

# RECOGNITION OF VARIOUS WAVES FROM ELECTROCARDIOGRAM BY USING WAVELET TRANSFORM

Nikhil S. Kale<sup>1</sup>, Dr.Sunil S. Morade<sup>2</sup>

<sup>1</sup>Dept. Of E&TC, K.K.W.I.E.E.R, Nashik, Maharashtra, India

Email: nikskale91@gmail.com

<sup>2</sup>Professor, Dept. Of K.K.W.I.E.E.R, Nashik, Maharashtra, India

Email: ssmorade@kkwagh.edu.in

\*\*\*

**Abstract** - Electrocardiogram is common bio signals used to detect the heart activities by non invasive techniques. A wavelet based denoising algorithm on ECG signals is used for extracting features such as amplitude of the ECG signal. Signal processing is done by removing high frequencies components using the proposed algorithm. Component analysis is done using moving average filter and 1<sup>st</sup> order derivative filter. Simulation shows satisfactory result of ECG signal analysis. The proposed scheme uses mobile phone as ECG signal generator which will be further applied to the medical kit, and digital output will be sent to MATLAB where the proposed algorithm will process he obtained signal and analysis will be done.

**Key Words:** ECG, QRS, wavelet transform, denoising, moving filter, heart rate calculation.

## 1.INTRODUCTION

ECG is the most common bio signal to detect heart activities by non-invasive method. It routinely accesses the muscular and electrical behavior of the heart. In biomedical engineering most commonly used method are Digital signal processing and data analysis. Electrocardiogram signal contain T, S, R, Q, P wave. These waves show the rhythmic depolarization and repolarization. It is used basically in diagnosing various diseases related with heart. This signal is measured by applying electrodes at the human body in non-invasive manner. These signals are then passed on through amplifier and A/D converter for further processing.

### Amplitude

Parameter	Amplitude (mV)
P Wave	0.25
R Wave	1.60
Q Wave	25% of R wave
T Wave	0.1 to 0.5

### Duration

Parameter	Duration (Sec)
P-R Interval	0.12 to 0.20
Q-T Interval	0.35 to 0.44
S-T Interval	0.05 to 0.15
P wave Interval	0.11
QRS Interval	0.09

60 to 100 beat/minute is the standard range for heart beat. If it is higher than it is called tachycardia and if it is slower than it is called bradycardia. Blockage present in AV node if PR interval is more than 0.2sec.

Depolarization of the atrial musculature occurs due to wave P. Repolarization of atria and depolarization of the ventricles, which occur simultaneously that generates QRS complex.

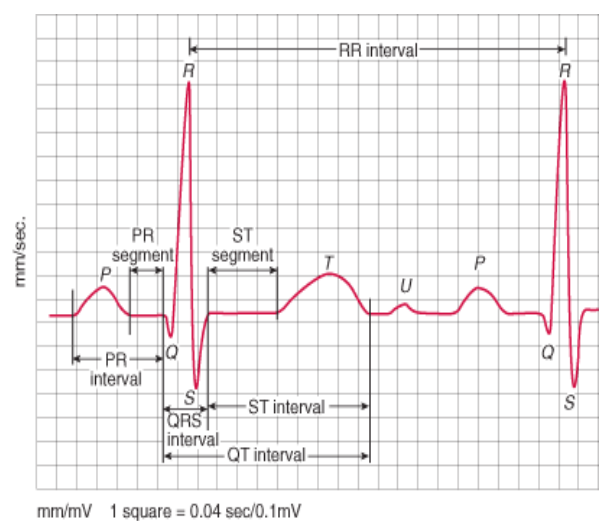


Fig.1. Normal ECG waveform

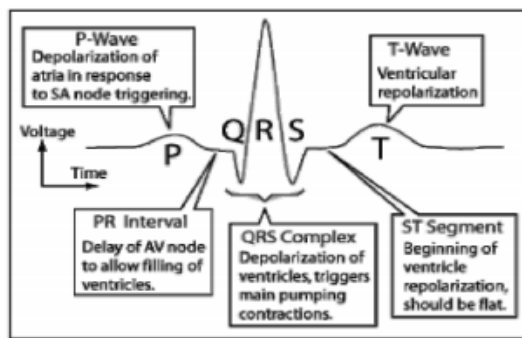


Fig.2 Waveform detail

There are two problems of Digitized Signal- interference with other noisy signals and this can be remove before data processing. Embedded devices requires effective design of Digital filters and signal processing. ECG signal analysis compute the heart rate frequency. Many algorithms have been proposed for obtaining the heart rate frequency through ECG.

QRS complex can be detected using various algorithms as wavelet transforms or filter banks, genetic algorithms, artificial neural networks.[2]. Adaptive threshold [3] method is use to detect QRS complex. ECG signal spectral analyze [4] and Short-Term Autocorrelation method [5] are use to detect heart rate. Complicated implementation to microprocessor unit is major drawback for above methods.

The proposed design of filters and algorithms for wavelet transform is very simple and efficient and is implemented using MATLAB 2014 software. The paper is divided into following sections: II. Wavelet Transform, III. Proposed System, IV. Simulation Results

## 2.WAVELET TRANSFORM

Mathematic functions with oscillatory nature with the difference of finite oscillatory nature is called wavelet. A daughter wavelet of the original mother wavelet is a decaying waveform, finite length, when scaled and translated results. Thus, translation variables and different scaling result in a different daughter wavelet from a single mother wavelet.

They are divided into discrete wavelet transforms (DWT) & continuous wavelet transforms (CWT). Wavelet transforms provide variable time frequency resolution where as Fourier transform of a signal provide frequency resolution.

A convolution of the wavelet function  $\psi(t)$  with signal  $x(t)$  is called wavelet transform. Approximation coefficients  $S$  is generated from scaling function can be

convolved with signal. Orthonormal discrete wavelets are related with scaling functions  $\phi(t)$ .

The discrete wavelet transform can be shown as:

$$T_{p,q} = \int_{-\infty}^{\infty} \phi_{p,q}(t)x(t)dt \dots \dots \dots (1)$$

we can rebuild the original [5] by selecting an orthonormal wavelet basis  $\psi_{p,q}(t)$ .

The approximation coefficient of the signal at the scale  $p$  and location  $q$  can be shown as:

$$S_{p,q} = \int_{-\infty}^{\infty} \phi_{p,q}(t)x(t)dt \dots \dots \dots (2)$$

But the discrete input signal is of finite length  $N$ . So,  $0 < p < P$  range of scales that can be investigated.

Thus a discrete approximation can be shown as:

$$x_0(t) = \sum_{p=1}^P d_p(t) + x_p(t) \dots \dots \dots (3)$$

Where, detail signal approximation corresponding to scale  $p$  and the mean signal approximation at scale  $P$ , for finite length signal is shown as:

$$d_0(t) = \sum_{q=1}^{P-p} T_{p,q} \phi_{p,q}(t) \dots \dots \dots (4)$$

The detail of the next lower scale and approximation combine to form the signal approximation.

$$S_{p,q} = x_{p-1}(t) - d_p(t) \dots \dots \dots (5)$$

## 3.PROPOSED SYSTEM

The first step of proposed system is a pre-processing is so here first we use FIR 1 filter (least square linear phase), Butterworth filter are applying for filtering and preprocessing. DWT having R- peak data and define R- peak data and finding its values. So here amplitude difference is 0.5 and peak is above this

value [11]. The Methodology of R- peak detection is shown in Figure 3 below:

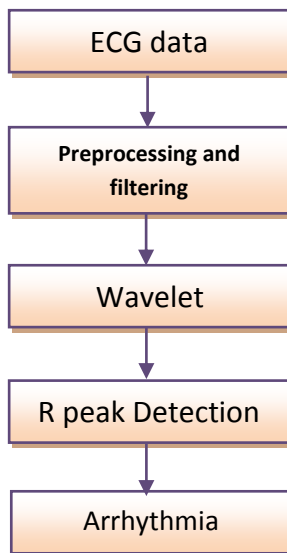


Fig.3 Flow chart

**ECG signal:** ECG signals are collected from Physionet MIT-BIH arrhythmia database. Two overlapping ECG is splitting in single - single way

1. X axis represents as samples.
2. Y axis represents as amplitude

**Preprocessing:** There are different types of noise in ECG signal which are listed below

1. Baseline drift
2. Frequency interference
3. Muscle noise internal amplifier noise
4. Artifacts.
5. Electrode contact noise.

Artifacts are introducing noise of ECG signal which results from moving electrode. The range of frequency is 300-500 Hz. The original signal having 300 Hz and resultant signal having 500 Hz .

**Wavelet transform:** Wavelets transform having good resolution, efficient localization and high frequency.

**R Peak Detection:** In the first step, feature extracted for R peak detection, So R – peak having largest amplitude. Hence amplitude of 0.5 is taken from threshold. Finally location of two successive R peaks is the R-R interval.

**4.SIMULATION RESULTS**

MATLAB software used to perform the analysis of wavelet ECG signal. MATLAB having a interactive system and high performance are allowing to solve problems in technical computation.

The raw Electrocardiogram signal is shown below:

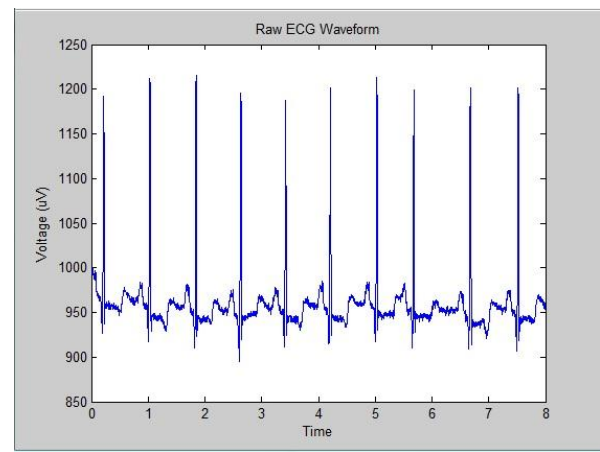


Fig.4. Electrocardiogram waveform

The filtering techniques are applied and the filtered output is as follows

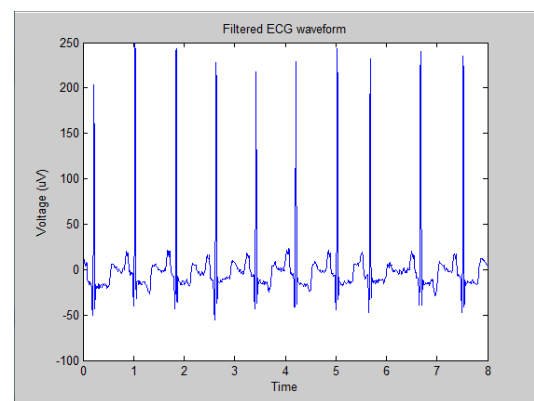


Fig..5. Filtered ECG waveform

Thus, from the signal total R peaks are detected. These R peaks further help us in detecting arrhythmia.

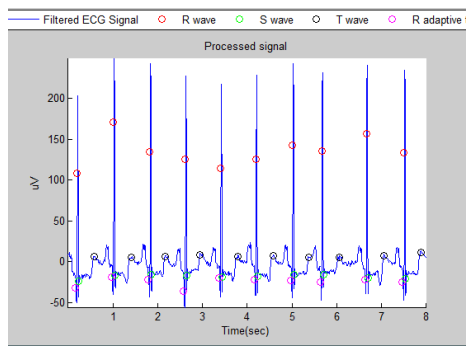


Fig..6. Filtered ECG waveform

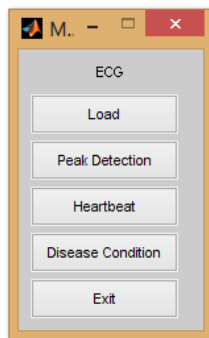


Fig.7 GUI for System

## 5.CONCLUSION

In proposed approach the main problem which faced people in arrhythmia analysis for automatic ECG having large no. of variations in morphological ECG waveforms. In this new approach is objective is a simple method having a reduced amount of computational time without compromising with the accuracy.

In new proposed algorithm use of filter and DCT, a new R- peak is implemented .The information of R- peak is very useful for analysis ,classification, and arrhythmia detection such as Bradycardia and Tachycardia . From this new technique Bradycardia and Tachycardia can be easy way to identify from R-peak location and possibility of R-peak is more. R-R interval From the R-peak location can be easily estimated that will provide much better heart beats for patient. The main advantage is less time for detection of ECG signal.

## ACKNOWLEDGMENT

In my proposed work support of K.K.W. I.E.ER, Nasik for providing the research facilities.

## REFERENCES

- [1] L. Cromwell, F.J. Weibell, E.A. Pfeiffer (2005) Biomedical Instrumentation and Measurements, Prentice Hall of India, New Delhi
- [2] Kohler, B.-U.; Hennig, C.; Orglmeister, R. The principles of software QRS detection. Engineering in Medicine and Biology Magazine IEEE, vol. 21, pp. 42 – 57, January -February 2002.
- [3] I. I. Christov. Real time electrocardiogram QRS detection using combined adaptive threshold. BioMedical Engineering OnLine, 2004. [cit: 2011-10-16]. [Online]. Available on internet: <http://www.biomedical-engineering-online.com/content/3/1/28>.
- [4] Surda, J.; Lovas, S.; Pucik, J.; Jus, M. Spectral Properties of ECG Signal. Radioelektronika, 2007. 17th International Conference, Brno, Czech Republic, 24th – 25th April 2007, pp. 1 – 5.
- [5] Piotrowskia Z.; Rózanowski K. Robust Algorithm for Heart Rate (HR) Detection and Heart Rate Variability (HRV) Estimation. ACTA PHYSICA POLONICA, vol. 118, pp. 131 – 135, No. 1/2010.
- [6] Pan, Jiapu; Tompkins, Willis J. A Real-Time QRS Detection Algorithm. IEEE Transactions on Biomedical Engineering, vol. BME-22, pp. 230 – 236, March 2005.
- [7] J.I.Willems and CSE working party, “Recommendations for measurement standards in quantitative ECG” European Heart Journal 1985)6,815-825.
- [8] Bekir Karhkand,YiikselOzba, “ A New approach for Arrhythmia classification” 18th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, Amsterdam
- [9] Chung-chien chiu tong hong, “using correlation coefficient in ECG waveform for Arrhythmia detection” Biomedical engineering applications basis communications June 2005 vol.17 no-4 ,147-152
- [10] S.C.Saxena, V. Kumar and S. T. Hamde, “Feature extraction from ECG signals using wavelet transforms for disease diagnostic” International Journal of Systems Science, 2002, volume 33, number 13, pages 1073–1085.
- [11] Pan J. and Tompkins W.J., “A real-time QRS detection algorithm”, IEEE Trans. Biomed. Eng., vol. 32, pp. 230–236, 1985

## BIOGRAPHIES



Nikhil S. Kale (PG student)  
Dept, Electronics and  
Telecommunication  
K.K.Wagh IEER  
Nashik, India  
Email:-nikskale91@gmail.com