Early-Prediction of Atrial fibrillation and Congestive Heart Failure

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ABSTRACT

(AF) is a heart condition that causes an irregular and often abnormally fast heart rate it can be considerably higher than 100 beats a minute.

Sometimes AF does not cause any symptoms and a person who has it is completely unaware that their heart rate is irregular.

(CHF) is a chronic progressive condition that affects the pumping power of heart muscle.

It specifically refers to the stage in which fluid builds up within the heart and causes it to pump inefficiently.

By using ML models, we could predict early stages of both AF & CHF with accuracy 99.67% & 98.87% .

We tested the model by using our hardware device that we built to capture real time ECG signals from AF & CHF patients.

The device will be existed and available in hospital and sports fields.

Then the results will be displayed in our Mobile Application where the models are deployed on to analyze the ECG signals.

OBJECTIVES

The importance of early detection of cardiovascular disease is what makes the difference between life and death, by being aware of the early signs of heart disease such as atrial fibrillation and congestive heart failure.

With the help of our project, we aim to early detection of these diseases in order to help both the doctor and the patient, and thus you will have a better chance of treatment, improving the condition and avoiding serious complications, resulting in a reduction in the number of deaths resulting from these cardiovascular diseases (AF) & (CHF).

Project Scope:

With the help of our project, we aim to early detection of these diseases in order to help both the doctor and the patient (in Hospital Reception & Emergency Room and Sports Field), and thus you will have a better chance of treatment, improving the condition and avoiding serious complications, resulting in a reduction in the number of deaths resulting from these diseases and emergency rooms in hospitals that can be followed up quickly for operations if necessary.

As well as Sports Field, then direct transfer to the hospital for treatment. (Figure 1)

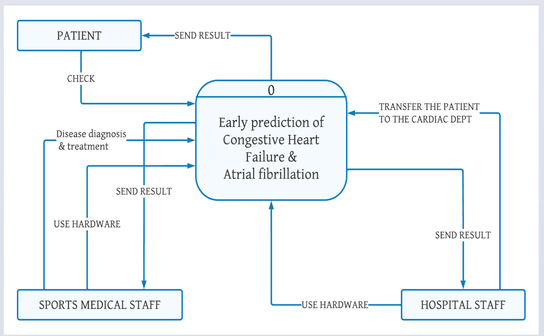

Figure 1 : Context Diagram

The following figure is use case diagram that shows the entities that interact with our project . (Figure 2)

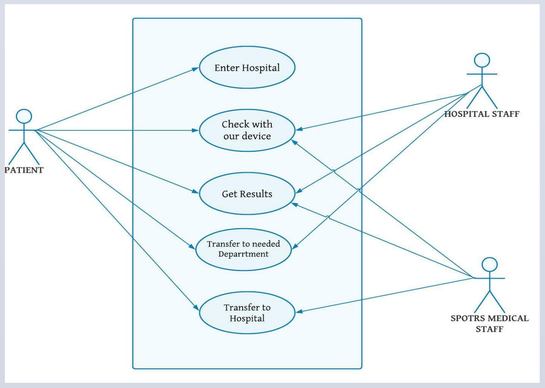

Figure 2 : Use Case Diagram

The following figure DFD that shows a flow of data through the system. (Figure 3)

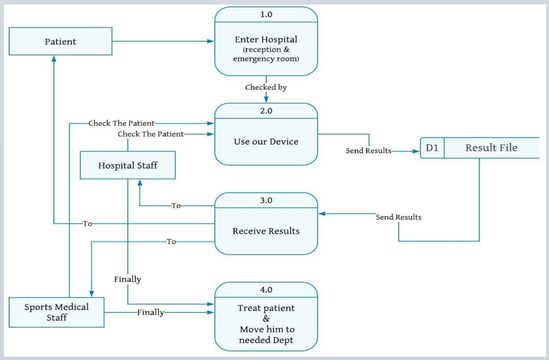

Figure 3 : DFD Diagram

MATERIALS & METHODS

- DATA SET
  - The ECG signals used in this study were from public databases (PhysioBank & PhysioNet) is shown in Table 1

Table 1 : Datasets Used in Machine learning models

Data Set	Disease
MIT-BIH Atrial Fibrillation Database	AF
Predicting Paroxysmal Atrial Fibrillation/Flutter: The PhysioNet/Computing in Cardiology Challenge 2001	AF
MIT-BIH Arrhythmia Database	Normal
BIDMC Congestive Heart Failure Database	CHF
PTB Diagnostic ECG Database	CHF

- METHODOLOGY
  - CHF –Machine learning:

    Reading the data set first, then using some feature extractions to extract labels based on time and sample frequency.

    Then, using machine learning, classify data using various algorithms and compare them to choose the best one. DT resulted 95.38% accuracy, KNN resulted in 96.33% accuracy, ANN resulted in 98.21% accuracy, SVM resulted in 98.29 % accuracy, and RF resulted in 98.87 % accuracy.

  - AF-machine learning:

    Initially, we used three different data sets:

    one for atrial fibrillation, one for atrial flatter, and one for a normal rhythm. We read the data, then apply some feature extraction to extract labels and save them in a csv file. We then classify the input into two labels, (A) for atrial and (O) for ordinary and do some preprocessing to remove num values.

    Split data into training and validation groups, then used machine learning's K-fold algorithm to test the data, resulting 99.31% accuracy

RESULTS

- In CHF Machine learning model, we used different algorithms to determine the best algorithm
  - The RF algorithm was the best by accuracy 98.87%.

  The other algorithms accuracy is shown in Table 2 & Figure 4

Table 2 : Accuracy of machine learning algorithms Used to predict CHF

Algorithm	Accuracy
Decision Tree (DT)	95.38%
K-Nearest Neighbor (KNN)	96.33%
Artificial Neural Network (ANN)	98.21%
Support Vector Machine (SVM)	98.29%
Random Forest (RF)	98.87%

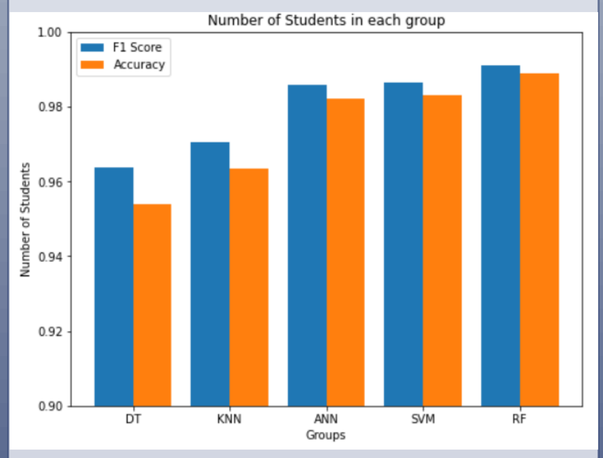

Figure 4 : Accuracy of machine learning algorithms Used to predict CHF

- AF Machine learning model used **K-fold** and showing accuracy in Table 3.

Table 3: Accuracy of machine learning algorithms Used to predict CHF

Algorithm	Accuracy
K-Fold	99.67%

HARDWARE & APPLICATION

- HARDWARE

  We built a device that take Real time signals form patients by using AD-8232 sensor & Electrodes

  And ESP-8266 Wi-Fi mcunode that sends Signals to Application

  We use PCP to keep it safe & reduce the disadvantages of using wires

  The Whole size of the device is about 5 x 6 cm so our users can move and carry it easily (Figure 5 & 6)

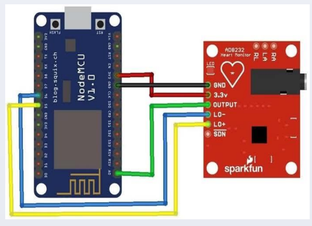

Figure 5 : Circuit Diagram

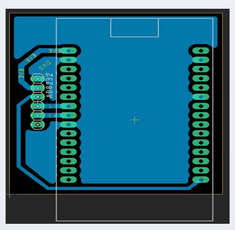

Figure 6 : PCP Design

- APPLICATION

  The goal of the mobile application was to make it simple to use and to present the analysis findings & results of the patients' heart signals.

  There are two prediction machine learning models are deployed on the Application one for Atrial fibrillation prediction and the other one is for congestive heart failure (Figure 7 , 8 & 9)

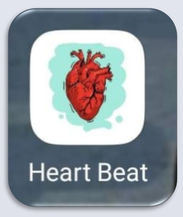

Figure 7 : App icon

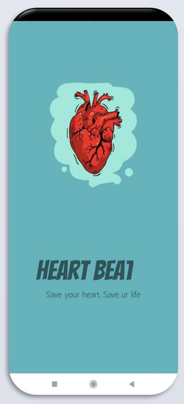

Figure 8 : App launch

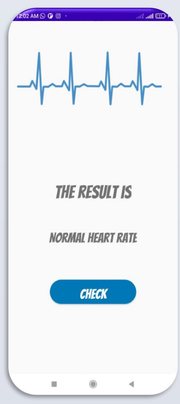

Figure 9 : App results

TEST

We tested the project to make sure that there is no failure in any component (Figures 10 , 11 & 12)

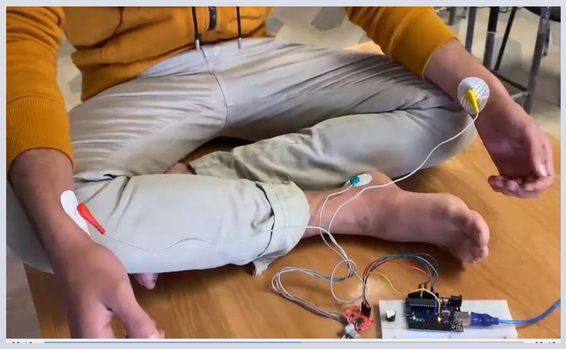

Figure 10 : How Electrodes & AD-8232 Sensor take Real time signals from patient

Figure 11 : Testing with models

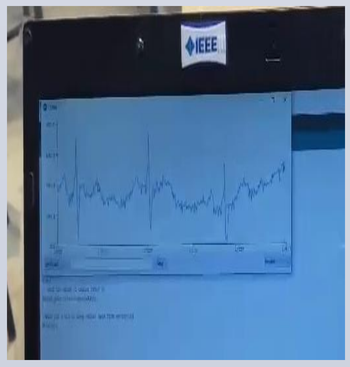

Figure 12 : Taken Signals By Hardware

CONCLUSION

The project depends on a device that takes real time signals from cardio patients.

The device is connected to An application that predicts atrial fibrillation (AF) and congestive heart failure (CHF), two types of chronic heart disease.

The device sends real time signals to firebase which send it to the application directly.

The application has machine learning models that deployed on it

Machine learning models that applies various algorithms of Machine learning such as SVM, DT, RF, ANN, KNN, and K-FOLD and compares them to each other & CNN deep learning

to choose the best technique & algorithm that predicts AF & CHF accurately

We rely on machine learning algorithms because of overfitting in deep learning.

On machine learning model the best algorithms are K-FOLD to AF with accuracy 99.67% and RF to CHF with accuracy 98.87%

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