Robust System for Patient Specific Classification of ECG Signal Using PCA and Neural Network

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Abstract *Many works have been proposed for ECG data classification. Detection of ECG arrhythmias is necessary for the treatment of patients for diagnosing the heart disease at the early stage. It is very difficult for doctors to analyze long ECG records in the short period of time and also human eye is poorly suited to detect the morphological variation of ECG signal, hence imposing the need for an effective diagnostic system so we proposed a generic and patient specific classification system designed for robust and accurate detection of ECG heartbeat patterns In the system, proposed feature extraction uses morphological feature which are projected onto a lower dimensional feature space using Principal Component Analysis (PCA) and temporal feature from ECG data, for pattern recognition we uses artificial neural network ANNs.it is powerful tools for pattern recognition .it having the capability to learn complex and nonlinear surfaces. The performance of ECG pattern classification strongly depends on the characterization power of the features extracted from the ECG data and the design of the classifier. The wavelet transform is an efficient tool for analysing nonstationary ECG signal due to its time–frequency localization properties PCA is the optimal linear transformations is a well-known statistical method that has been used for data analysis, data compression, redundancy and dimensionality reduction, PCA finds a projection of the input pattern vectors onto a lower dimensional feature space that retains the maximum amount of energy among all possible linear transformations of the pattern space. The proposed classification system can adapt significant interpatient variation in ECG patterns by training the network structure, and thus, achieves higher accuracy over larger datasets.*

Key Words: *ECG , PCA, ANN*

1. INTRODUCTION

Each heartbeat in the cardiac cycle of the recorded ECG waveform shows the time evolution of the heart's electrical activity, which is made of different electrical depolarization–repolarization patterns of the heart. Any change in the morphological pattern or disorder of heart rate is an indication of an arrhythmia, which could be detected by analysis of the recorded ECG waveform. Real time automated ECG analysis in clinical view is of great assistance to clinicians in detecting cardiac arrhythmias, which often arise as effect of a cardiac disease, and it may be life-threatening and require immediate therapy. However automated classification of ECG beats is a challenging problem as the morphological and temporal feature of ECG signals show significant variations for different patients and under different temporal and physical conditions. Many algorithms have been presented for automatic detection and classification of ECG heartbeat patterns such as signal processing technique filter banks, statistical and heuristic approaches, hidden Markov models, support vector machine and mixture-of-experts method. But ECG classifier systems based on past approaches have not performed well in practice because of their most important and common drawback of having an inconsistent performance when classifying a new patient's ECG waveform. This makes system unreliable to be widely used clinical assistance and causes degradation in their accuracy and efficiency for larger database

The wavelet transform can be used to decompose an ECG signal according to scale, thus allowing separation of the relevant ECG waveform morphology descriptors from the noise, interference, baseline drift, and amplitude variation of the original signal.

PCA is statistical method used for dimensionality reduction in which input morphological feature vector is projecting it onto a lower dimensional feature space using Principal Component Analysis (PCA) in order to significantly reduce redundancies in such a high-dimensional data space. The lower dimensional morphological feature vector is then combined with critical temporal features related to inter beat time interval to improve accuracy and robustness of classification.

ANNs are powerful tools for pattern recognition as they have the capability to learn complex, nonlinear surfaces among different classes, and such ability can therefore be the key for ECG beat recognition and classification.

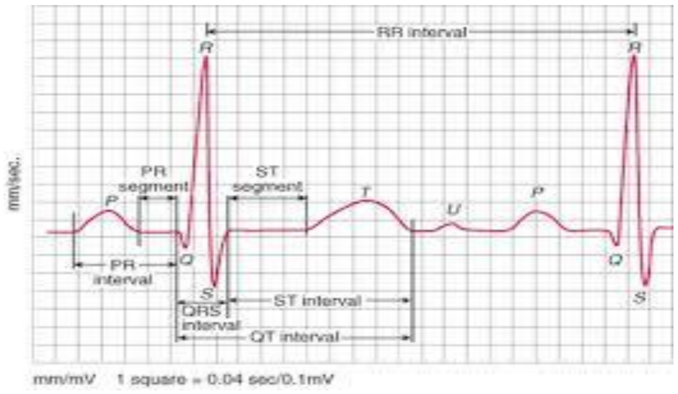


Fig (a) ECG signal

2. METHODOLOGY

The system for patient specific classification of ECG data will be developed in modules. These modules are combined and training will be given to the system. The MIT/BIH arrhythmia database is used for training and performance evaluation of the proposed patient specific ECG classifier. The database contains annotation for both timing information and beat class information verified by independent experts.

The proposed ECG classification system is given below in fig (b)

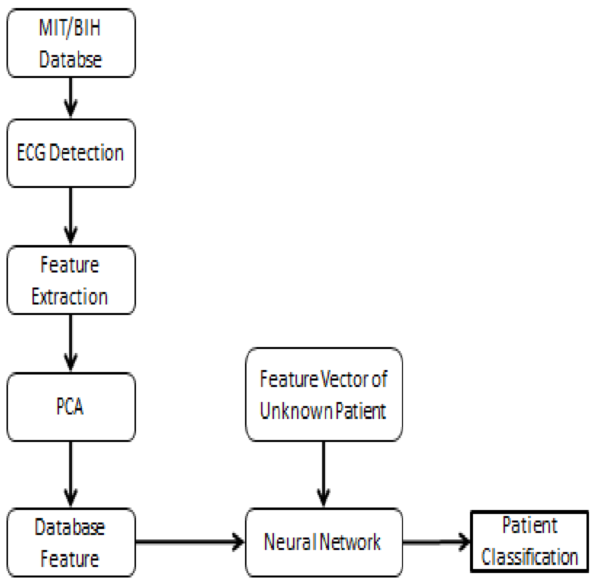


Fig (b)

2.1 ECG Data

The MIT/BIH arrhythmia database is used for training and performance evaluation of the proposed patient specific ECG classifier. The database contains annotation for both timing information and beat class information verified by independent experts.

2.2 ECG Detection module

The ECG is detected using Eigenvector method. These methods are based on an Eigen decomposition of the correlation matrix of the noise-corrupted signal. It is used for estimating frequencies and powers of signals from noise-corrupted measurement.The eigen vector associated with the minimum eigen value of the estimated autocorrelation matrix is used to calculate the PSD.

2.3 Feature Extraction module

Once the ECG detected using above method the morphological and temporal feature will be extracted from ECG data. Wavelet transform is used to extract morphological information from the detected ECG signal. In order to effectively extract the morphological information from ECG data we can also use translation-invariant dyadic wavelet transform (TIDWT)

2.4 Dimension reduction using PCA module

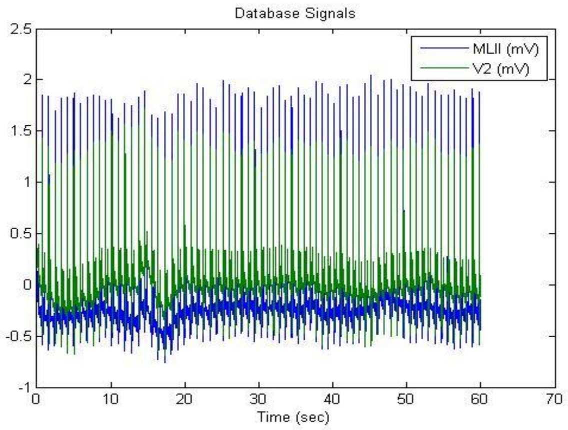
The wavelet-based morphological features in the training set are post processed using PCA to reduce dimensionality (and redundancy) of input feature vectors.

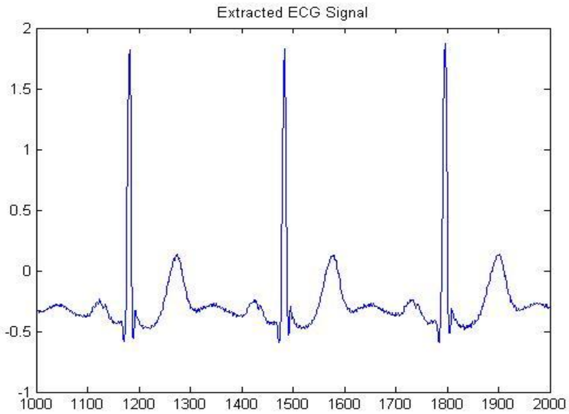
2.5 Feature Database

The feature database consisting morphological and temporal features of healthy and diseased persons can be created for training of Neural Network.

2.6 ECG data classification module

ANNs are powerful tools for pattern recognition as they have the capability to learn complex, nonlinear surfaces among different classes, and such ability can therefore be the key for ECG beat recognition and classification Therefore ANNs are used for the classification of ECG data from each individual patient in the database. ANN compares features of test case patient with the features stored in database to classify patient as normal or diseased heart patient.





3. CONCLUSIONS

we proposed an automated patient-specific ECG heartbeat classifier, which is based on an efficient formation of morphological and temporal features from the ECG data and evolutionary neural network processing of the input patterns individually for each patient.

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