ECG Analysis and Arrhythmia Classification using Narrowband Frequency Signal

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Abstract: Electrocardiogram (ECG), a non invasive technique plays a crucial function in communication part and as well as in signal processing. A methodology used to diagnose cardiovascular diseases with the help of narrowband frequency signals has been proposed. An ECG signal provides useful information about electrophysiology of heart rhythm and diagnose the disease. ECG signals are contaminated under the help of Power Line Interference (PLI) and also bioelectric signals. It provides valuable results of heart disease and cardio vascular system. It is complicated by process raw cardiogram signal in PLI. This can be overcome by the technique known as Ramanujan periodic transform (RPT) with some noise in result. In this proposed work, the noise is reduced by exploitation QRS detection algorithm and arrhythmia classification. The noise is detected by calculating the summation (E) of Euclidean error in each and every back (G) in filter based techniques.

Keywords: PLI, ECG, QRS, filter, narrow – band frequency, RPT.

1. Introduction

Narrowband frequency cause vital role in any quite system or signals with the explanation for interference is termed as narrowband interference. Now-a-days populations are increased rapidly. So it is impossible to identify every heart disease accurately in given time. In earlier surveys attempts are made to reduce the narrowband signals of frequency with interface in signal process.

Electrocardiogram

An ECG signal is beneficial to provide information about electrophysiology of heart rhythm and to diagnose the heart diseases. It is terribly tough to process raw signal in Power Line Interface and it can be overcome by Ramanujan periodic transformation (RPT) with having some noise in results. In this research work, tendency to noises from result and removing by QRS detection formula with the assistance of noise reduction filter. In recent years, Electrocardiogram [ECG] method using microcomputers were increased in rapid technology. An ECG signals were having both depolarized and re-polarized intensive of human heart. ECG having preprocessing technique with important applications to diagnose the heart disease and provides the results

Electromagnetic interference

To reduce the noise in results, QRS detection algorithm has been proposed. An ECG signal having Electromagnetic interference (EMI) with preprocessing technique from frequency 50/60 HZ. The noise signal is passed through noise reduction filter by the narrowband interference. In this research work, Ramanujan Periodic Transform (RPT) has been explained as existing technique and QRS detection algorithm as proposed technique. The results of simulation and overall summary of cardiogram analysis and arrhythmia have been classified.

ECG waveform depiction

In earlier reference ECG wave is shaped as a projection of bridged potential vectors of the heart. ECG wave has a few pinnacles and "arrangements", it is valuable for conclude part.
These are
P-wave - shows the depolarized wave that circulates from the SA hub to the atria, and its span is between 80 to 100 milliseconds.
P-R interim - shows the measure of time that the electrical motivation going from the sinus hub to the AV hub and entering the ventricles and is between 120 to 200 milliseconds.
P-R portion - Corresponds to the time between the parts of the bargains to the beginning of ventricular depolarization. Last about 100ms.
QRS complex - Represents ventricular depolarization. The span of the QRS complex is regularly 0.06 to 0.1 seconds.
Q-wave - Represents the ordinary left-to-right depolarization of the bury ventricular septum.
R-wave - Represents early depolarization of the ventricles.
S-wave - Represents late depolarization of the ventricles.
S-T portion – it shows up after QRS and demonstrates that the whole ventricle is depolarized.
Q-T interim - shows the absolute time that requirement for both repolarization and ventricular depolarization to occur, so it is estimation for the normal ventricular activity span. This time can change from 0.2 to 0.4 seconds relating to pulse.
T-wave - demonstrates ventricular repolarization and its time is bigger than depolarization.

The standard 12-channel ECG is gotten utilizing four appendage leads and chest leads in six positions. The correct leg is utilized to put the reference terminal. The left arm, right arm, and left leg are utilized to get, I, II, III. A consolidated reference known as Wilson's focal terminal is framed by joining the left arm, right arm, left leg leads, and is utilized as the reference for the chest leads. The enlarged appendage leads known as aVR, aVL, aVF (aV for the increased lead, R for the correct arm, L for the left arm, and F for the left foot) are acquired by utilizing the reference being Wilson's focal terminal without the investigating appendage lead.
Leads I, II and III are normally alluded to bipolar leads as they utilize just two anodes to infer a view. One anode goes about as the positive cathode while the different as the negative terminal (subsequently bipolar) .Chest (precordial) leads are

V1: Fourth intercostal space, right sternal edge.
V2: Fourth intercostal space, left sternal edge.
V3: Between the second and fourth terminals
V4: Fifth intercostal space in the midclavicular line.
V5: On fifth rib, front axillary line.
V6: In the midaxillary line.

To make accounts with the chest leads (diverse cathode), the three appendage leads are associated with structure a detached terminal with high protections. The chest leads predominantly identify potential vectors coordinated towards the back. These vectors are not really perceivable in the frontal plane . Since the mean QRS vector is typically coordinated downwards and towards the left back area, the QRS vectors recorded by drives V1–V3 are generally negative, while those recognized by V5 and V6 are certain. In drives V1 and V2, QRS = - ve in light of the fact that, the chest anode in these leads is closer to the base of the heart, which is the course of electronegativity during the vast majority of the ventricular depolarization process. In drives V4, V5, V6, QRS = +ve on the grounds that the chest cathode in these leads is closer the heart peak, which is the heading of electropositivity during the vast majority of depolarization.

2. Proposed Work

In proposed method, QRS complex with the help of Pan-Tompkins algorithm to detect the heart disease have been briefly explained. QRS complex plays a vital role in ECG signal by getting accurate result in precise time duration. There are two methodologies are followed to get amplitude and duration in accurate time. They are:

1. Derivative – based methods
2. Pan – Tompkins algorithm

Derivative – Based methods:
Implementation of this technique, QRS complex having best result with fine slope and sharp turning point. The derivative method is used to calculate the rate of sharpest turning point with the operator (d/dt) (P. P. Vaidyanathan,2014).

Pan – Topkins algorithm:
It is another replacement method for QRS complex. It is most developed stategy than Derivative – based technique with accurate outcome. It is useful to reduce the noise from ECG signal and also called as Pam – Topkins algorithm.

Period Estimation:
It is important to obtain a accurate result in precise time period to diagnose heart beat QRS complex. This function is done in MATLAB to find the complete cycle time of R- Complex.The peak rate of given algorithm is 70 Hz in entire cycle samples of 65 to 77. The completion time of analyse the QRS complex duration is 0.06 seconds (60 ms) to 0.1 seconds (10 ms) with accuracy. If the time duration is extends more than 10ms then it will indicate the related heart disease of the patient.ECG waves are having several formations and peaks to diagnosis various heart diseases. They are:

P-wave: It indicates depolarized waveforms in atria node having duration 80 to 100 ms.
QRS complex: It represents Ventricular depolarization having duration of 0.06 to 0.1 seconds.

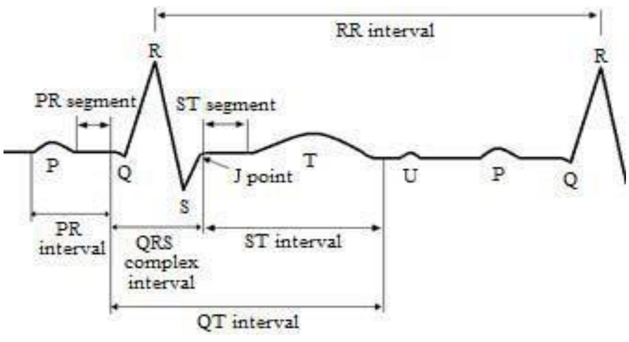

Figure 1 : Normal ECG waveform

Q-wave: It denoted from left-to-right depolarization of inter-Ventricular septum.
R-wave: It represents early depolarization of ventricles.
S-wave: It represents late depolarization of ventricles.
T-wave: It indicates ventricular depolarization and its time is larger than depolarization.

Classification:

The main objective of ECG signal classification is to produce accurate results of heart diseases and to spot an input of ECG database. Then it can be designed for accurate classifier and processed to testing. Pattern recognition is one of the important process to analyse the waves of signals by gathering all the features from the given data. This feature are calculated by numerical pattern recognition (Z. Dokur, 2001). By improving an efficiency of algorithms and speed of computer to process image in computer–aided tomography (CAT) in image processing or image editor.

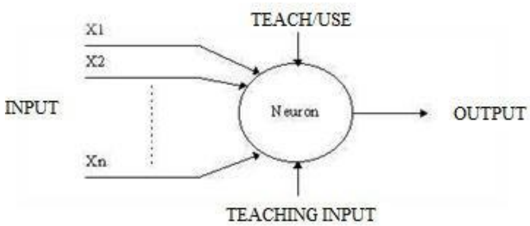

Figure 2 : Three input of and one output neuron unit

Neural Network – based classifier:

Neural networks are mainly found from the biological neuron model as shown in figure by using simple logical method and simulation results. This method is widely used for pattern – recognition to provide accurate results as output and also in data classification.

The neural network model widely invented for data or signal processing which is also known as knowledge processing system. It can be interconnected with all elements parallel as neurons through learning processing system. Sometimes it may provide inaccurate results and this can be overcome by trained set of neuron networks which can easily analyse the techniques of computer systems, the knowledge processing system may receive all the learning duration time with parallel network to improve hardware design . This is valuable to convert from input signal to output vector in a non – linear function of sequence order.

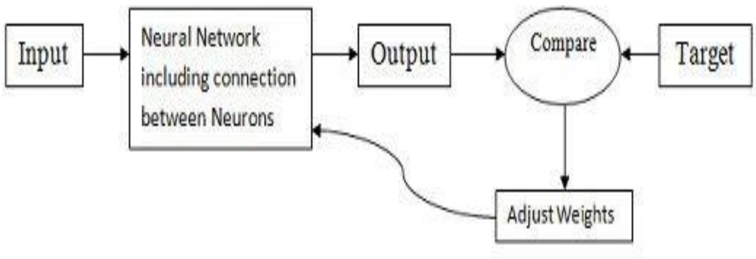

Figure 3: Simple neural network structure

Architecture of Neural Networks

In this section, architecture of neural networks is discussed. The architecture of NN is vital in this research work has its own pattern of neural network.

Feed-forward Network

Feed-forward NN is characterized from its transition direction of data or signal, just one direction are going to be the knowledge or signal travel from input to output. It has no feedback from each output, therefore the output doesn't affect an equivalent layer of a neuron. Feed-forward NN is additionally utilized in pattern recognition.

3. Results and Discussion

The proposed system yield maximum output with minimum complexity and the manual work and time spend by the doctors is reduced by this classification. Provides clear output regarding whether the patient is normal or with any type of arrhythmia diseases. The noise in the ECG signals are reduced so, it has no error in the classification of arrhythmia. The following are the outputs and results obtained from the work done.

Output of the Original ECG Signal

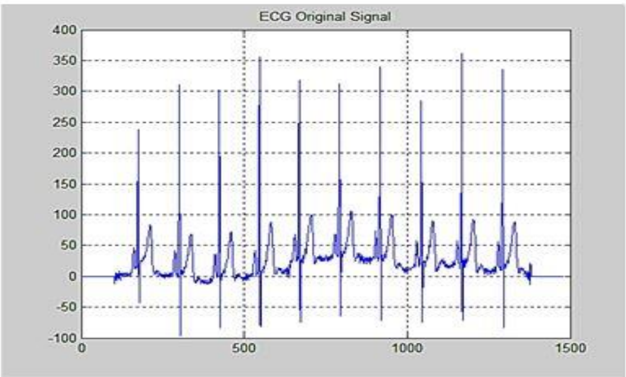

Figure 4: Graphical representation of the original ECG signal

Output of Bandpass Digital Filter and Normalize Result

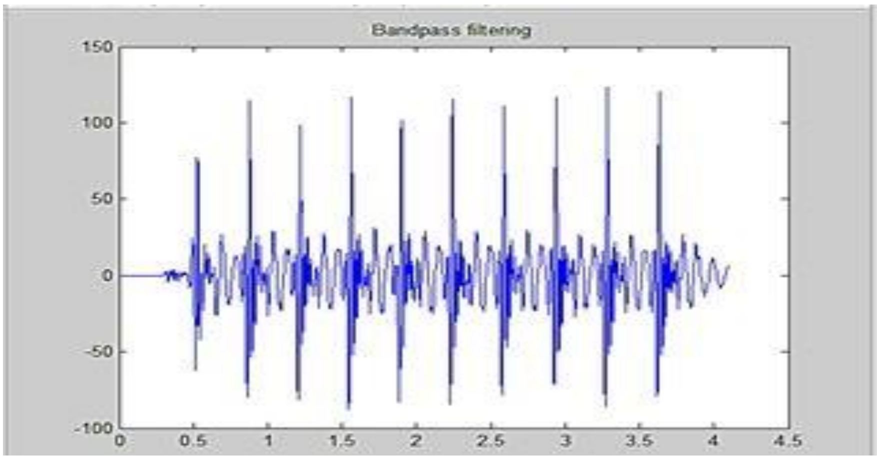

Figure 5 : Output after bandpass filtering process

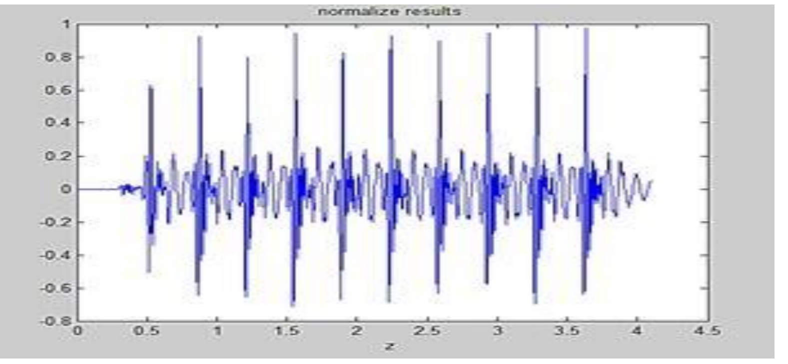

Figure 6: Normalizing technique

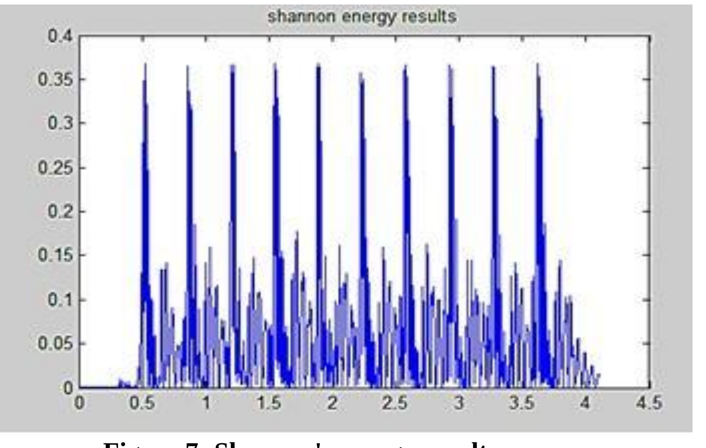

Figure 7: Shannon's energy result

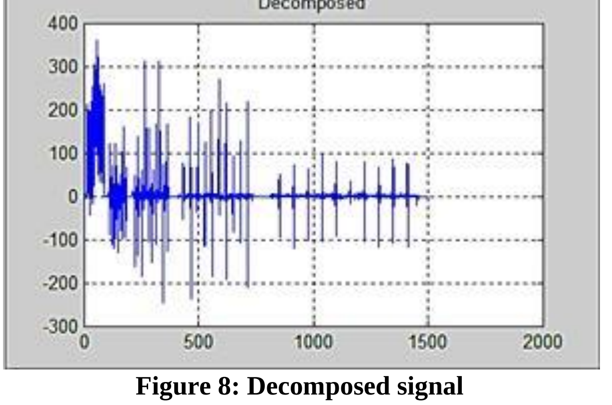

Figure 8: Decomposed signal

Reconstruction of ECG Signals

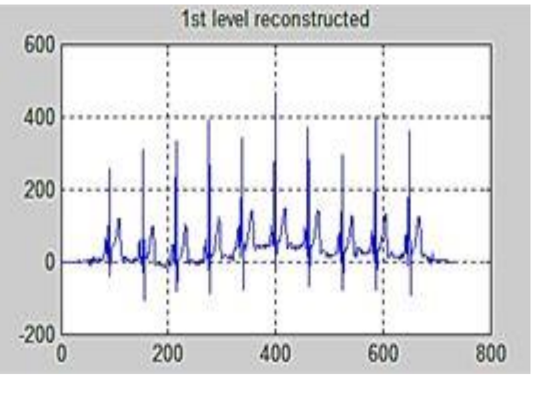

Figure 9: Specification of 1st level reconstruction of ECG signal

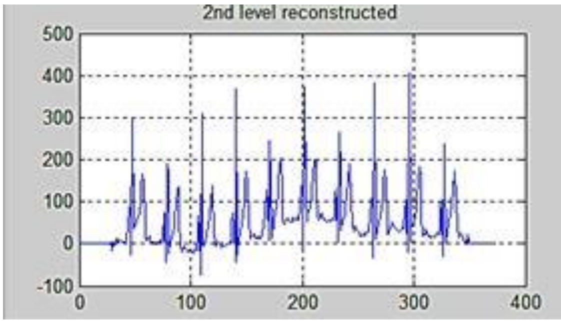

Figure 10: Specification of 2nd level reconstruction of ECG signal

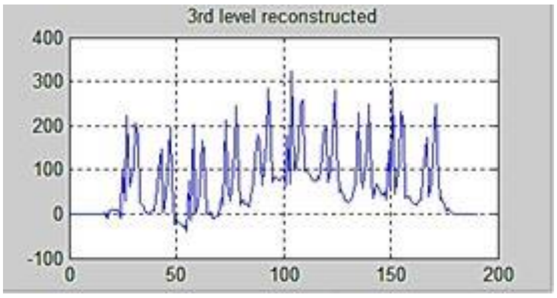

Figure 11: Specification of 3rd level reconstruction of ECG signal

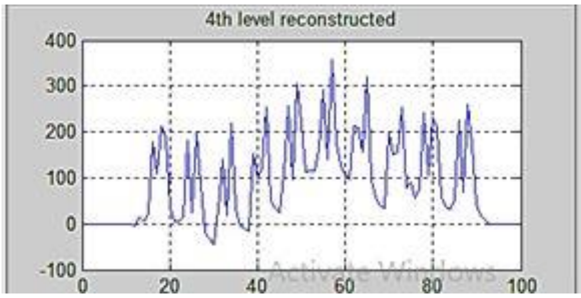

Figure 12: Specification of 4th level reconstruction of ECG signal

Output Smoothing of Signal

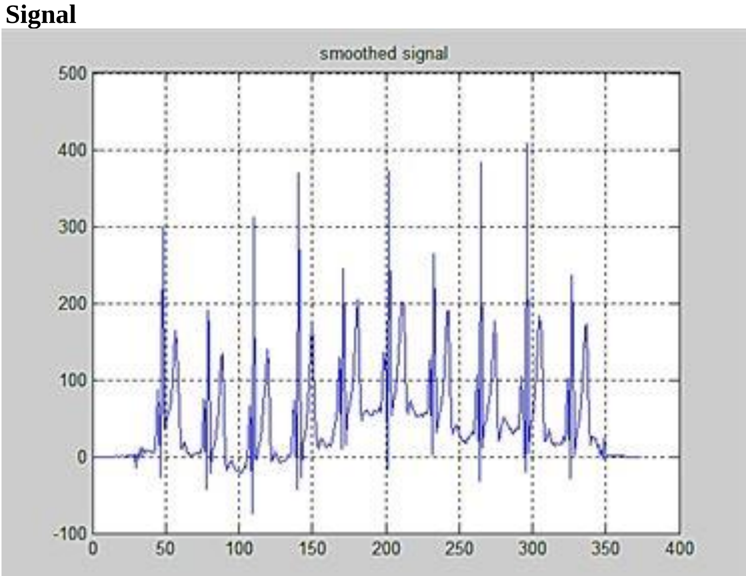

Figure 13: Graphical representation of ECG signal after smoothing

Detection of R

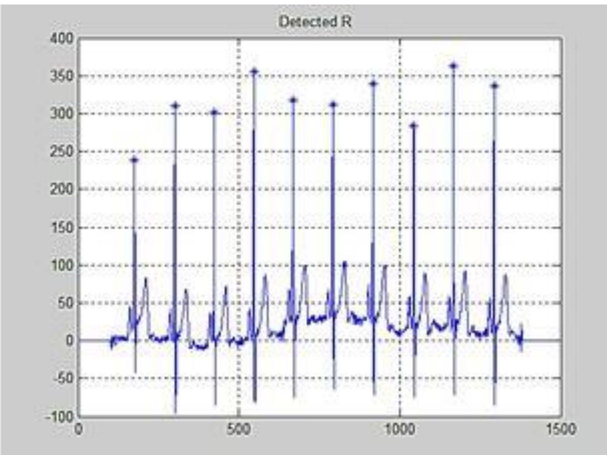

Figure 14: Detection of R component in ECG signal

Detection of ORS Complex and Arrthymia Classification

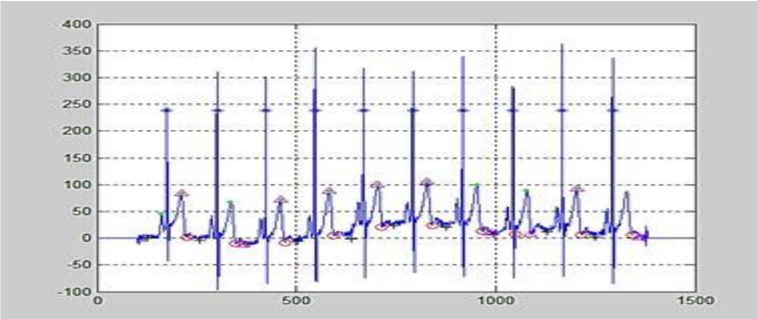

Figure 15 : Detection of QRS complex and arrhythmia

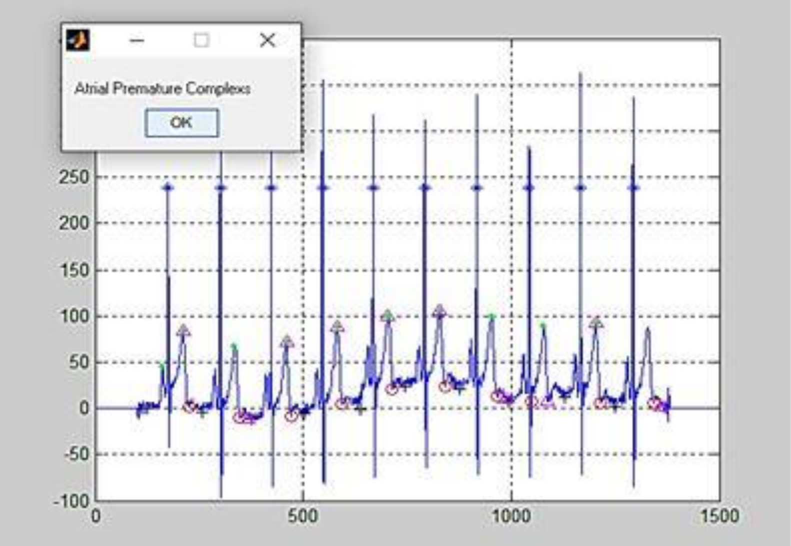

Figure 16: Detection of arrhythmia

Figure 17: The atrial premature complex

4.Conclusion

This research workconcentrate to reduce noise from signal processing in precise time period with respect to cardiology diagnosis. This deal with the arrhythmia classification and to identify the specific heart disease. This is done by reducing noise in input ECG signal. To achieve this accurate result by using QRS algorithm with noise detecting filter. Analyzing the signal from arrhythmia is done by peak QRS algorithm (PQRS) to diagnose heart disease in precise time period of 10ms. If it exceeds in estimation period, then it is will give result of related heart diseases. Additionally, the abnormal heart signal can be identified by comparing with normal heart signal.

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