# Design and Simulation Application of Heart Attack Prediction Using Fused Clinical and ECG Data

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***Abstract-*** Heart is a most important and vital organ in the whole body which performs different functions throughout the day. The term heart attack has become the most familiar disease for doctors in the medical field today. The need to predict the attacks accurately is of major importance as the patients having heart attack are increasing day by day because of many reasons like stress, lack of physical exercise ,bad habits like smoking ,alcohol etc. This paper describes the efficient method of predicting the heart attack using the fusion of both clinical data as well as ECG parameters to increase the accuracy. Probabilistic Neural Network is adopted for training and testing the data. The comparison of results is done for all the three methods and the fusion method is found more efficient.

***Index Terms***- ECG, Clinical Data, PNN, heart rate, Variability, Acceleration, Deceleration.

## I. INTRODUCTION

**PMATERIALS AND METHODS ADAPTED**

rediction of heart attack is made either based on clinical data or using ECG parameters. When we are predicting the heart attack through the clinical method mainly the following 13 parameters with reference to [3] are used:

1. Person age: age in years
2. Gender: sex (1 = male; 0 = female)
3. chest pain type (cp)
   -- Value 1: typical angina
   -- Value 2: atypical angina
   -- Value 3: non-anginal pain
   -- Value 4: asymptomatic
4. restbps: resting blood pressure (in mm Hg on Admission to the hospital)
5. chol: serum cholestoral in mg/dl #10 (trestbps)
6. fbs: (fasting blood sugar > 120 mg/dl) (1 = true; 0 = false)
7. restecg: resting electrocardiographic results
   -- Value 0: normal
   -- Value 1: having ST-T wave abnormality (T wave inversions and/or ST elevation or depression of > 0.05 mV)
   -- Value 2: showing probable or definite left ventricular hypertrophy by Estes' criteria
8. thalach: maximum heart rate achieved
9. exang: exercise induced angina (1 = yes; 0 = no)
10. oldpeak = ST depression induced by exercise relative to rest
11 slope: the slope of the peak exercise ST segment
   --Value 1: upsloping
   --Value 2: flat
   --Value 3: downsloping
12. ca: number of major vessels (0-3) colored by flourosopy )
13. thal: 3 = normal; 6 = fixed defect; 7 = reversable defect
14. num: diagnosis of heart disease (angiographic disease status)
   -- Value 1: Absence
   -- Value 2: Presence

## II. DATA PREPROCESSING

The available data need to be arrange in format so that further processing becomes easy, for these unnecessary data can be filtered, duplicated records can be removed, normalize the dataset , make data encoding if required. Arrange data cleanly, if require combine the dataset.

From ECG signal fetch the required parameters and make the dataset, if require make data preprocessing as above.

Finally fuse the clinical and ECG data in signal knowledgebase.

The parameters considered in ECG method to predict heart attack are:

1. Heart rate
2. Variability
3. Accelerations
4. Decelerations

How to calculate heart rate from an ECG signal? Standard ECG related textbooks of physiology and medicine Science [7] provide the theory that heart rate (HR) is readily calculated from the ECG as follows:

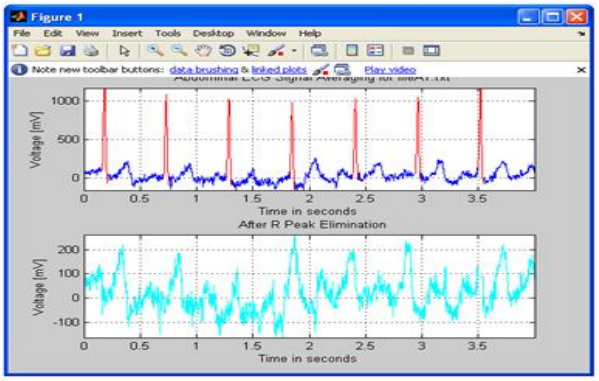


**Figure 1: ECG Sample**

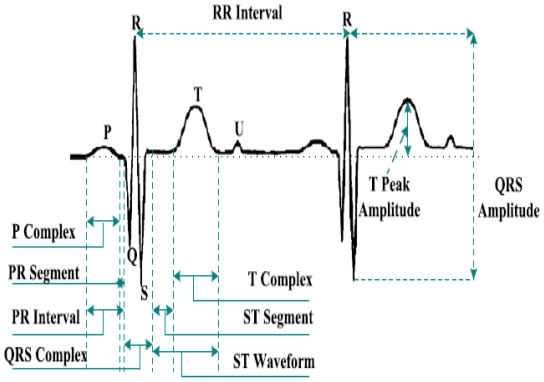


**Figure 2:ECG waveform**

Depending on availability of parameters ie R-R distance in mm , or in seconds or in number of squares the HR can be formulates as :

- HR = 1500 / RR in mm
- HR = 60 / RR interval in seconds.
- HR = 300 / number of large squares between successive R waves

In each of the above formula, the authors are actually referring to instantaneous heart rates, which is the number of times the heart would beat if successive RR intervals were constant.

If the rhythm is regular as in ECG1, i.e. successive RR intervals are fairly constant, then 1500 / RR in mm may give a reasonably accurate value of HR. However, if RR intervals vary, it is best to determine the number of RR intervals that are contained in a 10 second strip and multiply this by six.

If the rhythm is regular is irregular then the difference of RR-peak with respect to next is considered as variability.

## III. Key Points

1. To determine HR from an ECG, RR variability must be assessed. If successive RR intervals appear relatively constant, then average HR is approximately 1500 / RR in mm.

Flowchart to determine heart rate:

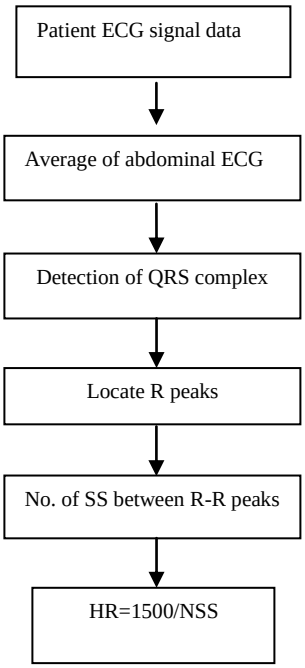


**Figure 3:Flowchart for HR calculation**

2. If RR intervals vary, average HR (ventricular rate) should be estimated by determining the number of RR intervals in a 10 second strip and multiplying this by 6.

3. If cardiac cycle duration changes significantly and abruptly, then HR should be calculated over shorter periods of time (it may be as short as one cardiac cycle) to correctly interpret underlying physiology.

In our work we are fusing both the methods described above to increase the accuracy of prediction. Then the fused data undergoes training we have used PNN for training because of its advantages like parallelism, fast training process and training samples can be added or removed without extensive retraining. Then the data is stored in the knowledge base and with reference to knowledge base testing is applied and after that heart attack prediction is done.

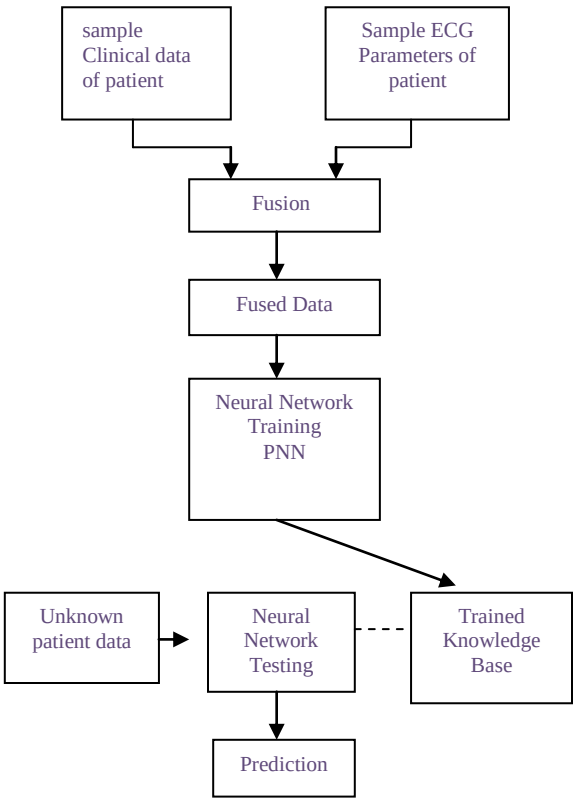


**Figure 4: Heart Disease Prediction using fusion of clinical and ECG data**

**Dataset**

In our study abdominal signals were used, which were obtained from the ECG database of the PhysioNet bank. This database contains a series of multichannel abdominal electrocardiogram (ECG) recordings, taken from a many subjects. The records have variable durations, and were taken 10 subject recordings for our analysis. These records may be very useful for testing signal separation algorithms.

## IV. RESULTS AND DISCUSSION

The fusion method is tested taking total of 17 parameters 13 from clinical method and 4 from ECG method. The same patients data set was taken for all the three methods. The results are compared using ROC curve in which fusion methodology has found the more accurate and efficient one .

Table 1 shows the comparison results of the three methods in which same patient data set was considered.

**Table 1: Result analysis**

| Method | Accuracy |
|---|---|
| Clinical | 89% |
| ECG | 83% |
| Fusion | 93% |

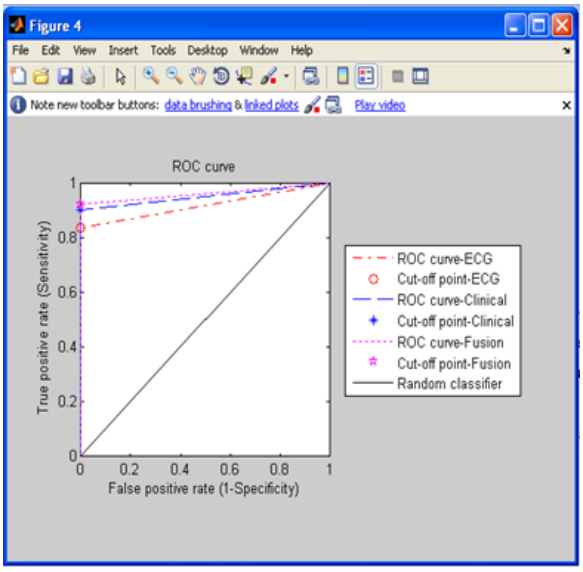


**Figure4 : ROC curve comparison**

## V. CONCLUSION

In this developed paper it has been proved that the fusion of clinical and ECG parameters gives better accuracy when compared to clinical and ECG methods individually. Predicting the probability of getting heart attack by having a history of previous attacks using fusion method can be considered for future work.

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