

## A Study of the Processes Involved in ECG Signal Analysis

S.Hemajothi, \*\* Geethabala, \*\*\* Dr.S.Arunarani

\*Professor, Department of Electronics and Communication Engineering,

\*Prince Shri Venkateshwara Padmavathy Engineering College, Ponmar, Chennai-600127.

\*\*Assistant Professor, Department of Electronics and Communication Engineering.

\*\*Prince Dr.K.Vasudevan College of Engineering & Technology, Chennai.

\*\*\*Faculty, Prince Shri Venkateshwara Arts and Science College, Gowriwakkam.

### ABSTRACT

ECG Signal Analysis involves various processes and techniques which in the recent years, have yielded better results in terms of accuracy in the diagnosis of heart diseases. This paper deals with some of the recent developments in the processes such as denoising, data compression, feature extraction and classification of the ECG signals. These processes are discussed each with suitable examples.

### Keywords :

Artificial Neural Networks, Wavelet Transform, Arrhythmia

### INTRODUCTION

There is a need for tackling large number of patients with various kinds of heart diseases. Medical science in collusion with Computer Science has, during the recent years, evolved methods that could be used for expert diagnosis by the cardiologists. Electrocardiogram (ECG) is an invaluable tool for diagnosis of heart diseases. The normal ECG waveform with its various segments is shown in Figure.1. With the help of ECG, the electrical activity within the heart can be easily detected from the outside of the body. When the ECG is abnormal it is called Arrhythmia. The patterns of the waveform change due to abnormalities of the heart. The methods used for diagnosis generally involve four essential processes to arrive at the accurate and quick decisions about the kind of heart disease a patient suffers from. They are: 1. Data Compression 2. Denoising Feature Extraction and 4. Classification. In this paper each process is explained with examples from the recent researches using Artificial Neural Network. An Artificial Neural Network, often just called a neural network, is a mathematical model inspired by biological neural networks. A neural network consists of an interconnected group of artificial neurons, and it processes information using a connectionist approach to computation. In most cases a neural network is an adaptive system that changes its structure during a learning phase. Neural networks are used to model complex relationships between inputs and outputs or to find patterns in data[12].

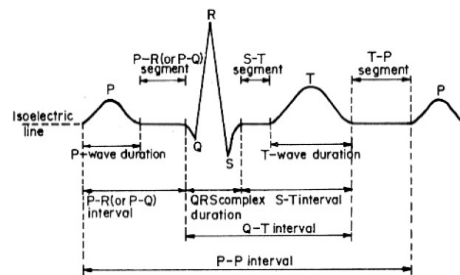


Figure 1: The normal ECG waveform

I. DATA COMPRESSION

Quite a large volume of ECG data produced by monitoring systems over a period of time, need to be compressed for efficient storage. ECG signals are collected both over long periods of time and at high resolution. This creates substantial volumes of data for storage and transmission. Data compression seeks to reduce the number of bits of information required to store or transmit digitized ECG signal without significant loss of signal quality.

In a project taken up by Dr. Anubhuti Kare et al[9], they have developed and implemented a low complexity „lossy“ ECG Encoding Algorithm capable of at least a 2 : 1 compression rate. There are two types of Compression techniques „lossless“ and „lossy“. Since lossy compression technique gives a better compression rate, this technique has been used. A Coder- Decoder, based on a new emerging Transformation technique called Wavelet Transform coding, has been chosen so as to achieve the compression ratio 2 :1 .

Wavelet Transforms: A number of alternative time – frequency methods are now available for signal analysis. Of these, the wavelet transform has emerged over recent years as the most favored tool by researchers for analyzing problematic signals across a wide variety of areas in Science, Engineering and Medicine.

It is found that the compression technique using Discrete Wavelet Transform (DWT) is more effective compared to the Discrete Cosine Transform (DCT). The algorithm that has been implemented using Wavelet Transform technique seems to be the best choice for ECG data compression.(Table 1)

Table 1

DCT Compression	DWT Compression
CR = 90%	CR = 95%
PRD about 1%	PRD less than 1%
Algorithm Execution Time about 7 sec	Algorithm Execution Time about 3 sec

DENOISING

One of the main problems in biomedical data processing like electrocardiography is the separation of the wanted signal from noises caused by power line interference, external electromagnetic fields, random body movements and respiration. ECG filtering is done so that the desired information is not distorted by interferences or altered in any way.

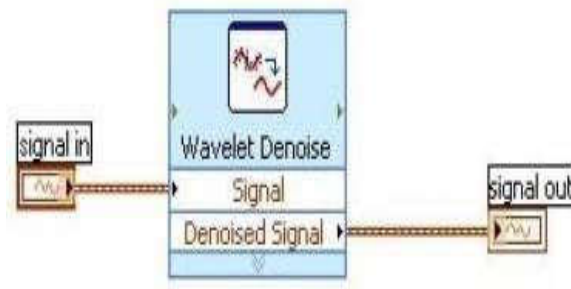
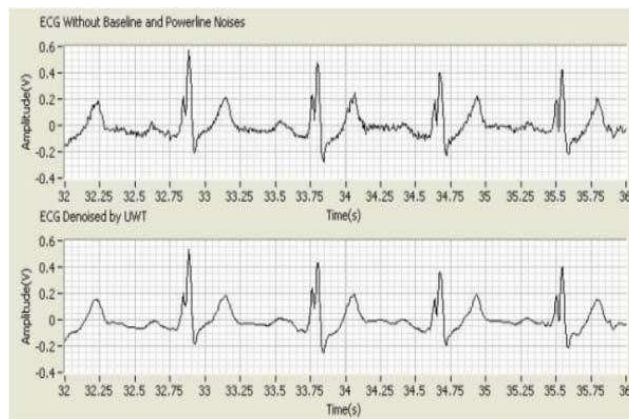


Figure 2: Removing wideband noises from an ECG signal by applying the UWT

For the purpose of filtering ECG, Manpreet [8] uses a combination of Moving Average Method and IIR Notch filter. A moving average filter smoothes data by replacing each data point with the average of neighboring data points. This removes the baseline drift of original ECG signal and thus the power spectral density is removed. The IIR Notch filter is applied to this smoothed signal.

Chinmay Chandrasekar et al [3] have used Adaptive Power line Interference Canceller which is an improved adaptive canceller for the reduction of the fundamental power line interference component and harmonics in ECG recordings. They used RLS (Recursive Least Squares) algorithm which is a special version of the adaptive filter which has less computational complexity and good filtering capacity.

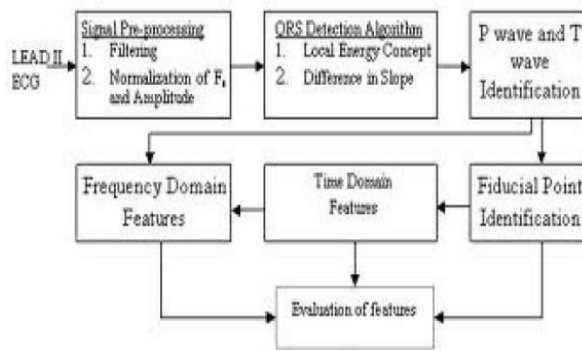
The Figure.3 shows a sample signal before and after noise removal.



**Figure 3: ECG signals before and after UWT de-noising**

### FEATURE EXTRACTION

An expert Cardiologist will not be able to monitor a large number of cardiac patients efficiently and so computer aided feature extraction and analysis of ECG signal for disease diagnosis has become necessary. The input data will be transformed into a reduced representation set of features (also named features vector). Transforming the input data into the set of features is called *feature extraction*. If the features extracted are carefully chosen it is expected that the features set will extract the relevant information from the input data in order to perform the desired task using this reduced representation.



**Figure 4.Steps in Feature Extraction**

The flowchart in Figure.4 indicates the steps involved in Feature Extraction. For the purpose of diagnosis, we need to extract various features from the preprocessed ECG data, including QRS intervals, QRS amplitude, PR intervals, ST intervals etc., In this kind of analysis, identification and extraction is the first step. The most prominent feature here is QRS complex and the accurate detection of QRS complex forms the basis for the extraction of other features.

There are four approaches to feature extraction viz 1) Syntactic Approach 2) Non Syntactic Approach 3) Hybrid Approach 4) Transformative Approach. Of these the Non Syntactic method is widely used. In the Transformative Approach, the use of Wavelet Transform (WT) in QRS detection has given accuracy of detection and simplicity in calculation without any seed for preprocessing.

### CONCLUSION AND FUTURE WORK

The discussion so far made shows that new techniques are being evolved by researchers in each process involved in signal analysis so that more accuracy is achieved and treatment is given before it is too late. There is scope for future research in each process leading to 100% accuracy.

### References

- [1] Thaweesak Yinglhwornsuk: "Classification of Cardiac Arrhythmia via SVM", International Conference on Biomedical Engineering and Technology IPCBEE. Vol. 34 2012, IACSIT Press, Singapore.
- [2] Rajiv Rajan, V.K Giri: "A Unified Approach of ECG Signal Analysis", International Journal of Soft Computing Engineering (IJSCE)ISSN : 2231 – 2307, Vol. 2, Issue -3, July 2012.
- [3] M K Islam, AANMM Haque, G.Tangim, T.Ahamad and MRH Khondoker: "Study and Analysis of ECG Signal Using MATLAB and LABVIEW as Effective Tools", International Journal of Computer and Electrical Engineering Vol.4 ,No.3, June 2012.
- [4] Shahnaz Ayub, J.P.Saini: "Fusion Beats Extraction from ECG Using Neural Networks based Soft Computing Techniques", Advances in Applied Science Research, 2010, I(2) 76 – 83.
- [5] R. Acharya U , A. Kumar , P.S. Bhat , C . M . Lim , S. S. Iyengar , N. Kannathal, S . M . Krishnan: "Classification of Cardiac Abnormalities using Heart Rate Signals", Medical and Biological Engineering and Computing(2004), Vol.42, PP 288 – 293.

- [6] Alexandros Pantelopoulos and Nicollaos Bourbakis, “ECG Beat Classification using Optimal Projections in Overcomplete Dictionaries”, 23<sup>rd</sup> IEEE International Conference on Tools with Artificial Intelligence, 2011.
- [7] Manpreet Kaur, Birmohan Singh: “Powerline Interference Reduction in ECG Using Cobination of MA method and IIR Notch”, International Journal of Recent Trends in Engineering, Vol.2 No.6, Nov 2009.
- [8] Anubhuti Khare, Manish Saxena, Vijay B Nerker :” ECG Data Compression using DWT”, Internatioanl Journal of Engineering and Advanced Technology (IJEAT) ISSN : 2249 – 8958, Vol. 1, Issue -1, Oct 2011.
- [9] Surendra Dalu, Nilesh Pawar: “Detection and Classifictaion of QRS and ST segment using WNN”, International Journal of Computer Science and Network(IJCSN) , Vol. 1, Issue – 3, June 2012, [www.ijcsn.org](http://www.ijcsn.org), ISSN 2277 – 5420.
- [10] Miss Hong Liang: “ECG Feature Elements Identification for Cardiologist Expert Diagnosis”, Proceedings of the 2005 IEEE Engineering in Medicine and Biology 27<sup>th</sup> Annual Conference, Sanghai, China Sept 1-4 2005.