

Detection of Atrial Fibrillation Using Artificial Neural Network with Power Spectrum Density of RR Interval of Electrocardiogram

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Abstract. Atrial fibrillation (AF) is a disorder of the heart with fairly high mortality in adults. AF is a common heart arrhythmia which is characterized by a missing or irregular contraction of atria. Therefore, finding a method to detect atrial fibrillation is necessary. In this article a system to detect atrial fibrillation has been proposed. Detection system utilized backpropagation artificial neural network. Data input in this method includes power spectrum density of R-peaks interval of electrocardiogram which is selected by wrapping method. This research uses parameter learning rate, momentum, epoch and hidden layer. System produces good performance with accuracy, sensitivity, and specificity of 83.55%, 86.72 % and 81.47 %, respectively.

1. Introduction

Atrial fibrillation (AF) is a serious heart condition where the atria contracts irregularly in rapid succession so that blood can not completely pump into ventricle [1]. Blood is not pumped completely become one of the causes blockage of blood to the brain and increases the risk of stroke [2]. Atrial fibrillation is a heart disorder that is difficult to detect, this is because the appearance that cannot be predicted certainly.

One way to detect atrial fibrillation is to studying the morphology of electrocardiogram. Atrial fibrillation has morphological characteristics in the electrocardiogram that is missed of P wave, and irregularity of heart rate which is represented by R peaks [3]. Figure 1 shows the appearance of the electrocardiogram in patients with normal (NSR) and atrial fibrillation (AF).

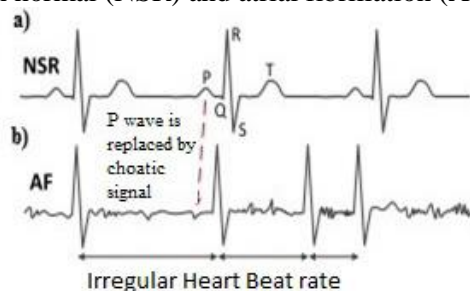


Figure 1. ECG signal in normal and atrial fibrillation patient

Characteristics of atrial fibrillation can be used as a marker of the emergence of atrial fibrillation, therefore, the features used in this study is the culmination of irregularity information R. Several studies have been done using this feature including the detection of atrial fibrillation by using a fuzzy inference system with the features of the P wave on the electrocardiogram [5], automatic detection by using support vector machine [6]. The classification used is back propagation neural network.

2. Numerical Methods

There are three general stages in this study. Figure 2 shows each of the stages and they will be explained as well. The Data were taken from the database of physionet atrial fibrillation with a sample frequency of 250 Hz, it was taken with a record time span of one hour.

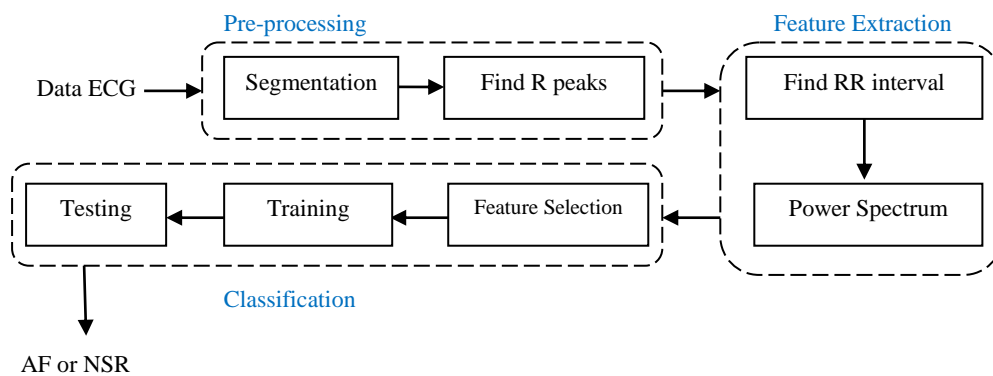


Figure 2. Flow chart for the research

a. Preprocessing

This is the stage of the data preparation. This phase consists of several stages inside namely segmentation and positioning of R peak. Segmentation is the process of data sharing wherein each segment consists of 10000 of data, if it is converted into units of time with data sampling frequency of 250 Hz, then each of segment represents 40 seconds of ECG recording. This process is intended to make the appearance of irregular heart rate can be monitored easily. The next stage is the stage of determining the position of the R peak, where R peak position can be searched using the algorithm Pan-Tomkin with an accuracy of 99.3% [7].

b. Feature Extraction

Extraction feature has two stages in it. They are named the stages of finding R peak intervals in each segment and the power spectrum as well. R peak intervals are the characteristic of atrial fibrillation, so it can be used as a feature to detect atrial fibrillation of the heart. The interval distance between the peak of R (RR interval) can be calculated by using equation 1.

$$RRI(n) = R(n + 1) - R(n) \quad (1)$$

The next stage is the stage of finding the power spectrum in each segment. Power spectrum is one characteristic of a signal [8].

c. Classification

Classification stage starts from selecting the best features. The best feature is a feature that provides a lot of information to group and normal atrial fibrillation. Feature selection using wrapping techniques that run at software weka by using the power spectrum as attributes. Next Stage is training of a neural network by using the feature selection that is resulted from the previous stage. Neural network used is named back propagation neural network. In the training phase, the main objective is to find the optimal weights to detect atrial fibrillation. Optimal weight is represented by good training performance. Training performance can be seen by analyzing the mean square error with the increasing of repetitions. The parameter used is the learning rate, momentum, hidden layers and the number of epochs. The next stage is the testing phase. This phase is to test the weight performed on test data and produce the output of accuracy, specifications, and sensitivity.

3. Results and Discussion

Parameters at the training stage is set with number of learning rate = 0.05 momentum = 0.9, epoch = 40000, and the hidden layer = 5 with output 1. The selection feature stage produces 5 selected features. The results of the performance of each feature can be seen in Figure 3.

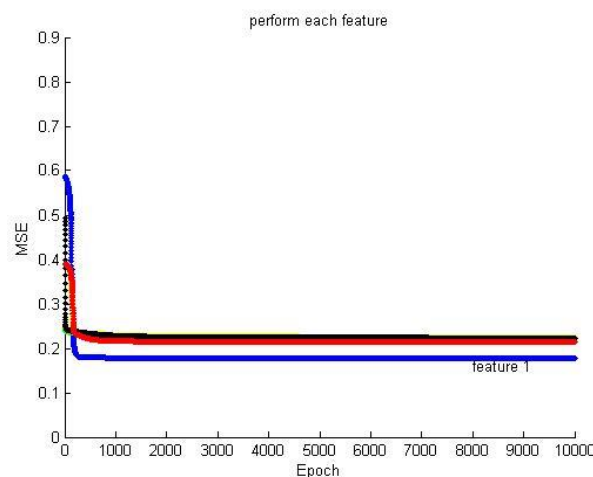


Figure 3. Perform each feature

Figure 3 shows the performance of each feature that has been carried out through training of artificial neural networks. The blue line is the feature that has the best performance of the other features. This performance can be improved by combining all the features. A good feature has small and convergent mean square error. Figure 4 shows the results of the performance of some combined features.

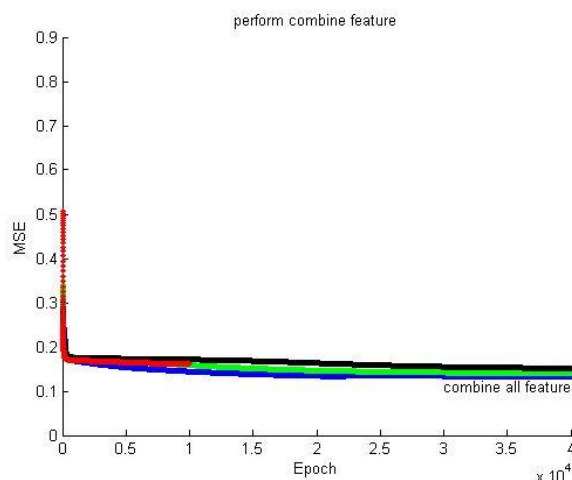


Figure 4. Perform combine feature

Figure 4 shows the blue line that is a combination of the five features with smallest mean square error that is 0.13 and it is convergent. Training will be stopped when the mean square error is convergent in which the mean square error does not change many times as we get epoch. The training process produces useful weights for the testing phase. In the testing phase, the weights will be used to test the system's ability to sort whether the data belong to atrial fibrillation or not. The decision is determined by the threshold used. This research respectively resulted in accuracy, sensitivity, and specifications that are 83.55%, 86.72% and 81.47%. This result is good enough to detect atrial fibrillation.

4. References

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