and the server is frail. Indeed, even this proposed framework is just utilized in the clinic. Another paper of Sanjay Kumar Sen Asst. Teacher, Computer Science and Engg.,"Foreseeing and Diagnosing of Heart Disease Using Machine Learning Algorithms" had completed testing to locate the prescient execution of various classifiers. They chose 4 famous classifiers thinking about their subjective execution for the investigation. They likewise pick one dataset from heart accessible at UCI AI storehouse. The four calculations they have utilized are Naïve based Classifier, SVM, Decision Tree and K-Nearest Neighbor. They have said that the Naïve based calculation is having the best execution. In actuality, the downside is that they have just picked one dataset as opposed to the increasingly accessible dataset for the heart which may demonstrate some distinction in the execution speed.

V. PROPOSED WORK

As we have seen the unpredictability in the present gadgets, we have to conquer those complexities. The present framework is excessively expensive and the client and the specialist need ceaseless information association required. So sparing the specialist and patients' opportunity we have accompanied sending information through ordinary content. We are interfacing three sensors which give four distinct readings of the body to be specific body temperature, circulatory strain and heartbeat. This information are gathered by the NodeMCU. This framework utilizes Machine Learning systems which make the assignment of the client's simple by dealing with the information consistently by examining the information. The beneath chart is the design ofthe framework.

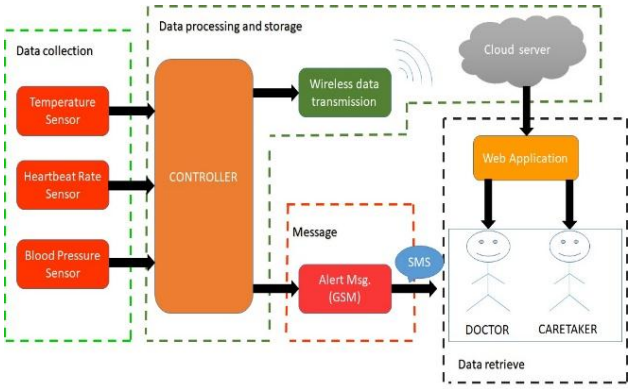

Figure 1: System Architecture

As we have seen the unpredictability in the present gadgets, we have to conquer those complexities. The present framework is excessively exorbitant and the client and the specialist need nonstop information association required. So sparing the specialist and patients' opportunity we have accompanied sending information through ordinary content. We are interfacing three sensors which give four unique readings of the body in particular body temperature, circulatory strain and heart beat. This information are gathered by the NodeMCU. This framework in the contemporary day way of life individuals has no opportunity to go through with their family. In such a bustling life it's hard to keep a disengaged outing of their bustling timetable for the specialist for predictable medicinal registration. There is a need for new-present day thought and innovation which helps in sparing their time. The explanation for this undertaking is to plan a gadget for observing the patient's body whenever utilizing web availability. The capacity of this gadget is to quantify some natural parameter of the patient's body like Temperature, Heartbeat, Blood weight, ECG with the assistance of sensors and these sensors will assume a job to detect the body temperature, heartbeat and pulse of the patient and sends the qualities to framework server through WIFI-Module. All data about the patient wellbeing will be put away on the server; it empowers the specialists to screen the patient's wellbeing, where the specialist can consistently screen the patient's condition on his Smart phone.uses Machine Learning procedures which makes the undertaking of the clients simple by dealing with the information constantly by investigating the information. The underneath outline is the engineering of the framework.

A. *DATA COLLECTION MODULE:*

Main objective of this module is to collect data from human body. We use various sensors for measuring physical parameter like temperature, heart rate & blood pressure. For measuring parameter sensors are made in contact with human body. All the sensors are connected with controller. We use NODEMCU (ESP8266) as controller. Sensors generate appropriate signal to controller. Controller processes this signal and gets values of parameter.

i. Temperature Sensor:

Temperature is most regular estimated physical parameter. LM35 sensor is utilized in this undertaking for estimating body temperature. The yield of LM35 is relative to temperature in Celsius (◦C). LM35 has alluring element to pick it. The scope of temperature estimated by this sensor is - 55◦C to +150 ◦C with exactness ±0.5 ◦C.

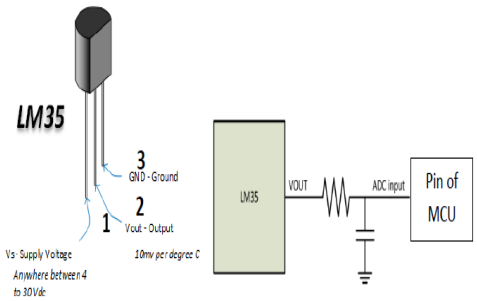

Figure 2:LM35 & it's interfacing with NodeMCU

ii. Blood Pressure and Heart Rate Sensor :

Heartbeat is the heaviness of the blood in the channels as it is guided around the body by the heart. Exactly when your heart throbs, it contracts and pushes blood through the supply courses to the rest of your body. This power makes weight on the supply courses. Heartbeat is recorded as two numbers—the systolic weight (as the heart pounds) over the diastolic weight (as the heart loosens up between throbs). The unit which gauges this is called Sphygmomanometer. If an individual have hypertension, checking circulatory endure home is fundamental for some person. Circulatory strain does not remain a comparable always. It changes to address your body's issues. It is impacted by various components including body position, breathing or eager state, exercise and rest. It is perfect to measure beat when you are free and sitting or resting. issues like heart ambush, stroke or kidney contamination. you need your heartbeat checked reliably in light of the fact that there is no reactions for hypertension. In this project, following picture of blood pressure sensor is used by us.

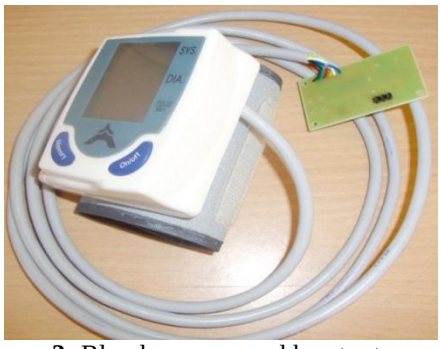

Figure 3: Blood pressure and heart rate sensor

This sensor has features like Intelligent automatic compression and decompression,3 minutes automatic power saving device, Fully Automatic, Clinical Accuracy, High-accuracy, Power by External +5V DC etc.

iii. Node MCU :

NodeMCU is an open source IoT platform.[8][9] It incorporates firmware which keeps running on the ESP8266 Wi-Fi SoC from Espressif Systems, and equipment which depends on the ESP-12 module.[10][11]. The expression "NodeMCU" as a matter of course alludes to the firmware as opposed to the advancement packs. The firmware utilizes the Lua scripting language. It depends on the eLua venture, and based on the Espressif Non-OS SDK for ESP8266. It utilizes many open source ventures, for example, lua-cjson[12] and SPIFFS[13].

Figure 4: Node MCU

B. *DATA PROCESSING AND STORAGE :*

For separating information from gathered information, examination is imperative. Information Mining is utilized for removing educated data from expansive information. E-wellbeing finding framework can help therapeutic experts in foreseeing condition of coronary illness dependent on the clinical information of patients bolstered into the framework and gathered from sensors. There are numerous instruments accessible which are utilized for expectation yet they have a few restrictions. A large portion of them are not ready to manage huge information. AI calculations assume essential job in breaking down and extricating data from gathered information precisely. AI is colossally utilized in conclusion different infection. Among different calculations utilized for ML, choice tree is the most famous because of its straightforwardness and interpretability. These days other exact calculations than choice tree is utilized, for example, SVM, irregular timberland and fake neural systems.

i. Dataset Description:

We have used heart dataset which is available on UCI Machine Learning Repository. Dataset consists of 303 samples and 13 input features as well as 1 output feature. These features describe personal, medical condition etc. whereas the output feature describes class of heart disease state. Output has two class value 1 indicates that heart disease is present and value 0 indicates that patient is normal. A list of feature is given in below table.

Table 1: Feature Table

Feature No.	Feature Name
1	Age
2	Gender
3	Cp

4	Trestbps
5	Chol
6	Fbs
7	Restecg
8	Thalach
9	Exang
10	Oldpeak
11	Slop
12	Ca
13	Thal
14	Num

ii. Algorithms

a. Naïve base classifier:

This classifier is a powerful probabilistic representation, and its use for classification has received considerable attention. This classifier learns from training data the conditional probability of each attribute Ai given the class label C. Classification is then done by applying Bayes rule to compute the probability of C given the particular instances of A1…..An and then predicting the class with the highest posterior probability. The goal of classification is to correctly predict the value of a designated discrete class variable given a vector of predictors or attributes. In particular, the Naive Bayes classifier is a Bayesian network where the class has no parents and each attribute has the class as its sole parent. Although the naïve Bayesian (NB) algorithm is simple, it is very effective in many real world datasets because it can give better predictive accuracy than well known well known methods like C4.5 and BP [14],[15] and is extremely efficient in that it learns in a linear fashion using ensemble mechanisms, such as bagging and boosting, to combine classifier predictions [16] However, when attributes are redundant and not normally distributed, the predictive accuracy is reduced [17].

```
In [4]: runfile('D:/sem 7/Project/Heart-Disease-Predicti
Leaning-master/nev.py', wdir='D:/sem 7/Project/Heart-Dis
Machine-Leaning-master')
Testing  Naïve base classifier  values using Split
confusion_matrix :
[[14  4]
 [ 3 10]]
accuracy_score :  0.7741935483870968
classification_report
              precision    recall  f1-score   support

         0.0       0.82      0.78      0.80        18
         1.0       0.71      0.77      0.74        13

   micro avg       0.77      0.77      0.77        31
   macro avg       0.77      0.77      0.77        31
weighted avg       0.78      0.77      0.78        31
```

Figure 5: Naïve Base Classifier result efficiency

b. Support Vector Machine:

Support vector machines exist in different forms, linear and non-linear. A support vector machine is a supervised classifier. What is usual in this context, two different datasets are involved with SVM, training and a test set. In the ideal situation the classes are linearly separable. In such situation a line can be found, which splits the two classes perfectly. However not only one line splits the dataset perfectly, but a whole bunch of lines do. From these lines the best is selected as the "separating line". The best line is found by maximizing the distance to the nearest points of both classes in the training set. The maximization of this distance can be converted to an equivalent minimization problem, which is easier to solve. The data points on the maximal margin lines are called the support vectors. Most often datasets are not nicely distributed such that the classes can be separated by a line or higher order function. Real datasets contain random errors or noise which creates a less clean dataset. Although it is possible to create a model that perfectly separates the data, it is not desirable, because such models are over-fitting on the training data. Overfitting is caused by incorporating the random errors or noise in the model. Therefore the model is not generic, and makes significantly more errors on other datasets. Creating simpler models keeps the model from over-fitting. The complexity of the model has to be balanced between fitting on the training data and being generic. This can be achieved by allowing models which can make errors. A SVM can make some errors to avoid over-fitting. It tries to minimize the number of errors that will be made. Support vector machines classifiers are applied in many applications. They are very popular in recent research. This popularity is due to the good overall empirical performance. Comparing the naive Bayes and the SVMclassifier, the SVM has been applied the most[18].

```
In [86]: runfile('D:/sem 7/Project/Heart-Disease-Predic
Leaning-master/svm.py', wdir='D:/sem 7/Project/Heart-Di
Machine-Leaning-master')
Testing  Linear SVC values using Split
confusion_matrix :
[[16  1]
 [ 4 10]]
accuracy_score :  0.8387096774193549
classification_report
              precision    recall  f1-score   support

         0.0       0.80      0.94      0.86        17
         1.0       0.91      0.71      0.80        14

   micro avg       0.84      0.84      0.84        31
   macro avg       0.85      0.83      0.83        31
weighted avg       0.85      0.84      0.84        31
```

Figure 6: Support Vector Machine result efficiency

c. Decision Tree:

A decision tree partitions the input space of a dataset into mutually exclusive regions, each of which is assigned a

label, a value or an action to characterize its data points. The decision tree mechanism is transparent and we can follow a tree structure easily to see how the decision is made. A decision tree is a tree structure consisting of internal and external nodes connected by branches. An internal node is a decision making unit that evaluates a decision function to determine which child node to visit next. The external node, on the other hand, has no child nodes and is associated with a label or value that [19][20].

```
In [87]: runfile('D:/sem 7/Project/Heart-Disease-Predicti
Leaning-master/decision tree.py', wdir='D:/sem 7/Project/
Prediction-using-Machine-Leaning-master')
Testing  decision tree values using Split
confusion_matrix :
[[12  5]
 [ 3 11]]
accuracy_score :  0.7419354838709677
classification_report
              precision    recall  f1-score   support

         0.0       0.80      0.71      0.75        17
         1.0       0.69      0.79      0.73        14

   micro avg       0.74      0.74      0.74        31
   macro avg       0.74      0.75      0.74        31
weighted avg       0.75      0.74      0.74        31
```

Figure 7: Decision Tree result efficiency

d. K-Nearest Neighbour:

This classifier is considered as a statistical learning algorithm and it is extremely simple to implement and leaves itself open to a wide variety of variations. In brief, the training portion of nearest-neighbour does little more than store the data points presented to it. When asked to make a prediction about an unknown point, the nearest-neighbour classifier finds the closest training-point to the unknown point and predicts the category of that training point according to some distance metric. The distance metric used in nearest neighbour methods for numerical attributes can be simple Euclidean distance[18].

```
In [95]: runfile('D:/sem 7/Project/Heart-Disease-Predic
Leaning-master/k -neart.py', wdir='D:/sem 7/Project/Hea
using-Machine-Leaning-master')
Testing  KNN values using Split
confusion_matrix :
[[16  1]
 [ 3 11]]
accuracy_score :  0.8709677419354839
classification_report
              precision    recall  f1-score   support

         0.0       0.84      0.94      0.89        17
         1.0       0.92      0.79      0.85        14

   micro avg       0.87      0.87      0.87        31
   macro avg       0.88      0.86      0.87        31
weighted avg       0.88      0.87      0.87        31
```

Figure 8: K-nearest neighbor result efficiency

e. Random forest algorithm:

Random forest algorithm is a supervised classification algorithm. As the name suggest, this algorithm creates the forest with a number of trees. In general, the more trees in the forest the more robust the forest looks like. In the same way in the random forest classifier, the higher the number of trees in the forest gives the high accuracy results. There are three methodologies for Random Forest, for example, Forest-RI(Random Input choice) and Forest-RC (Random blend) and blended of Forest-RI and Forest-RC. The Random Forest procedure has some desirable qualities, for example

- It is not difficult to utilize, basic and effortlessly parallelized.
- It doesn't oblige models or parameters to choose aside from the quantity of indicators to pick at arbitrary at every node.

It runs effectively on extensive databases; it is
runs effectively on extensive databases; it is

Advantages:

1) The same random forest algorithm or the random forest classifier can use for both classification and the regression task.

2) Random forest classifier will handle the missing values.

3) When we have more trees in the forest, random forest classifier won't overfitt the model[14][15].

```
In [98]: runfile('D:/sem 7/Project/Heart-Disease-Predic
Leaning-master/random.py', wdir='D:/sem 7/Project/Heart
using-Machine-Leaning-master')
Testing  random forest values using Split
confusion_matrix :
[[16  1]
 [ 2 12]]
accuracy_score :  0.9032258064516129
classification_report
              precision    recall  f1-score   support

         0.0       0.89      0.94      0.91        17
         1.0       0.92      0.86      0.89        14

   micro avg       0.90      0.90      0.90        31
   macro avg       0.91      0.90      0.90        31
weighted avg       0.90      0.90      0.90        31
```

Figure 9: Random forest algorithm

iii. Performance Comparison

Table 2: Performance table

Algorithm	Correct classification rate	Miss classification rate
Naïve base classifier	67.74193548387096	32.25806451612904

Support Vector Machine	83.8709677419354	16.129032258064598
Decision Tree	74.19354838709677	25.80645161290323
K-Nearest Neighbour	87.09677419354839	12.903225806451616
Random forest	90.32258064516129	9.677419354838705

C. *MESSAGE MODULE*:

Hypertension has no manifestations so it is hard to recognize it. On the off chance that individual's circulatory strain gets High or Low to ordinary BP, he requires some treatment. In this module, in crisis circumstance like patients BP get high\low, heart beat gets excessively high or low and so forth., at that point framework sends ready message to specialist and relatives of patient. Alongside message framework likewise send geographic area of patient. Framework will remind understanding for some day by day action like drug time, practice time, check up time and so forth for communicating something specific in this undertaking GSM A6 module utilized.

i. GSM A6 Module:

The A6 GSM Module is a smaller than usual GSM/GPRS center improvement board dependent on GPRS A6 module. It underpins double band GSM/GPRS organize, accessible for GPRS and SMS message information remote transmission. The board highlights smaller size and low current utilization. With power sparing system, the present utilization is as low as 3mA in rest mode. It speaks with microcontroller by means of UART port, underpins direction including GSM 07.07, GSM 07.05 and Ai-Thinker improved AT commands.

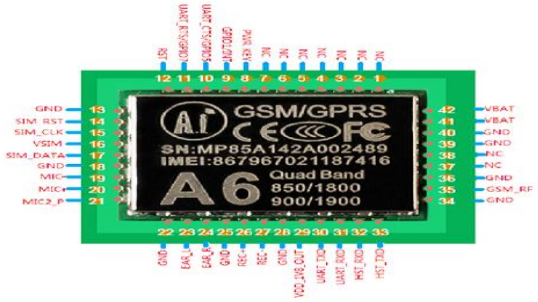

Figure 10: GSM A6 module

D. *DATA RETRIEVE MODULE:*

Data store stored on server are retrieve by doctor and relative of patient through android application. Advantage of this is doctor can monitor patient at any time form anywhere in world. Monitoring patient doctor can make decision about treatment.

VI. RESULT

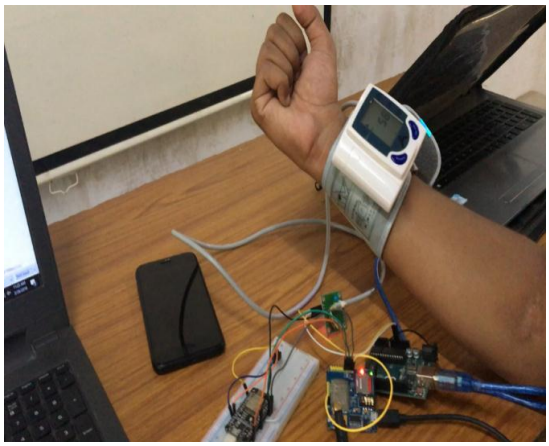

Figure 11: System setup

Figure 12: Measuring pressure

Figure 13: Login page

Figure 14: Doctor Details

Figure 16: Generated Report

Figure 15: Personal details

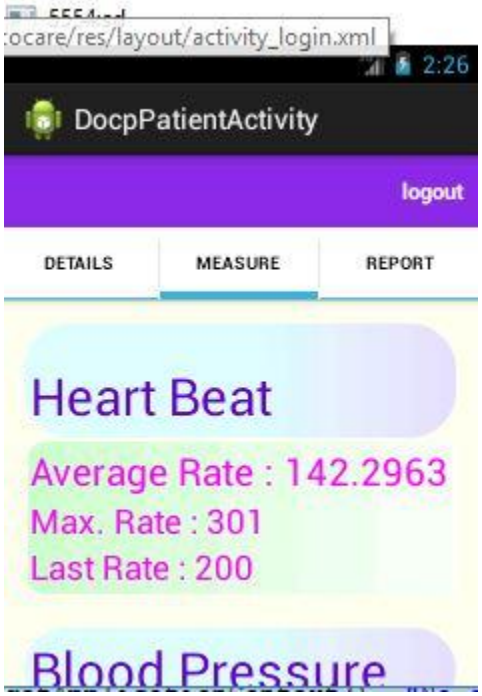

Figure 17: Measured value

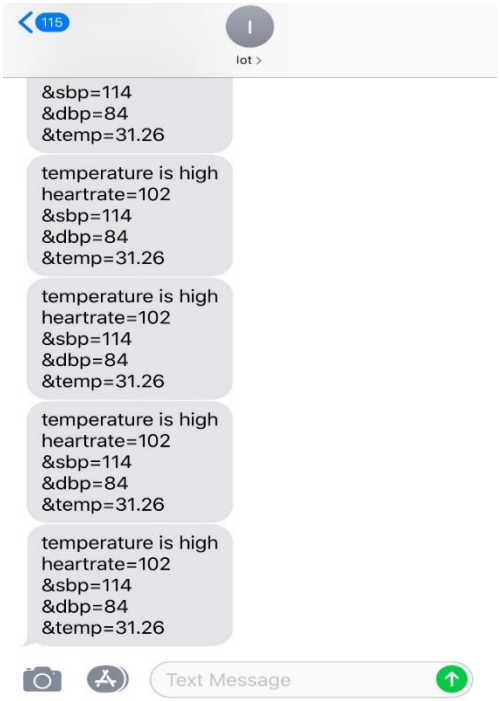

Figure 18: Emergency Alert Message

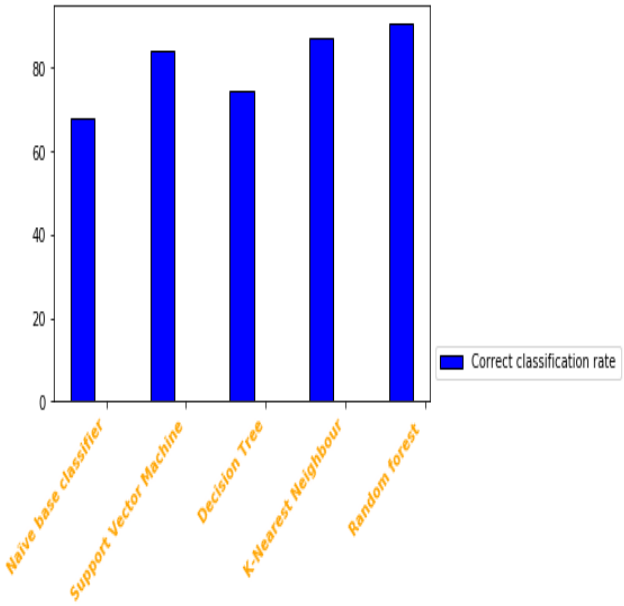

Figure 19: Correct Classification Rate

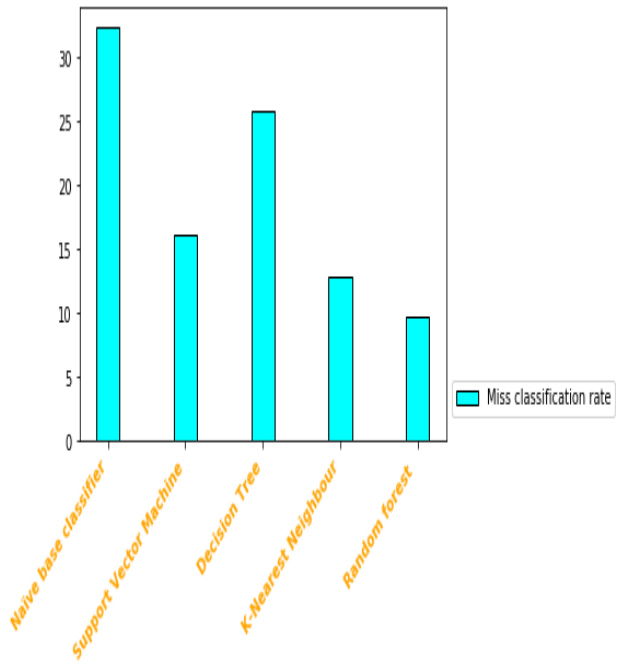

Figure 20: Miss Classification Rate

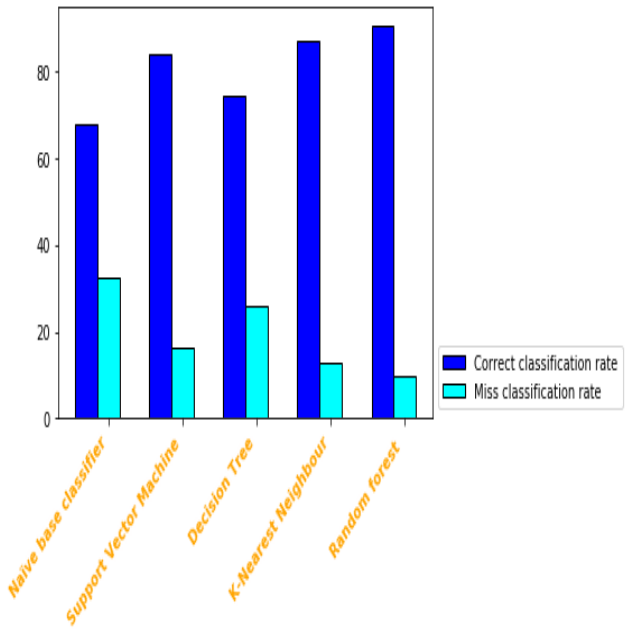

Figure 21: Correct Classification Rate Vs Miss Classification Rate

VII. CONCLUSION

The main objective of the experiment was successfully achieved. All the individual modules like Heartbeat detection module, Temperature module etc. and GSM module gave out the intended results. The designed system modules can further be optimized and produced to a final

single circuit. More important fact that came up during project design is that all the circuit components used in the E-health detection system are available easily. The E-Health Care system utilizes these concepts to come up with a system for better quality of life for people in society. In this paper, we did a trial to locate the prescient execution of various classifiers. We select four well known classifiers thinking about their subjective execution for the investigation. We additionally pick one dataset from heart accessible at UCI AI storehouse. Random forest is the best in execution. It is very well to be reasoned that Random forest classifier is the best when contrasted with Naïve base classifier, Support Vector Machine, Decision Tree and K-Nearest Neighbor,. With the goal that we utilize random forest classifier for foreseeing heart disease.

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