A Survey: Feature Extraction of ECG Signals using HAAR Wavelet

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Abstract— This project deals with the study of ECG signal by using Haar wavelet analysis. We took 10 waveforms of ECG signals and applied them to Matlab simulator to study the various components of signals. Wavelet Transform Technique gives good frequency & time information of ECG signal.

Key words: Feature Extraction, ECG Signals

I. INTRODUCTION

A wavelet analysis used in Digital image processing for feature extraction. Wavelet is used in many recent development techniques. The principles are similar to those of Fourier analysis. Earlier, ECG signal were examined only in time domain, but this information is insufficient .Thus to acquire information in both time and frequency domain we apply wavelet transform to the ECG signals.ECG signals are non-stationary, random periodic in nature and whose behavior changes with temporal domain. The proper processing of ECG signal and its accurate detection and prediction is very much essential since it determines the condition of the heart. The analysis of ECG signal requires the information both in time and frequency, for acute clinical diagnosis. Hence the Haar wavelet transforms are used to analyze these signals. The wavelet analysis of ECG signal is performed using MATLAB software. MATLAB is a high performance; interactive software which is used in signal and image processing domain for proper analysis. Wavelet tool box is being provided by Matlab. Matlab consist of different function to perform different computation. It provides tools for the proper simulation, analysis and synthesis of signals, images and videos using wavelets and wavelet packets within the MATLAB domain.

Wavelets are mathematical functions that cut data into diff erent frequency components, and then emphasize on each component with a resolution matched to its level. They have advantages over Fourier and short term Fourier methods in analyzing situations where the signal contains irregularities and sharp transition spikes. Wavelets were studied independently in the fields of mathematics, quantum physics, electrical and electronics engineering, and Seismic geology. Interchanges between these fields during the last ten years have led to various new wavelet applications such as detection of face, detection of palm, image compression, turbulence, human vision, radar, and earthquake prediction. Sine and cosine wave used to superimpose on different signals and represent them.

Wavelets are well-suited for approximating data with sharp discontinuities.In signal processing, wavelets make it possible to recover weak signals from noise. This has proven useful especially in the processing of ECG, X-ray and magnetic-resonance images in medical applications. Images processed in this way can be removed without blurring or disturbing the details.

A wavelet-compressed image can be decreased up to 25 percent of the size of a similar-quality image using the more familiar JPEG method. Thus, for example, a image that is of 200 KB requires a minute to download in JPEG format will require only 50 KB and take 15 seconds to download in wavelet-compressed form.

II. ABOUT WAVELET

A. Haar Wavelet:

The Haar transform is one of the oldest transform functions introduced in 1910 and was proposed by Hungarian mathematician Alfred Haar.

The Haar transform is the simplest of the wavelet transform. In this transform it cross-multiplies a function against the Haar wavelet with various shifts and stretches, like the Fourier transform cross-multiplies a function against a sine wave with two phases and many stretches.

The output of Haar transform will have the same energy as the input. One property of the Haar wavelet is that it has concise support, which means that it disappears outside of a finite interval. Unfortunately, Haar wavelets are not continuously distinguishable which somewhat limits their applications.

B. Mother Wavelet:

To create other window function a paradigm called as mother wavelet is required. These windows are of shifted version and are compressed. It is represented by symbol Ψ. Basic wavelet shape is characterized by mother wavelet.

C. Father Wavelet:

It is represented by ø. it is used to characterize the scale of wavelet. It covers entire domain of interest.

D. Daughter Wavelet:

All other wavelets except mother and father wavelets are the daughter wavelets. It is represented by Ψμj, ix, iy, iz(x, y, z) ,Where μ: directionality of wavelet functions,J: scale characteristic of wavelet. i: vertical and horizontal shifts of wavelet

E. Decomposition:

The wavelet theory allows us to understand the theory of scale and resolution. As the data is redundant we don't observe the image at each resolution level. Suppose we process a signal at resolution r0, only the additional details can be studied clearly which are present at higher resolution r1. Thus by using decomposition the difference can be calculated where the signal is decomposed at wavelet orthonormal basis and can be calculated by pyramid transform as well.

F. ECG:

An Electrocardiogram (ECG) is a test used to determine the periodic activity of the heart condition. This activity is recorded on graph sheets or some kinds of detector by placing the electrodes on certain body parts of a person. The record

shows a series of electrical waves that occurs during each beat of the heart

These human ECG signals are very weak and in the mV range and the frequency range is 0.05-100Hz and most of the important information is contained in the range of 0.5-45Hz . Electrocardiography is the method to detect many heart related issues and is generally used to observe any damage to the heart and congenital heart defects and coronary artery diseases etc.

ONE duration of the electrical wave crossing the heart which in turn decides whether the electrical activity is normal or slow or uneven and the second is the amount of electrical activity passing through the heart which permits to find whether the parts of the heart are too large or overworked.

III. DESIGN STEPS

1) Collection of 10 ECG signals from MIT-BIH
2) Resize of collected ECG signals.
3) Decomposition of ECG signals using Haar wavelet transform .
4) Finding out the wavelet energy.
5) Plotting of wavelet co-efficients.

IV. RESULTS

A. Arrhythmia:

It relates to a heart disease which relates to the rhythm or rate of the heartbeat. Due to arrhythmia the heart beat can be too fast, too slow or randomly rhythmic. Arrhythmia is harmless, but some can be dangerous leading to death. In this disease the heart cannot pump enough blood to the body. Thus deficiency of blood to the organs damages the brain and other organs.

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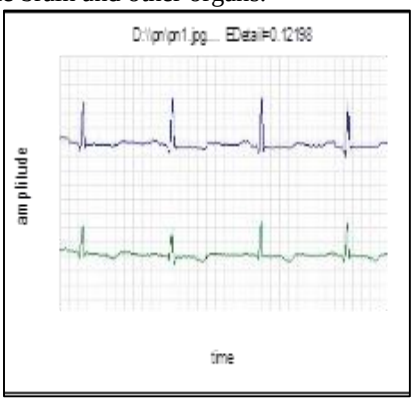
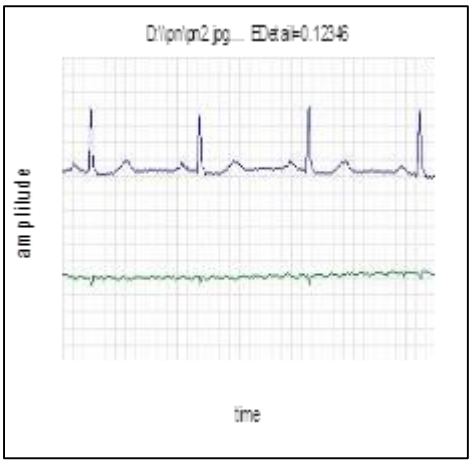
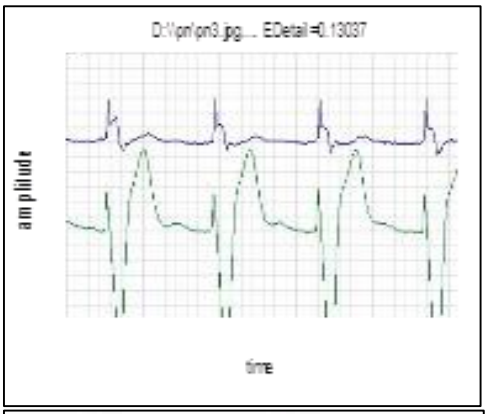
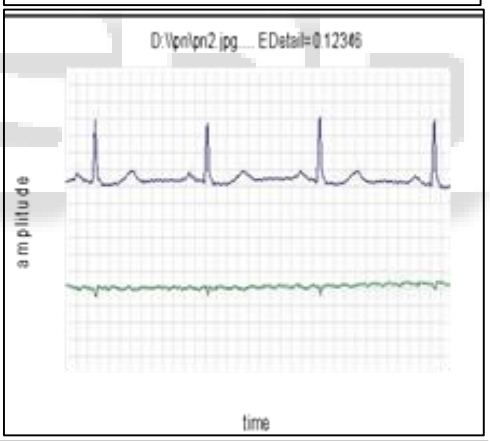
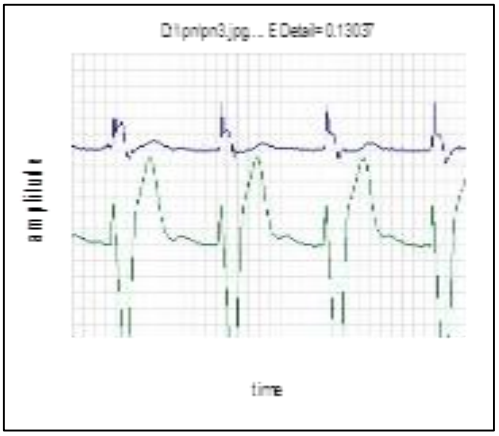










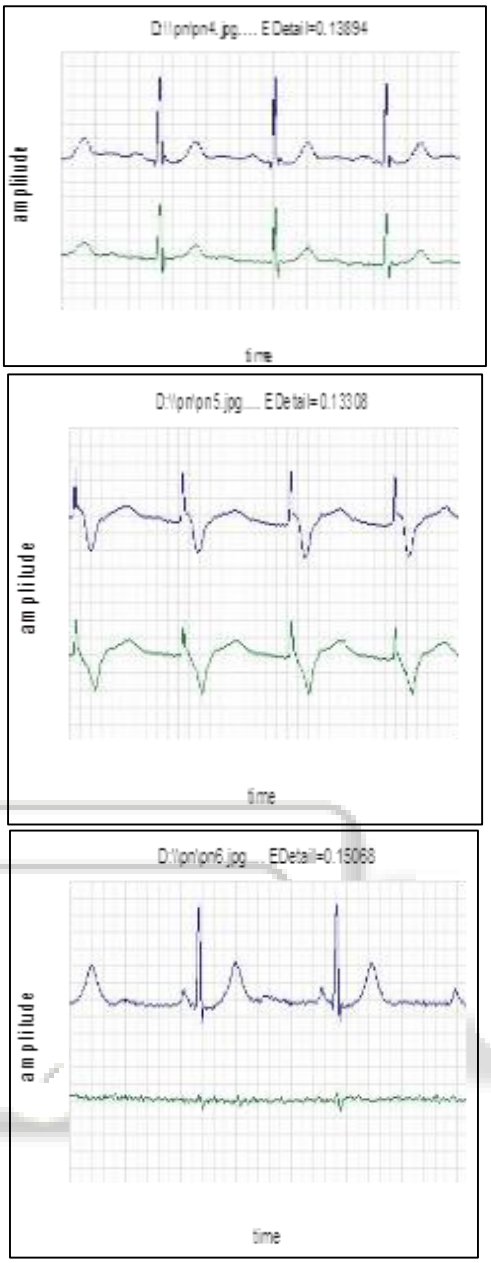
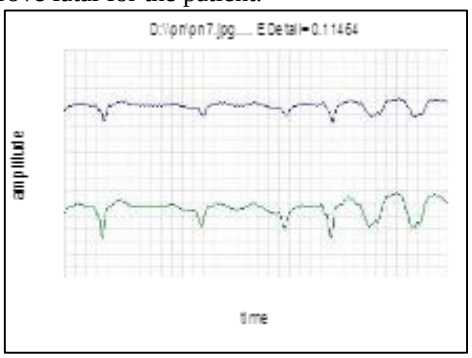


Fig. 1: Graphs

B. Malignant Entricular Arrhythmia:

The cause of this disease is due to the coronary heart diseases. This is also related to organic heart disease. In this the blood supply to heart is less than as it is supposed to be. Sometimes it may prove fatal for the patient.



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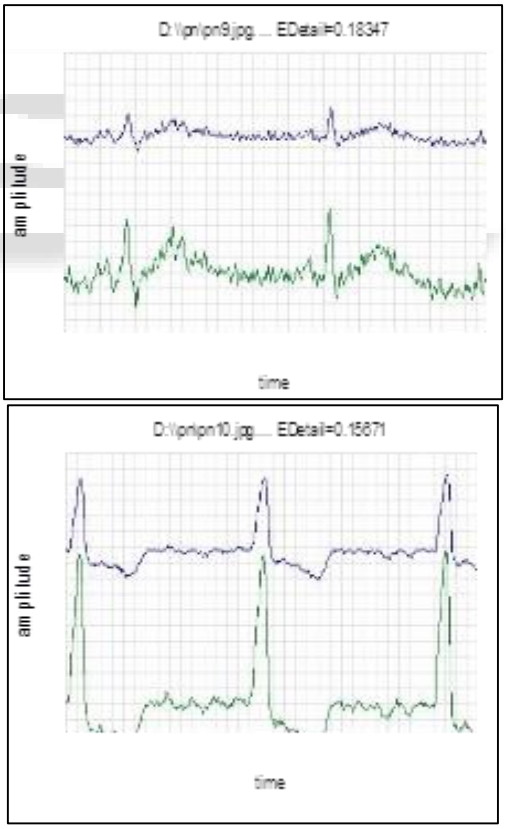

Fig. 2: Graphs

C. Ventricular Tachyarrhythmia:

Due to improper activity of heart its heart beat increases rapidly. It starts in the bottom chambers at the ventricles. They are the main pumping chambers of the heart. It can cause low blood pressure also.

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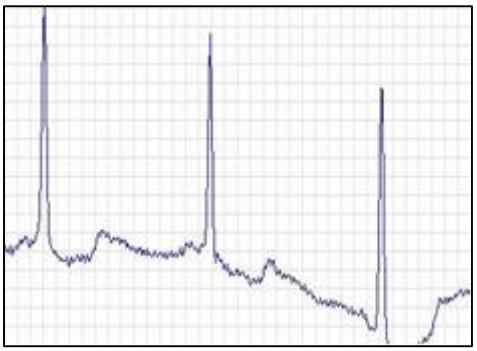
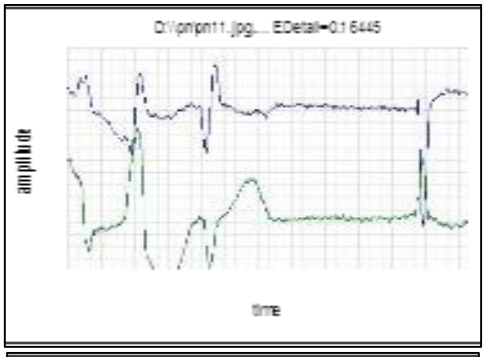
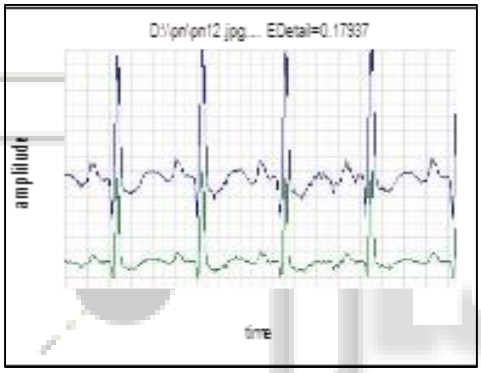


Time





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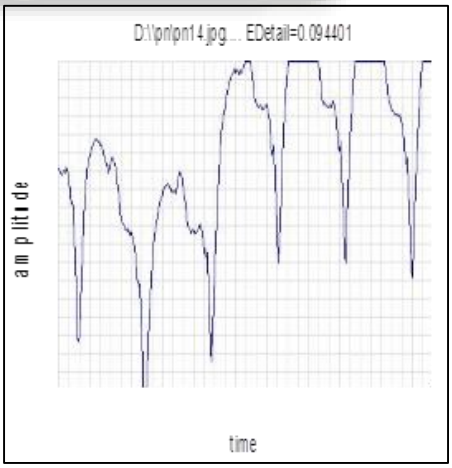

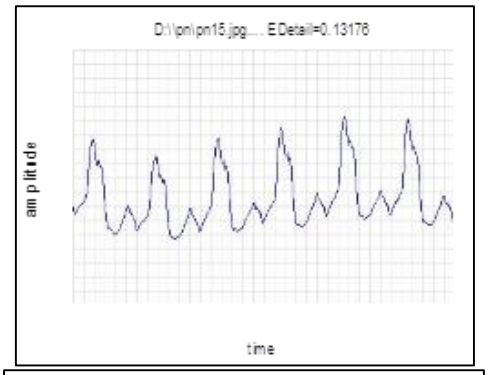

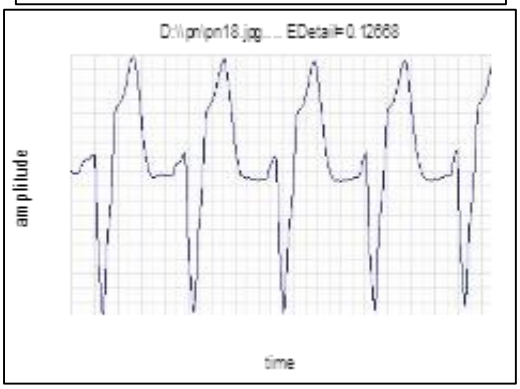

Fig. 3: Graphs

V. COMBINED RESULTS OF ALL WAVELET COEFFICIENTS

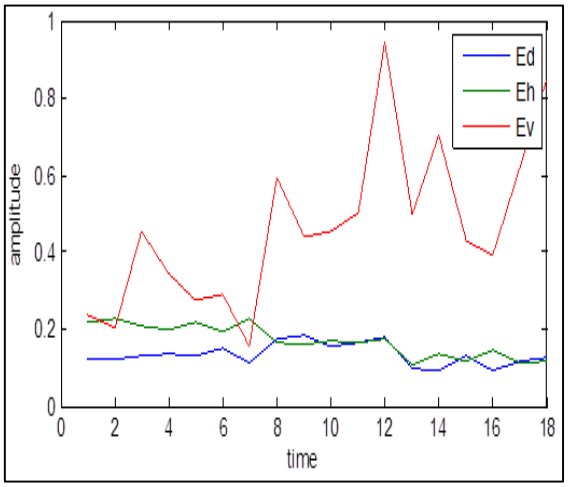

Fig. 4: Graphs

VI. CONCLUSION

Wavelet Transform Technique gives good frequency & time information of ECG signal because here we can easily identify & sometimes locate also the changes in pathological condition of ECG signal. Haar 10 Wavelet is use for analysis of ECG signal gives high & low frequency component of the signal.

Debauches' also use for some other feature analysis of ECG.

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