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Smart Hospital for Heart Disease Prediction Using IoT

Avinash Golande[#], Pranav Sorte[#], Vikas Suryawanshi[#], Advait Yermalkar[#], Utkarsha Yermalkar[#], Sandip Satpute[#]

[#] *Department of Computer Engineering, Rajarshi Shahu College of Engineering, Tathawade, Pune*
E-mail: avinash.golande@gmail.com, pranavsorte97@gmail.com, 143advait@gmail.com, vikassuryawanshi8698@gmail.com, utkarshaw234@gmail.com, sandipsatpute7799@gmail.com

***Abstract*— The Internet of Things (IoT) is inter communication of embedded devices using various network technologies. The IoT technology is all set to become the upcoming trend in the future. We are proposing a healthcare monitoring system consisting of ECG Sensors. The parameters which are having a significant amount of importance are sensed by the ECG sensors which are vital for remote monitoring of patient. A mobile app observation is used to continuously monitor the ECG of the patient and various data extraction techniques are performed on the ECG wave to extract attributes to correctly predict heart diseases. .Data mining with its various algorithms reduce the extra efforts and time required to conduct various tests to detect diseases.. Data is collected from ECG sensors. The data is stored onto s storage medium where data mining algorithms are performed on the data collected. These algorithms predict whether the patient has any heart disease. The results can be referred by the doctors for diagnosis purpose. By using IOT technology and data mining algorithms the predication of heart disease is going to do in system.**

***Keywords*— Internet of things (IoT), Data mining, Naive Bayes.**

I. INTRODUCTION

Research, and its potential use for healthcare is an area still in its infancy. Internet of things is used in different types of field which increase the connectivity of various things on a scale that once was unimaginable. Now a days devices are connected to each other by iot ,by which living of human begins become easy. Heart is important part of human body .If heart is not working properly it will lead to many heart disease and also affect other parts of body. Heart disease is one of the most fatal disease, result in 12 million death annually. Impact of heart disease is so abrupt it rarely gives anyone a chance to track a situation .One person dies every 33 seconds due to heart disease in India.

The Internet of Things is explored and its suitability for healthcare is highlighted. Several pioneering works toward developing healthcare IoT systems are discussed. Building on the recurring themes from these works, a generic and standardized model for future end-to-end IoT healthcare systems is proposed. Research in related fields has shown that remote health monitoring is plausible, but perhaps more important are the benefits it could provide in different contexts. Remote health monitoring replaces the need of the patient to utilise the hospital resources and create an own source of resource for monitoring his own health thus reducing the strain on various hospital resources. Essentially, it can improve access to healthcare resources whilst reducing the efforts of healthcare systems, and can give people better control over their own health at all times. In today's modern world heart diseases is the most lethal one.

The heart diseases attack so instantly that there is very less time for a proper diagnosis., so diagnosing patients correctly on a time-to-time basis is the most difficult task for the medical facilities. Most of the fraternities tend to miss out on data which contains a lot of information and thus various diseases are detected after a specific amount of damage is done. This can be greatly reduced if the various health parameters are monitored which is possible with the help of remote monitoring. Remote monitoring include various devices like mobile application,wearable devices, etc.

We are using Internet of things and data mining in project to predicate the heart disease by using sensors such as ECG Sensors i.e AD8232.We are using data extraction techniques to calculate values of attributes such as Amplitude and RR intervals attribute from the ECG wave which is generated from the sensors. Extracting such attributes from the ECG wave we can apply various data mining algorithms and thus predict the result.

II. LITERATURE REVIEW

[1] Abhishek Taneja, used Cleveland Heart Disease database by using 15 and 8 attribute in it .In which 8 experiment done (4 with 8 attribute and 4 with 15 attribute) compared the precision, accuracy ,speed in each case. The

algorithm used are Naïve Bayes, Decision Tree,J48. From that it found that J48 better than ANN, Naïve bayes.

[2] Kumari Deepika, Dr. S. Seema, in "Predictive Analytics to Prevent and Control Chronic Diseases" they do heart Disease and Diabetes prediction using 4 algorithms and its Comparison .the algorithm they used are SVM,ANN, Naïve Bayes, Decision Tree for predicating the heart Disease and Diabetes. The future scope is Hybrid System Can be developed with higher accuracy with More data for there project.

[3] U. Rajendra Acharya , Vidya K. Sudarshan , Dhanjoo N. Ghista , Wei Jie Eugene Lim , Filippo Molinari ,Meena Sankaranarayanan ,they work on detecting carrying out HRV spectral analysis, made automated DM detection system, by using DWT features. Decision Tree (DT), K-NearestNeighbor (KNN), Naïve Bayes (NBC) and Support Vector Machine (SVM) thi algorithms are get used in it.

[4] Richa Sharma,Dr. Shailendra Narayan Singh,Dr. Sujata Khatri, "Medical Data Mining UsingDifferent Classification and ClusteringTechniques: A Critical Survey" .in which they used Naïve Bayes,wilcoxson ranksum test,Support Vector Machine (SVM) algorithms for summarizes various approaches, algorithms, Various datamining tools for heart disease prediction.

[5] Meenal Saini, Niyati Baliyan, Vineeta Bassi, survey on previous models and proposal of a new model is done in it by using Support Vector Machine,Linear Model,XGBLinear,GAM, Bagging with LM,Bagging with SVM,HCWV.

III. PROPOSED SYSTEM

In proposed system we going to first take data from patient about respective attribute and collect it in database. The working of system is divided into following modules

- Module 1: Data Collection.
- Module 2: Data Prediction.
- Module 3: User Interface Module

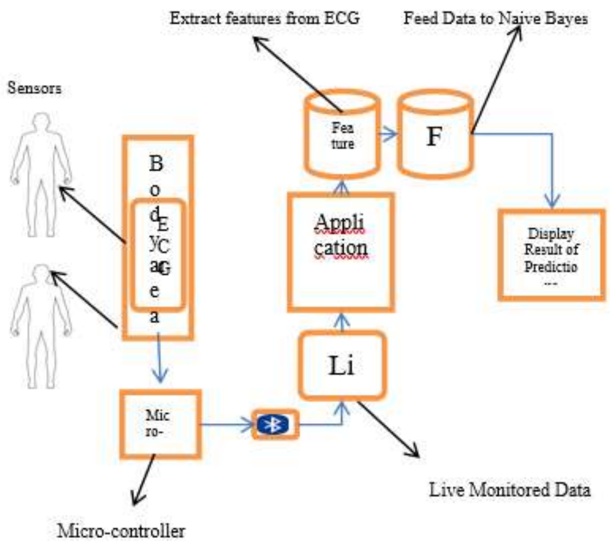

Fig 1.Block Diagram of Proposed System

Module 1 represents Data Collection in which the input is Analog data from various sensors .In this way data is get collected and output of this module is Converted data stored in database. Analog data from sensors will be converted to digital data. The digital data will be sampled as well as grouped together. This data will be sent through wireless transmission to the mobile application.

In Module 2 which is Data prediction, in this module various features of data is extracted and stored into a table which is later onto fed into one of the various data mining algorithms and predictions are done.

Module 3 is User Interface Module for which Input is_Data from sensors and Output is Displaying result and analysis of data. The sensors will send data to the mobile application i.e user interface module. The user can then monitor the ECG data which is sent on the mobile application. In case of emergencies he can consult a doctor by observing the data on the monitoring application.

Objectives of the proposed system are as follows:

- Make better decision.
- Instant Information.
- Enhance operational efficiencies.
- Improving the quality of healthcare and patient experience.

A. DETAILS OF THE SYSTEM

Sensors are used to collect various analog signal from the body. These signals are converted from analog to digital using a micro controller. These digital signal are plooted using serial plotter and then sent to mobile application using any any one of transmission medium.

In this project we are collecting ECG Data from AD8232 sensors. This data is very vital in order to achieve the task of monitoring and prediction.Continuous data is required in order to monitor the health of a patient.This data is made available using AD8232 Sensors and ESP32 (Low Energy Bluetooth). The Analog data is collected by the sensors and the conversion of Analog to Digital is done by ESP32 board microcontroller.The data collected from the sensors is displayed onto a mobile application which achieves the task of ECG Health Monitoring.

"ABNORMALITY DETECTION IN PATIENT'S CONDITION " in ECG cannot directly be used to detect any kinds of abnormalities in a patient. In order to detect abnormalities it necessary to extract features from ECG.Following is a sample of ECG:

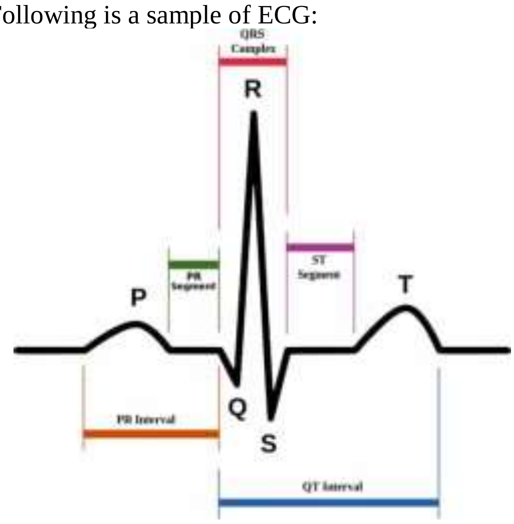

Fig 2. ECG Wave [27]

- The diseases which are caused by ECG are all due to the variation in the above features i.e P-Wave, R-Wave, Q-Wave, S-Wave, T-wave, QRS Complex, PR interval, ST Segment.
- In order to classify the disease it is necessary to extract features from the ECG Wave. The feature extraction is carried out using MATLAB (2018 Edition) using the Wavelet Transform Algorithm..
- The features which are extracted are stored in a file onto which Naive Bayes algorithm is performed.
- The Naive Bayes Algorithm is applied using WEKA tool, which is a data mining toolkit. Following are the types of heart diseases which are predicted:
  1. Bradycardia
  2. Tachycardia
  3. Ventricular Tachycardia
  4. Normal.

B. WORKING OF THE SYSTEM

The **User Interface** is made available in the form of Android Application. The Android Application is developed using Android Studio.

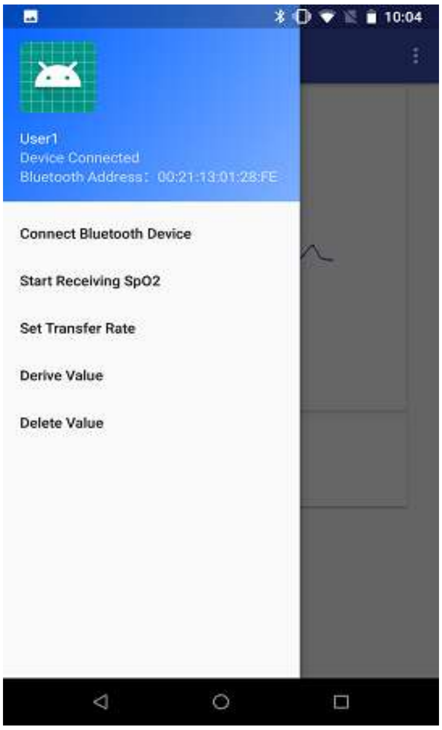

Fig 3. App interface 1

1) ECG Window:
   It shows the ECG of the person on whom the sensor is connected. It is displayed in waveform.
2) Heart rate:
   Shows the current heart rate of the person which is calculated from the ECG which is received.
3) Menu Slider:
   Connect Bluetooth Device - Used for connecting bluetooth device.
   Set Transfer Rate- Used for Setting transfer rate.
   Delete Value - Used for deleting a specific value.
4) RR Intervals -
   It shows the RR interval values between waves.

Minimum Requirements for installing and running the app:-
1. Android 5.0 and above.
2. Working Bluetooth

Fig 4. App interface 2

The ECG which comes from the sensors is continuosly monitored over the app, by using the app the user can get information about his heart rate which is derived from the ECG and displayed onto the app.

For the purpose of data mining the database from MIT-BIH Database repository is used, as it was not permitted to collect data from patients. MIT-BIH database is a validated database which is taken from various patients having heart abnormalities. The wavesforms from these databases is used for data extraction using MATLAB.

In MATLAB wavelet transform method is applied and various features of ECG such as Amplitude and the RR Intervals are extracted. Following are the screenshot and well as the table which is created after Data extraction.

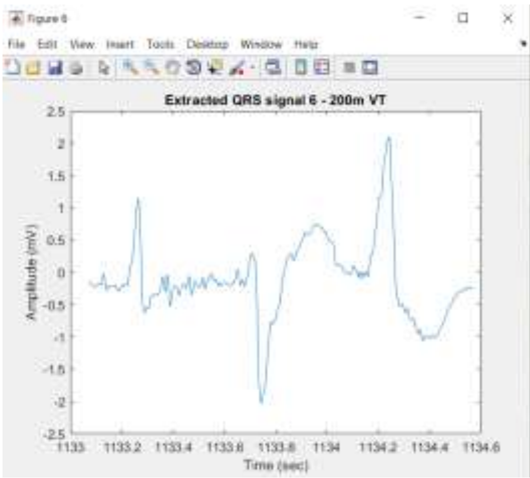

Fig 5. Feature extraction

```
@RELATION all-samples-4types

@ATTRIBUTE Amplitude REAL
@ATTRIBUTE RR REAL
@ATTRIBUTE class {(B,(N,(T,(VT}

@DATA
0.918632070124893,0.872222222292,(N
1.07035887569268,0.87500000007,(N
1.00747534543356,0.89166666738,(N
1.0243641868242,0.93333333408,(N
0.909587583542613,0.952777777854,(N
0.949826718415752,0.90277777785,(N
1.24939988970851,0.86944444514,(N
1.19657840758653,0.86666666736,(N
1.1192327535161,0.861111111179999,(N
1.04881136447269,0.916666666740001,(N
1.07584428459489,0.913888888961999,(N
1.07143904984079,0.916666666740001,(N
1.09186295002777,0.897222222293999,(N
1.03271833363252,0.90555555628,(N
0.812792145610561,0.886111111182,(N
1.13683711767277,0.86666666736,(N
1.00687285940562,0.911111111183999,(N
0.833548427089425,0.916666666740001,(N
1.03527198821382,0.900000000071998,(N
1.08298889256631,0.84722222229,(N
1.05921124279576,0.84166666734,(N
0.947378830938987,0.866666666730002,(N
0.834818048514632,0.88888888890,(N
0.845465165377381,0.897222222293998,(N
0.766285735071449,0.888888888896,(N
1.00011864721861,0.858333333402001,(N
1.12927653342567,0.852777777840001,(N
0.961422931552871,0.84444444512,(N
1.08134512633165,0.819444444509998,(N
1.11761415481646,0.855555555624001,(N
1.12895211190061,0.902777777850002,(N
0.925262732506505,0.911111111183999,(N
1.00439512968146,0.855555555624001,(N
```

Fig 6. Data Table

The above table is the data which is extracted from the ECG which include the Amplitude and the RR Intervals. Naive Bayes Algorithm is applied to this using the WEKA Tool. WEKA tool is an automated tool used for data mining purpose. It has many libraries which include Classification Algorithm,Clustering Algorithms, Association Rule Algorithms. We are applying Naive Bayes on te above table and we get the output as follows:

```
=== Run information ===

Scheme:       weka.classifiers.bayes.NaiveBayes
Relation:     all-samples-4types
Instances:    1410
Attributes:   3
              Amplitude
              RR
              class
Test mode:    evaluate on training data

=== Classifier model (full training set) ===

Naive Bayes Classifier

                 Class
Attribute          (B       (N       (T      (VT
               (0.04)   (0.89)   (0.04)   (0.03)
===============================================
Amplitude
  mean         1.2408   1.2565   1.2592    1.132
  std. dev.     0.343   0.2227    0.252   0.4174
  weight sum       55     1263       51       41
  precision    0.0013   0.0013   0.0013   0.0013

RR
  mean         1.8167   0.9347   1.6636   0.7296
  std. dev.    0.1445   0.0699    0.442   0.2686
  weight sum       55     1263       51       41
  precision    0.0052   0.0052   0.0052   0.0052
```

Fig 7. Result-1

```
Time taken to build model: 0 seconds

=== Evaluation on training set ===

Time taken to test model on training data: 0.02 seconds

=== Summary ===

Correctly Classified Instances        1350               95.7447 %
Incorrectly Classified Instances        60                4.2553 %
Kappa statistic                          0.7792
Mean absolute error                      0.0315
Root mean squared error                  0.1298
Relative absolute error                 32.2348 %
Root relative squared error             58.5458 %
Total Number of Instances             1410

=== Detailed Accuracy By Class ===

                TP Rate  FP Rate  Precision  Recall  F-Measure  MCC    ROC Area  PRC Area  Class
                0.891    0.013    0.731      0.891   0.803      0.799  0.994     0.832     (B
                0.987    0.122    0.986      0.987   0.987      0.878  0.987     0.998     (N
                0.529    0.008    0.711      0.529   0.607      0.601  0.986     0.725     (T
                0.659    0.009    0.675      0.659   0.667      0.657  0.957     0.559     (VT
Weighted Avg.   0.957    0.111    0.957      0.957   0.956      0.851  0.987     0.969

=== Confusion Matrix ===

   a    b    c    d   <-- classified as
  49    0    6    0 |    a = (B
   0 1247    4   12 |    b = (N
  17    6   27    1 |    c = (T
   1   12    1   27 |    d = (VT
```

Fig 8. Result-2

Algorithm Used:

Naive Bayes Algorithm-

Naive Bayes is a classification algorithm based on Bayes Theorem and the Maximum A Posteriori (MAP) hypothesis. It is useful for large data sets. It is also called as Idiot Bayes and Simple Bayes. Naive Bayes makes an assumption that the effect of an attribute value onn a given class in independent of the values of the other attributes. This assumption is known as class conditional independence.

Bayes' Theorem

Consider X={x1,x2,x3,…..xn} as a sample, whose components represent the values made on a set of attribute. In Bayes Theorem X is considered eveidence. Let H be a hypothesis such that the data X belongs to class C.

In classification, the goal is to determine P(H|X), the probability that the hypothesis H holds given the evidence.

In other words the probability that sample X belongs to class C.

P(H|X) is called as a Posteriori probability of H conditioned on X and is given a:

$P(H|X)=P(X|H).P(H)/P(X)$

Where,

P(H) is the priori Probability which is independent of X.

P(X) is the priori probability of X.

P(X|H) is the posteriori probability of X conditioned on H.

Confusion Matrix:\

TABLE 1
CONFUSION MATRIX

a	b	C	d	<-- classified as
49	0	6	0	a <= B
0	1247	4	27	b <= N
17	6	26	2	c <= T
1	12	1	27	d <= VT

B= Bradycardia
N= Normal
T= Tachycardia
VT= Ventricular Tachycardia

Accuracy - It is the ratio of number of correctpredictions to the total number of input samples. The following is the formula for accuracy
Accuracy = (TP+TN)/(TP+TN+FN+FP)
The Accuracy of the above matrix is 95.6738%.
Precision - It is the number of correct positive results divided by the number of positive results predicted by the classifier.
The precision for each classifies class is 0.731,0.986,0.703,0.659,0.956.
Real Time processing:- The real time processing which is shown in the app satisfies the requirement of continuous monitoring of a patient.

Ease of use:- The monitoring takes place in an Android application as applications on phone are more handy and easily understood by user. Application has a minimum requirements of a simple Smart phone, it does not require complicated hardware or any does not involve any kind of complexities in order to use the application.

IV. CONCLUSION

We studied various sensors and studied about app development and thus implemented a small system which accomplishes the task of ECG monitoring over an application and also performed a data mining algorithm to predict heart anomalies .The application can be well suited for patients who do not have time to consult the doctors and require quick monitoring.We are working towards the compactness of whole module so that it can be made into a wearable device.

A wearable device can be made for remote monitoring of the patient using more compact sensors.

More sensors can be used such as pulse rate sensor, temperature sensor, SP02 oxygen sensors and Blood pressure sensor in order to give more accuracy to the predicted data and also increase the scope of the system.

Heart disease will be detected without any occurrence of symptoms and hassle-free.

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