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Denoising and Detection of ECG Points using Wavelets & PCA

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Abstract-

The electrocardiogram (EKG or ECG) is a common diagnostic tool used to monitor heart activity. Heart diseases, which are one of the death reasons of men/women, are among the important problems on this century. Early diagnosis and medical treatment of heart diseases can prevent sudden death of the patient. One of the ways to diagnose heart diseases is to use electrocardiogram (ECG) signals. ECG signals are formed of P wave, QRS complex, and T wave. The ECG is a bioelectric signal, which records the heart's electrical activity versus time; therefore it is an important diagnostic tool for assessing heart function. During measurement of ECG, Noise is superimposed on them, due to AC interference, loose electrode connection, malfunctioning of machine, patient movement like respiration etc all of them collectively called Artifacts. Muscle Noise is one of the Artifacts. The primary aim of this work is to remove the followed the progress of instrumentation technology. Its most recent evolutionary step, to the computer-based system, has allowed patients to wear their computer monitor or has provided an enhanced, high resolution ECG that has opened new scene of ECG analysis and interpretations. The objective of the work is to automatically detect and mark these basic waveforms of ECG signal. Recently developed PCA will be used for this purpose. Principal component analysis (PCA) is a mathematical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of valuesof linearly uncorrelated variables called principal components. The number of principal components is less than or equal to the number of original variables. This transformation is defined in such a way that the first principal component has the largest possible variance and each succeeding component in turn has the highest variance possible under the constraint that it be orthogonal to (i.e., uncorrelated with) the preceding components. Principal components are guaranteed to be independent only if the data set is jointly normally distributed. PCA is sensitive to the relative scaling of the original variable

I. Introduction

The recording of the electrical activity associated with the functioning of the heart is known as electrocardiogram (EKG or ECG) . Heart diseases, which are one of the death reasons of men/women, are among the important problems on this century. Early diagnosis and medical treatment of heart diseases can prevent sudden death of the patient. One of the ways to diagnose heart diseases is to use electrocardiogram (ECG) signals. ECG signals are formed of P wave, QRS complex, and T wave. They are designated by capital letters P, Q, R, S, and T. In the normal beat phase of a heart, the main parameters, inspected include the shape, the duration, and the relationship with each other of P wave, QRS complex, and T wave components and R-R interval. The changes in these parameters indicate an illness of the heart that may occur by reason. All of the irregular beat phases are generally called arrhythmia and some arrhythmias are very dangerous for patient. Some automatic ECG interpreting systems is available. Moreover, the computer-based interpreter systems are currently being developed to diagnose arrhythmia in time, and various methods are applied to these systems. The ECG is a bioelectric signal, which records the heart's electrical activity versus time; therefore it is an important diagnostic tool for assessing heart function. The electrical current due to the de-polarization of the Sinus Atria (SA) node stimulates the surrounding myocardium and spreads into the heart tissues. A small proportion of the electrical current flow to the body surface. By applying electrodes on the skin at the selected points, the electrical potential generated by this current can be recorded as an ECG signal. The interpretation of the ECG signal is an application of pattern recognition. The purpose of pattern recognition is to automatically categories' a system into one of a number of different classes. An experienced cardiologist can easily diagnose various heart diseases just by looking at the ECG waveforms printout. In some specific cases, sophisticated ECG analyzers achieve a higher degree of accuracy than that of cardiologist, but at present there remains a group of ECG waveforms that are too difficult to identify by computers. However, the use of computerised analysis of easily obtainable ECG waveforms can considerably reduce the doctor's workload. During measurement of ECG, Noise is superimposed on them, due to AC interference, loose electrode connection, malfunctioning of machine, patient movement like respiration etc all of them collectively called Artifacts. Muscle Noise is one of the Artifact. The primary aim of this work is to remove the muscle tremor noise from ECG so that it can be use by the computer for classification. Generally ,the ECG is one of the oldest and the most popular instrument-bound measurements in medical applications. It has followed the progress of instrumentation technology. Its most recent evolutionary step, to the computer-based system, has allowed patients to wear their computer monitor or has provided an enhanced, high resolution ECG that has opened new scene of ECG analysis and interpretations. The electrocardiogram (ECG

or EKG) is a diagnostic tool that is routinely used to assess the electrical and muscular functions of the heart. Electrocardiograms (ECGs) are signals that originate from the action of the human heart. The ECG is the graphical representation of the potential difference between two points on the body surface, versus time.[2]

II. Principal Component Analysis

PCA is a simple method for extracting relevant information from confusing data sets. PCA is a way of identifying patterns in data, and expressing the data in such a way as to high light their similarities and differences. PCA is a special case of Factor Analysis that is highly useful in the analysis of many time series and the search for patterns of movement common to several series (true factor analysis makes different assumptions about the underlying structure and solves eigenvectors of a slightly different matrix). [13]

To find the PCA the following steps are involved .

Step 1. Calculate the mean of two signals
Step 2 Subtract the mean from the original signal.
Step 3 . Calculate the covariance matrix.
Step 4 . Calculate Eign value & Eign vector
Step 5. Calculate the new data set.
Step 6. Principal Component Calculation.
Step 7. Get Original data set.

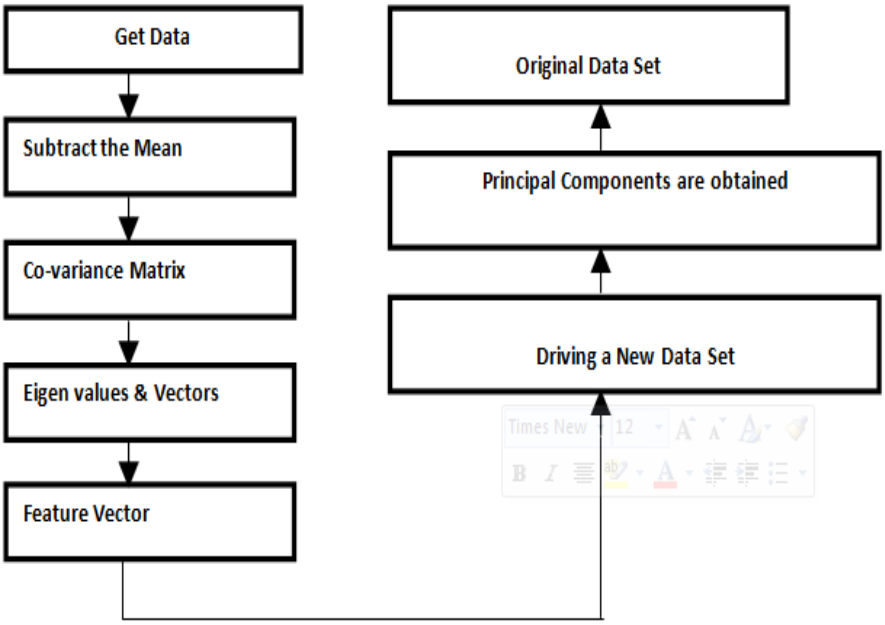

Figure 1: General Process of PCA .[13]

III. Wavelet Transform

A wavelet is a wave-like oscillation with amplitude that starts out at zero, increases, and then decreases back to zero. It can typically be visualized as a "brief oscillation" like one might see recorded by a seismograph or heart monitor. Generally, wavelets are purposefully crafted to have specific properties that make them useful for signal processing. Wavelets can be combined, using a "shift, multiply and sum" technique called convolution, with portions of an unknown signal to extract information from the unknown signal.

IV. Proposed Work

1) To understand the different type of noise present in the ECG signal and & PCA.
2) To remove the baseline wander and power line interference from ECG signal by wavelet.
3) To detect and automatically mark the basic waveforms of ECG (12 leads ECG signal) by PCA.

V. Flow Chart Of Methodology

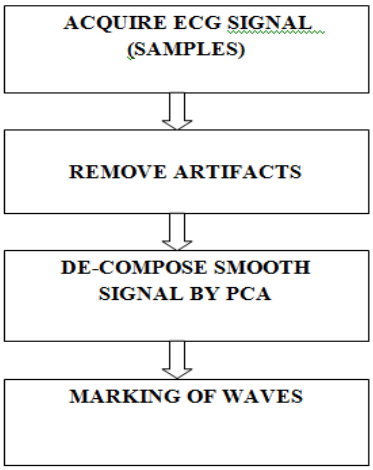

Figure 2: Flow Chart of Denoising & Detection Of ECG

VI. Experimental Results

In this study first of all take the data sample from European ST-T database. This is 1 lead ECG signal. This signal having a problem base line wandering and noise is also present. The base line problem is in the signal due to several reason figure 3 show the original signal of lead 1 having base line problem & noise .So first of all we have to remove the base line problem. There are so many techniques for removal of baseline problem but for this particular project wavelet technique is used .Firstly ECG signal is decomposed by using wavedec command. wavedec performs a multilevel one-dimensional wavelet analysis using either a specific wavelet ('wname') or a specific wavelet decomposition filters After the removal of base line next step is denoising the ECG signal as the input signal having noise. For denosing the ECG signal wdencmp is used .wdencmp is a one- or two-dimensional de-noising and compression-oriented function. wdencmp performs a de-noising or compression process of a signal using wavelets. The figures 3 to figure 6 shows the original signal , ECG signal without base line wander & denoising signal and marking of lead-1.

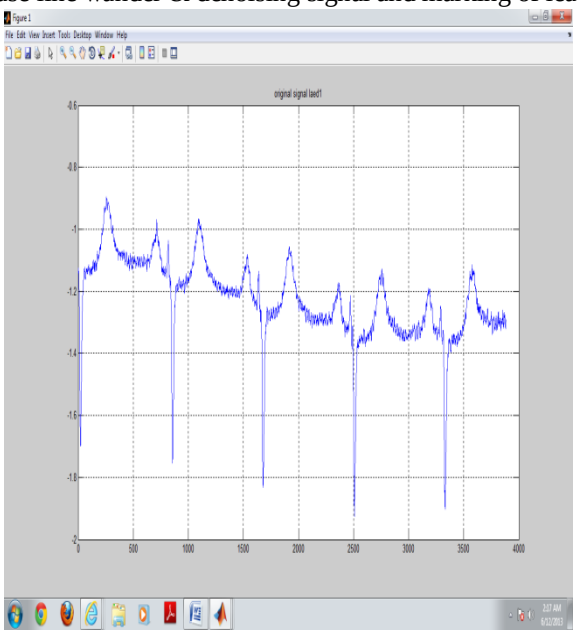

Figure 3: Original signal of lead- 1

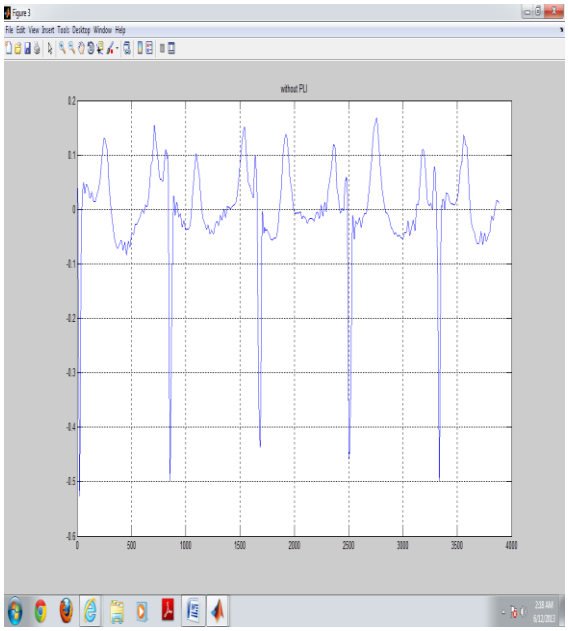

Figure 5: Denoising ECG signal lead 1

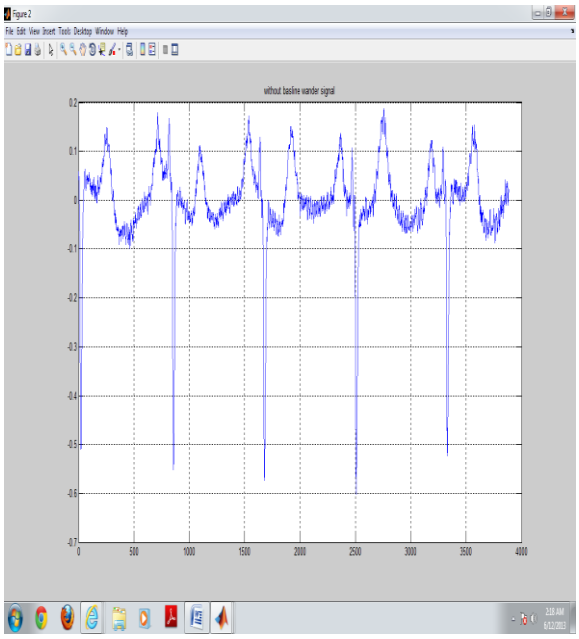

Figure 4: ECG signal without baseline wander of lead -1

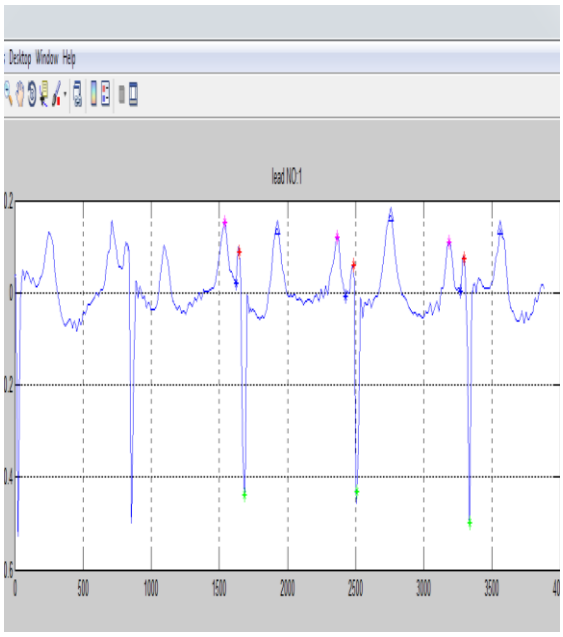

Figure 6: Marking of Lead- 1

VII. Conclusion

The electrocardiogram (ECG) is a common diagnostic tool used to monitor heart activity. Heart diseases, which are one of the death reasons of men/women, are among the important problems on this century. One of the ways to diagnose heart diseases is to use electrocardiogram (ECG) signals. In this dissertation firstly captured the 12 leads signal from physionet data base (European ST-T data base) . In this signal base line wander noise and other noises are involved. The reason for base line wander is the cables moving during the reading, Patient movement, dirty lead wires/electrodes, loose electrodes etc. The term noise does not refer to sound but rather to electrical interference. The reason for noise are, when an ECG machine is poorly grounded or not equipped to filter out this interference, you can get a thick looking ECG line . The base line wander problem can be removed by using the wavelet .There are so many techniques can be used for removal of baseline problem but for this project wavelet technique is used .Firstly ECG signal is decomposed by using wavedec command. wavedec performs a multilevel one-dimensional wavelet analysis. After the decomposition next command is wthcoef it is a one-dimensional de-noising and compression oriented function. Waverec performs a multilevel one-dimensional wavelet reconstruction using either a specific wavelet ('wname'). waverec is the inverse function of wavedec. After the removal of base line wander next step is denoising the ECG signal . For denosing the ECG signal wdencmp command is used. wdencmp is a one- or two-dimensional de-noising and compression-oriented function. After the result of denosing, the noise has been removed . For this function wavelet is used. The figures 3 to 6 shows the original signal ,ECG signal without base line wander & denoising signal of lead 1 . The next step is marking of ECG signal by using PCA. The PCA are presented as the diagnostic tool to aid the physician in the analysis of cardiac abnormalities. The experimental result shows that the detection rate to detect the P,QRS complex and T wave by this method is 100%. For this we used princomp (X) command which performs principal components analysis on the n-by-p data matrix X. Hence this method shows better result for automated ECG detection and it could not only help in early detection of diseases but also in reducing the workload of the medical data analyst. The captured ECG signal having base line wander & noise implemented them on MATLAB

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