

Detecting Cardiac Arrhythmia by Extracting ECG Features

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Abstract— Disturbance in the regular rhythmic activity of the heart called arrhythmia. Cardiac arrhythmia is caused by irregular firing patterns from SA node, abnormal activity from other parts of the heart. These types of abnormalities of heart may cause damage of heart. Electrocardiogram (ECG) feature extraction system is based on wavelet transform. ECG feature extraction plays a vital role in detecting most of the heart diseases. In an ECG signal one cardiac cycle is made up of P-QRS-T waves. In this feature extraction scheme we determine the amplitudes & intervals of the P-QRS-T segment for determine functioning of the heart. ECG signal is de-noised by removing the coefficients at higher scales. Then, QRS complexes are found & each complex is used to place the peaks of the individual waves, R-R intervals are there in one cardiac cycle and estimate the algorithm Pan-Tompkins algorithm.

Index Terms— Cardiac Arrhythmia, Electrocardiogram (ECG), Feature Extraction, Pan-Tompkins algorithm.

1 INTRODUCTION

Pan-Tompkins is based on QRS complex detection. And it analyzes the slope, amplitude and width. The different steps of the algorithm are shown in fig 1. The low pass & high pass filters forms a band pass filter, which reduces noise in the signal or ECG signal. Noise is like muscle noise.

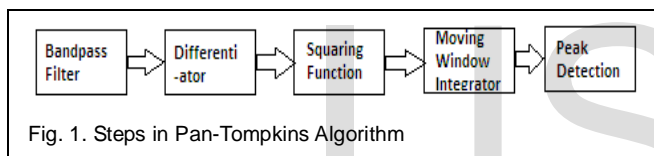


Fig. 1. Steps in Pan-Tompkins Algorithm

For Distinguishing QRS complexes from low-frequency ECG components such as the P & T waves the signal is passed through a differentiator for highlighting the high slopes. The third step is squaring operation, which is to lay stress on the higher values that are mainly because of QRS complexes. Then squared signal is passed through a Moving-Window Integrator of length of the window $N=30$ samples. The result is smooth peak ECG cycle. The output of the Moving-Window Integrator may be used to find QRS complexes, measure R-R intervals, & determine the QRS complex duration in Fig 2.

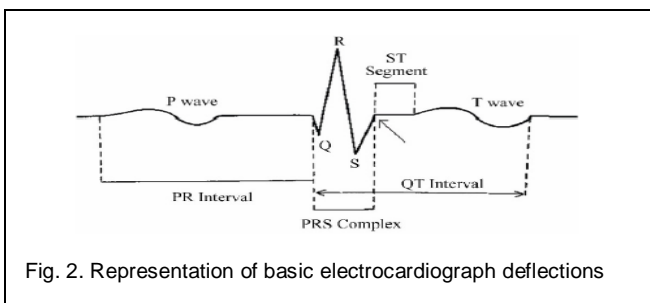


Fig. 2. Representation of basic electrocardiograph deflections

2 LITERATURE SURVEY

2.1 Review Stage

Before Wavelet Analysis for analyzing ECG signal there are two methods Linear Prediction & Morphological and Time-frequency Features of T-wave.

2.1.1 Linear Prediction:

The number of different important properties indicating that ECG signals has an important attribute in the remaining error signal obtained from Durbin's linear prediction algorithm.

A nonlinear transformation is used for each ECG's QRS complex, for the feature recognition. It transforms every residual error signal to a set of three states. The pulse-code train has the benefit of easy implementation in digital circuits to get computerized ECG diagnosis. The algorithm is useful in feature extraction. By using this method, our studies specify that the PVC (premature ventricular contraction) detection has at least 92% sensitivity [10].

2.1.2 Morphological and Time-frequency Features of T-wave:

The repolarization phase of heart activity is denoted by the T-wave segment in ECG. This T wave contains more information about the proper operation of electrical activities in heart. Long QT syndrome (LQT) and T-wave Alternans (TWA) have undetectable effects on time and amplitude of T-wave interval. Thus, several T-wave features can be used to classify LQT and TWA. Totally, 22 features including 17 morphological and 5 wavelet features have been extracted from T-wave to show the ability of this section to recognize the normal and abnormal records. by pre-processing, T-wave feature extraction and artificial neural network (ANN) we can implement recognition. T-wave is most important in description of LQT syndrome, Normal and TWA of ECG classification [9].

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2.2 Final Stage

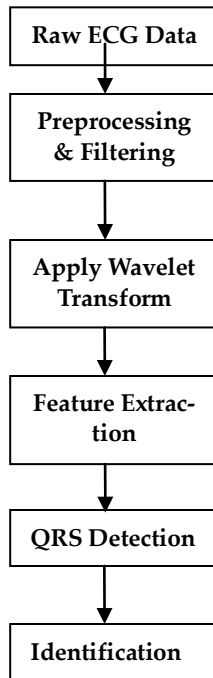


Fig 3: Stages of ECG signal processing

3 EQUATIONS

Low-pass filter:

25ms at the 200sps rate of sampling (sampling rate) is the filter delay.

High-pass filter:

By subtracting a first -order low-pass filter from an all pass filter, the high pass filter is implemented.

$$H_{lp}(Z) = \frac{1-z^{-32}}{1-z^{-1}} \quad \text{[Equation of low pass filter]} \quad (1)$$

This low-pass filter has a delay of 15.5 samples (i.e.77.5ms) & dc gain 32. The output of the low-pass filter is avoided by its dc gain and subtracted from the original signal to produce the high-pass filter.

The original signal is delayed by 16T (i.e.X-16)

The high-pass filter transfer function is formed from

$$H_{hp}(Z) = Z^{-16} - H_{lp}(Z)/32 \quad (2)$$

Put the equation (1) into (2)

$$H_{hp}(Z) = (-1/32 + Z^{-16}) - Z^{-17} + Z^{-32}/32 / (1 - Z^{-1}) \quad (3)$$

The filter may be implemented with difference equation:

$$Y(nT) = Y(nT - T) - X(nT)/32 + X(nT - 16T) - X(nT - 17T) + X(nT - 32T)/32 \quad (4)$$

5Hz is the low cut off frequency and the gain is one.

Derivative:

The derivative used with transfer function-

$$H(Z) = 0.1(-2Z^{-2} - Z^{-1} + Z^1 + 2Z^2) \quad (5)$$

$$Y(nT) = (2X(nT) + X(nT - T) - X(nT - 3T) - 2X(nT - 4T))/8 \quad \text{[With the difference equation]} \quad (6)$$

Squaring function:

The squared point by point signal is.

The equation is -

$$Y(nT) = [X(nT)]^2 \quad (7)$$

$$Y(nT) = (1/N)[X(nT - (N - 1)T) + X(nT - (N - 2)T) + \dots + X(nT)] \quad \text{[Moving-WindowIntegration]} \quad (8)$$

Where, in the width of the integration window, N is the number of samples.

4 HELPFUL HINTS

4.1 Result(Figures and Tables)

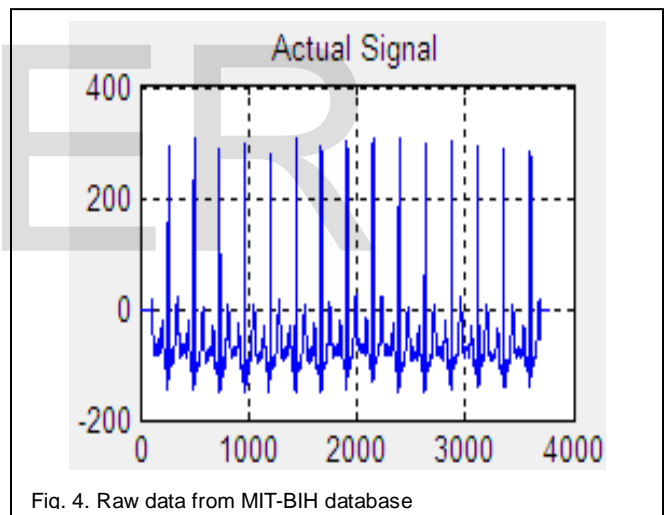


Fig. 4. Raw data from MIT-BIH database

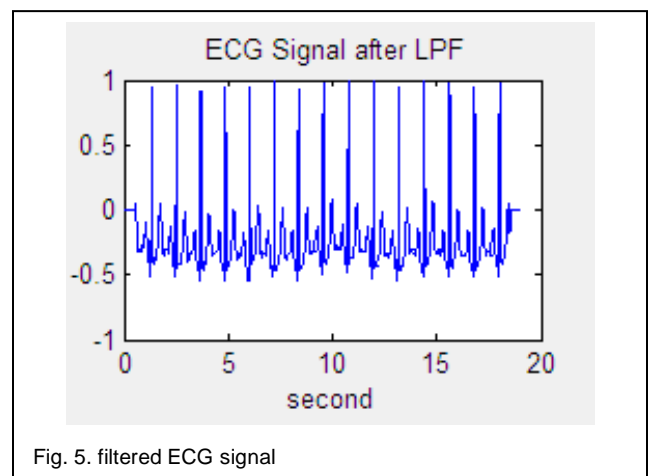
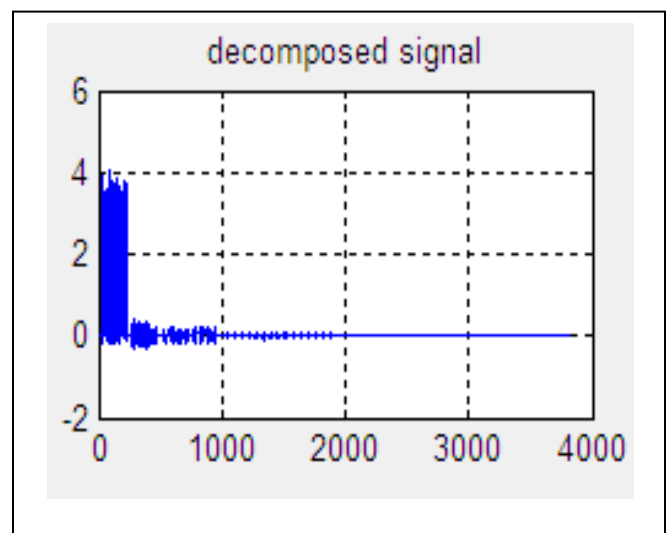
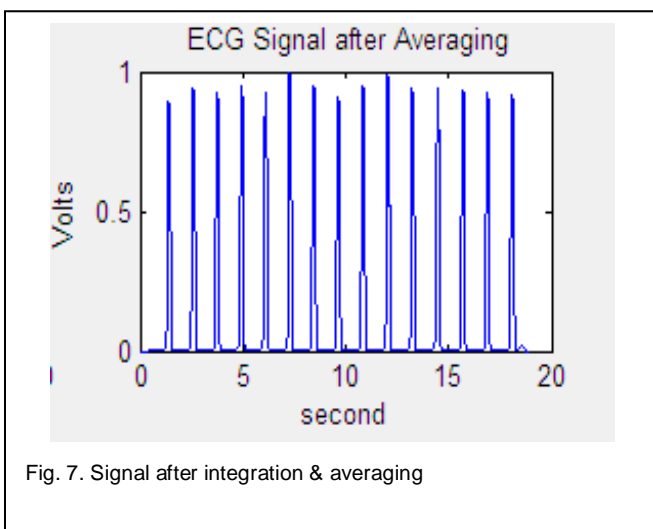
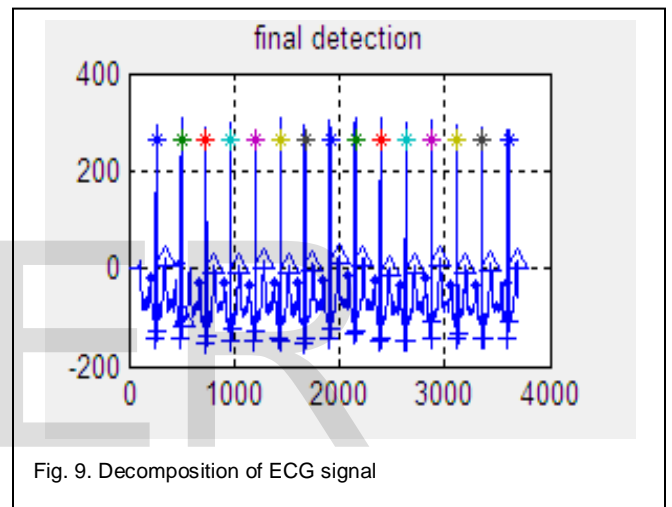
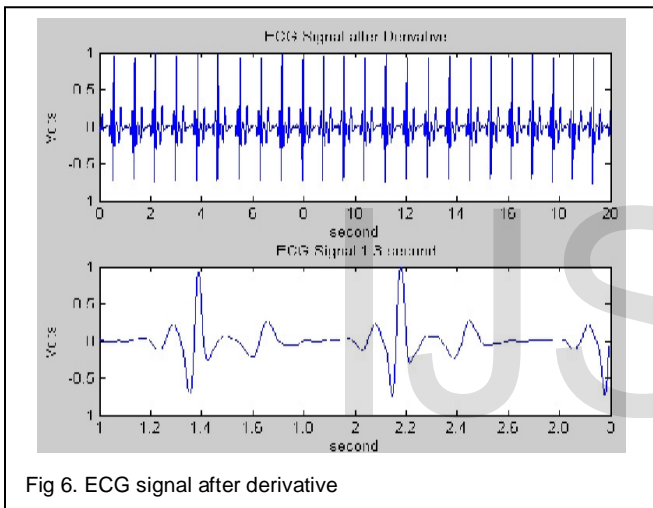
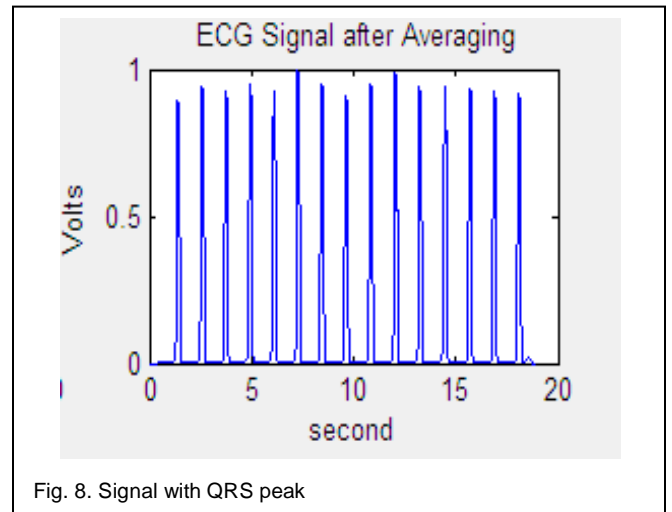
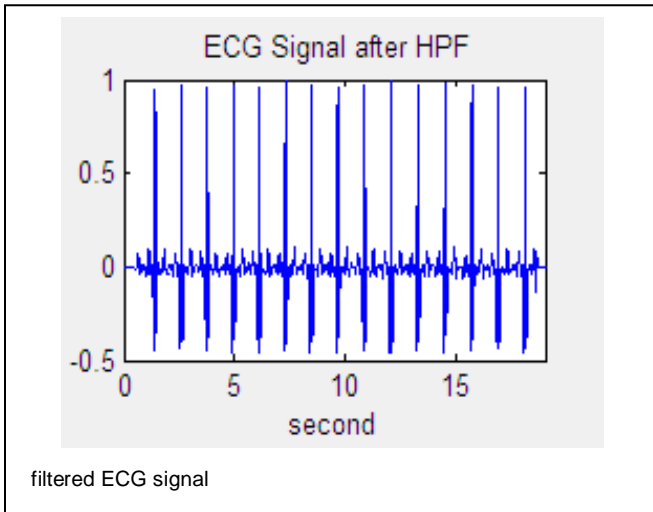
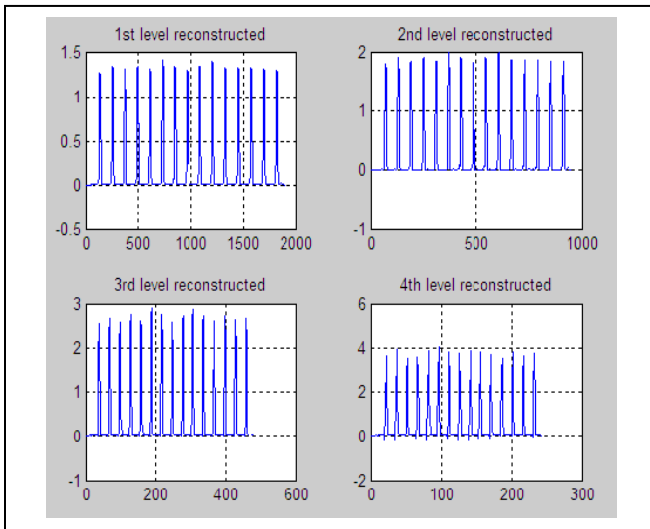


Fig. 5. filtered ECG signal





Final detection is type of arrhythmia identified & shows that type of arrhythmia.

TABLE 1
Different Types of Arrhythmia

Interval Differences	Types of Arrhythmia
RR Interval Longer	Bradycardia
RR Interval Shorter	Tachycardia
Long PR interval	First degree heart block
ST Segment elevated	Myocardial infraction
ST Segment short(absent)	Hypercalcemia
Wide QRS	Premature ventricular contraction
Absence of P wave (IVR)	Atrial fibrillation ,Idioventricular rhythm
Inverted T wave	Coronary ischemia
Long QT interval	Nocturnal hypoglycemia
More P waves than QRS complex	Second & third degree AV block
Tall or tent shaped T wave	Hyperkalemia

5 CONCLUSION

R Peak and QRS complex values are very useful in ECG analysis. The main benefit of this type of detection is less time consuming. From Pan-Tompkins algorithm it is concluded that no. of QRS waves is less in arrhythmia data compared to normal person.

The coefficients are plotted using DWT (Discrete Wavelet Transformation).

So, our result display type of arrhythmia if any abnormal signal is found otherwise it display normal wave or signal.

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