# A Review of ECG Signal De-noising and Peaks Detection Techniques

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***Abstract—*** *The Modern era is marked by tension and, therefore, heart is in trouble. Whole of the world is busy making research in ECG techniques. on Electrocardiogram and its feature extraction is the area of interest.. Analysis and classification let the medical professional to detect the heart ailments and other diseases. In our research method for De-noising of ECG signal and Feature extraction Algorithm is proposed. We considered the baseline wander problem in ECG signal which is basically due to the measurement error. This work involves the IIR filter Savitzky-Golay filter and Wavelet Transform. ECG signal is de-noised without affecting any information from ECG. We have also designed a feature Extraction algorithm which automatically detects the RR interval and QRS interval along with the amplitude of Q, R, and S. The whole algorithm including the de-noising of signal and Feature extraction. This work has been simulated on the MATLab software.*

***Keywords—ECG, Wavelet transform, Matlab, Feature Extraction.***

## I. INTRODUCTION

Many researches are going in the world to automate the process of preprocessing ECG signal & analyzing the same & compare it with the standard database. The system should be able to detect & publish the diagnosis automatically.

The electrocardiogram, aka the ECG or EKG (after the German word Electrocardiogram), was invented by Nobel prize winner Willem Einthoven, in 1903. More than a century later, the machine that measures and records the electrical signs of the heart in order to quickly

Diagnose many types of heart diseases, remains a cornerstone of cardiology practice [1]. The heart is a two stage electrical pump and the heart's electrical activity can be measured by electrodes placed on the skin. The electrocardiogram can measure the rate and rhythm of the heartbeat, as well as provide indirect evidence of blood flow to the heart muscle.

Electrocardiography is the technique by which electrical activities of the heart are studied The spread of excitation through myocardium produces local electrical potential .This low –intensity current flows through the body ,which acts as a volume conductor .This current can be picked up from surface of the body by using suitable electrodes and recorded in the form of electrocardiogram.

Electrocardiography is the instrument (machine) by which electrical activities of the heart are recorded .It is known as electrocardiogram.

**uses of ECG –**Electrocardiogram is useful in determining and diagnosing the following diseases:

1.Heart rate 2. Heart rhythm 3. Abnormal electrical conduction 4. Poor blood flow to heart muscle 5. Heart attack 6. Coronary artery 7. Hypertrophy of heart chambers

- ECG provide electrical rhythm of the heart. the heart muscle cells have electrical potential just like the cell in the body. A normal heart electrical system produces a characteristic p-qrs t wave pattern as the atria and ventricles depolarize and re polarize .
- ECG are also potentially able to diagnose an myocardial infarction but not always. Myocardia infarction shows on an ecg but a patient can suffer an MI and have in not be visible on time ecg.This is also called a non SI elevation MI.

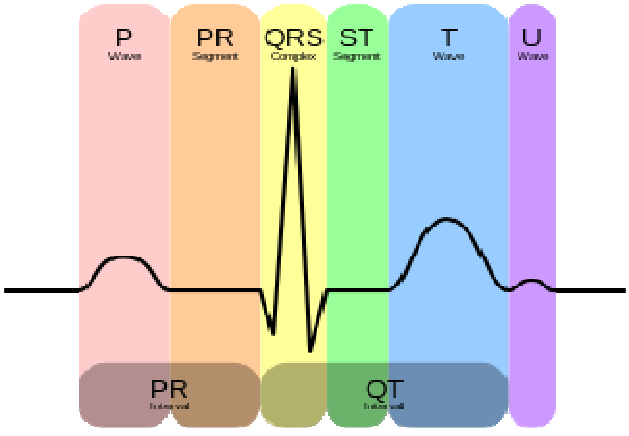


*Fig.1: A Sample ECG showing P-QRS-T-U Wave*

**P - WAVE :** The P -wave is caused by electrical potentials generated when the atria depolarize before atrial contraction begins. The P wave is amplitude 0.25mV is called Positive wave.

**QRS-COMPLEX : The QRS complex is caused by** potentials generated when the ventricles depolarize before contraction, that is, as the depolarization wave spreads through the ventricles.

**T-WAVE :** The T wave is caused by potentials generated as the ventricles recover from the state of depolarization. This process normally occurs in ventricular muscle 0.25 to 0.35 second after depolarization,[2] and the T wave is known as a *re- polarization wave.* The T-wave is amplitude 0.1 to 0.5 mV.

*Table. 1: Waves of Normal ECG*

| Wave | From-To | Cause | Duration(second) | Amplitude(mv) |
|---|---|---|---|---|
| P wave | - | Atrial depolarization | 0.1 | 0.1 to 0.12 |
| QRS complex | Onset of Q wave to the end of s wave | Ventricular depolarization and atrial repolarization | 0.08 to 0.10 | Q = 0.1 to 0.2<br>R = 1<br>S = 0.4 |
| T wave | - | Ventricular repolarization | 0.2 | 0.3 |
| P-R interval | Onset of P wave to onset of Q wave | Atrial depolarization and conduction through Av node | 0.18 (0.12 to 0.2) | - |
| Q-T interval | Onset of Q wave and end of T wave | Ventricular depolarization and ventricular repolarization | 0.4 to 0.42 | - |
| S-T segment | End of S wave and onset of T wave | Isoelectric | 0.08 | - |

## II. LITERATURE REVIEW

Dr A K Wadhwani et. al have simulated the ECG signal using MATLAB tool. The real life ECG signal is mixed with power line interference at 50 hz & then adaptive filter is used to filter out the noise. In second case the process is repeated with base line wandering noise at 0.5 hz & finally both type of noise are mixed together & then filtered out using the adaptive filter[3]. The results obtained in each case prove the validity . of the adaptive filtering Authors have suggested the future line of research in the direction of non traditional type of noise.

Akanksha Deo et. al have experimentally studied the denoising ECG signal using Least Mean square adaptive algorithm. LMS technique is simple to implement, stable & unbiased. In minimizing the error It removes the noise & extracts the signal by adapting the filter coefficient with least square algorithm[4]. The patch based non local means can effectively remove the noise. The authors suggest that there is a further scope of the development of more efficient algorithm.

Neha Soorma et. Al have studied the extraction of ECG signal. The paper explains feature extraction algorithm for ECG signal using wavelet transform & Hilbert-Huang transform. The strong mathematical model is used to detect & analyse the components of the signal which help to identify the different artefacts which help to find out abnormalities[5]. The HHT algorithm yield very reliable results in extraction feature of any signal. The lower frequency component is generated using HHT algorithm which is useful to analyze any non linear signal. Non-linear signals can also be detected and analysed using the above algorithm. Wavelet transform requires fixed basis function for the analysis & thus difficult to model. The results prove that HHT is efficient as compared to WT[9].

Bhumika et al have studied noise removal techniques for ECG signals. The noise present in ECG is removed using FIR filter.The study proves that FIR filter are advantageous over IIR filters. FIR filter are stable as they have non recursive structure. Easy to implement when fabricated.The filter response is of finite duration[6].

M.K. Islam et. Al have made a deep study & analysis of ECG signal using softwares called MATLAB & Labview. The study includes generation & simulation of ECG signal filtering & processing feature extraction[7] comparison between different ECG signal analysis algorithms & techniques viz. wavelet transform detection of any abnormalities in ECG, calculating beat.

K. Akilandeswari & R. Sathya have studied the problem of cardia arrhythmia.This medical problem should be detected at an early age ECG plays an important role in detecting the above mentioned problem[8] .The input signals from the data set were preprocessed by removing null value & transformed using Fast Fourier Transformation & Walsh - Hadamard Transformation.The output can be classified to detect the abnormalities[10].

## III. PROPOSED METHODOLOGY

A set of methods or principles or rules for regulating the process is called Methodology.

The Proposed Model has six major steps:

- Input ECG Signal download from Physiobank.
- Pass the Signal with high pass filter to remove Base line wander.
- Wavelet Transform is used to decompose the Signal.
- Savitzky-Golay Filter is used to smoothen the ECG Signal.

- Detect the P , Q , R , S peaks .
- Find RR interval mean & QRS interval mean


*Fig.2: The Block Diagram Of Proposed Algorithm*

**3.1 Wavelet Transform –**The Wavelet is a mathematical tool that decomposes a signal. Now a days Wavelet transform is one of the most popular method of the time frequency transformation.

**3.2 Application of Wavelet transform-** 1. Signal Processing 2.Data Compression 3. Smoothing and image denoising

**3.3 Savitzky-Golay Filter-** Savitzky-Golay smoothing filter are typically used to smooth out a noisy signal whose frequency span is large. In this type of application, Savitzky-Golay smoothing filters perform much better than standard averaging FIR filters, which tend to filter out a significant portion to the Signal' S high frequency content along with the noise.

**3.4 Detection R Peak and QRS Peak -** The R Peak in the signal has the largest amplitude among all the waves. The detection of the QRS complex is based on modulus maxima of the Wavelet transform.This is because modulus maxima and zero crossings of the wavelet Transform correspond to the sharp edges in the signal.The QRS complex produces two modulus maxima with opposite signs,with a zero crossing between them show in fig.The Q and S point occurs about the R peak with in 0.1 sec. The left point denoted the Q point and the right on denotes the S point.

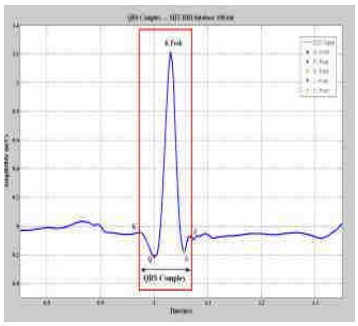

*Fig.3: Detection of R Peak and QRS Peak*

## IV. CONCLUSION

Health awareness has raised a demand for better heart care. In between this has motivated my research in the field of ECG analysis & diagnosis. In the present work we have pondered over the research made in recent time. Different techniques like adaptive filter is being used to denoise ECG signal. Least Mean Square technique is tested by other authors Hilbert – Huang transform has been developed & tested for ECG feature extraction. We have thoroughly .investigated the previous work which is not able to remove base line wander & efficiency is upto 90%. In our work we have used High pass filter to remove Baseline Wander we are 100% efficient in de-noising the Signal.

## V. FUTURE WORK

The scope of the future work is that PR interval , RT interval and ST interval can also be detected . This information can be useful in more accurate diagnosis**.** .

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