International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 06 | June 2018 www.irjet.net p-ISSN: 2395-0072

CONGESTIVE HEART FAILURE RECOGNITION BY ANALYZING THE ECG SIGNALS USING WAVELET COEFFICIENTS

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Abstract - *In this paper we have analyzed the digital data collected using the electrocardiogram for finding the heart disease considering data sets of twenty different disease cases using mat lab. Firstly we have filtered the ecg data for hum noise and muscle noise, using a series of filters and applied the zero cross algorithm for finding the no of zero crossings and the heart rate of each disease case. We have applied wavelet transform and found the wavelet 3D plot which is the representation of the wavelet coefficients, which helps for estimating the cardiac disease from the wavelet 3D plot of the patient's electrocardiogram.*

Key Words: **ECG, notch filter, wavelet, feature extraction, hum noise.**

1. INTRODUCTION:

In recent years, ECG signal plays an important role in the primary diagnosis, prognosis and survival analysis of heart diseases. Electrocardiography has a profound influence on the practice of medicine. The electrocardiogram signal contains an important amount of information that can be exploited in different manners. The ECG signal allows for the analysis of anatomic and physiologic aspects of the whole cardiac muscle. Different ECG signals are used to verify the proposed method using MATLAB software.

Time-frequency wavelet theory is used for the detection of tile threatening electrocardiography (ECG) arrhythmias. Wavelets are used extensively in Signal and Image Processing, Medicine, Finance, Radar, Sonar, Geology and many other varied fields. They are usually presented in mathematical formulae, but can actually be understood in terms of simple comparisons with your data.

In fact, beat detection is necessary to determine the heart rate, and several related arrhythmias such as Tachycardia, Bradycardia and Heart Rate Variation, it is also necessary for further processing of the signal in order to detect abnormal beats. The ECG feature extraction system provides fundamental features (amplitudes and intervals) to be used in subsequent automatic analysis.

2. ABOUT THE ECG SIGNAL:

The ECG is a graphic record of the direction and magnitude of the electrical activity that is generated by depolarization and depolarization of the atria and ventricles. One cardiac cycle in an ECG signal consists of the P-QRS-T waves.

The Electrocardiograph is very useful term in the medical analysis of the patient's condition and reveals the present and future estimations of the heart diseases which help the doctors to take required steps for curing the heart problems. A normal ECG signal consists of the P-QRS-T. The QRS part of the ECG signal is useful in estimating the heart rate of the person in most of the cases. The two basic diseases or defects found in the heart function are APC and PVC. APC is Atria Premature Contraction and PVC is Premature Ventricular Contraction.

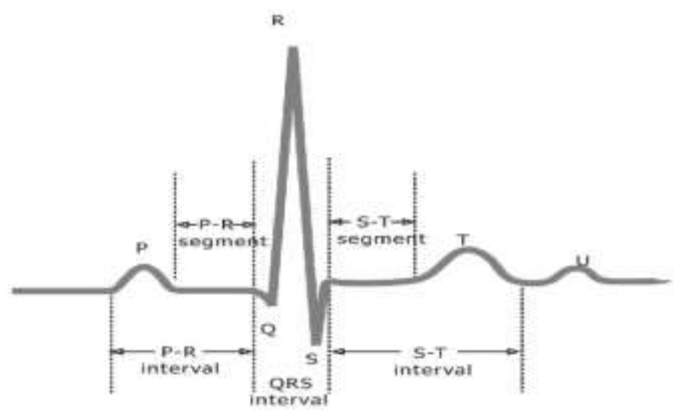

Fig 1. A typical ECG signal.

The QRS complex and the R to R interval are used to find the Arrhythmic beats and some famous algorithms are used to detect the QRS complexes using an algorithmic approach. An ECG is the combination of (P wave + QRS complex + T wave) and in general QRS complex is considerably larger than the P wave.

3. THE CONTINUOUS WAVELET TRANSFORM :

The wavelet transform is an emerging signal processing technique that can be used to represent real-life non stationary signals with high efficiency. Indeed, the wavelet transform is gaining momentum to become an alternative tool to traditional time-frequency representation techniques such as the discrete Fourier transform and the discrete cosine transform.

By virtue of its multi-resolution representation capability, the wavelet transform has been used effectively in vital applications such as transient signal analysis, numerical analysis, computer vision, and image compression, among many other audiovisual applications.

4. THE WAVELET 3D PLOT AND OBSERVATIONS:

In matlab we use the function "cwt" and apply the wavelet using "morlet" mother wavelet. We store the digital data in a variable "data".

cwt(data,1:1:10,'morl','3Dplot');

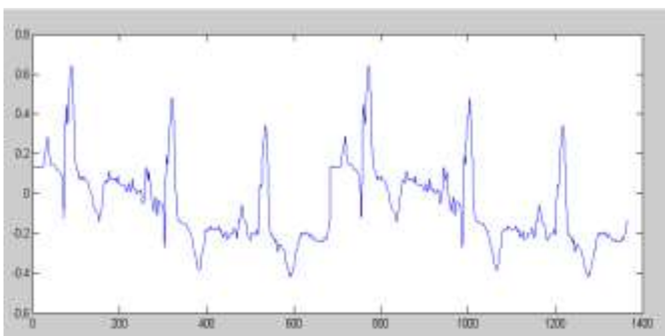

Fig 2. Sample ECG Signal from MIT database for the Congestive Heart Failure case.

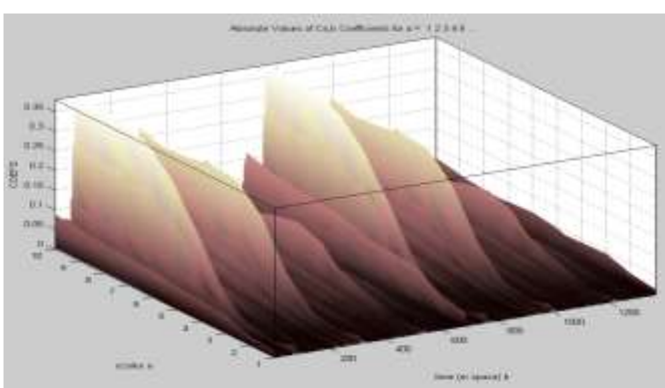

Fig 3. Wavelet 3D plot for ECG Signal from MIT database.

- The larger is the wavelet scale the more we can localize in to the signal and more is the computational complexity.
- The wavelet 3Dplot in the larger scale values resembles the signal for which the wavelet is found.
- The peak values in the base signal correspond to negative valued wavelet coefficients and vice versa.
- The wavelet generated for the initial scales is proportional to the signal taken or the ECG signal.
- The more is the scale range the computational complexity of the methodology to find the 3D plot increases to the respective extent.
- Wavelet generated with morlet mother wavelet looks better for finding even the minute changes of the signal in time axis.
- The wavelet for increasing scale number is faded down compared to the given ECG signal for each increasing scale value.
- Instead of visual observations comparison of ECG analysis using the wavelet coefficients yields better and accurate results.

5. IMPLEMENTATION STAGES:

- Collection of Bio Medical data.
- Collection of Reference data.
- Conversion in to digital values.
- Applying CWT and gathering the coefficients.
- Manual & Algorithmic approach for finding the disease.

6. ZERO CROSS ALGORITHM:

Heart Rate detection using notch filtering and band pass filtering with the use of 60-Hz Hum Eliminator and Heart Rate Detection Using ECG

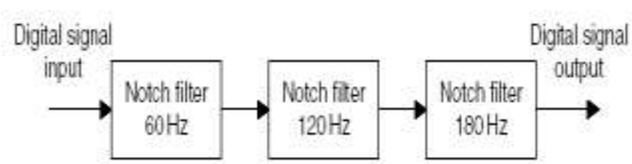

Fig 4. Hum noise filters for 60Hz, 120Hz, and 180Hz.

In this report we have explained the implementations on ECG data sets collected at 250Hz sampling rate. Hum noise created by poor power supplies, transformers, or electromagnetic interference sourced by a main power supply is characterized by a frequency of 60 Hz and its harmonics.

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6.1 Filter designing:

Notch filter coefficients were designed using pole zero placement method for 60,120 and 180 Hz components removal. Band pass filter coefficients for removing muscle noise between 0.25Hz to 40Hz is done using bilinear transformation method.

A major source of frequent interference is the electric-power system due to electric-field coupling between the power lines and the electrocardiograph or patient, which is the cause of the electrical field surrounding mains power lines.

Another cause is magnetic induction in the power line, whereby current in the power line generates a magnetic field around the line. Sometimes, the harmonics of 60-Hz hum exist due to nonlinear sensor and signal amplifier effects.

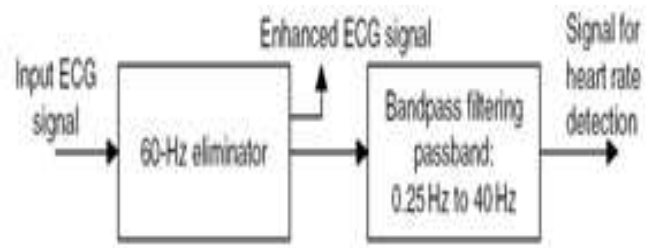

Fig 5. ECG signal enhancement system.

6.1.1 Analysis estimated results:

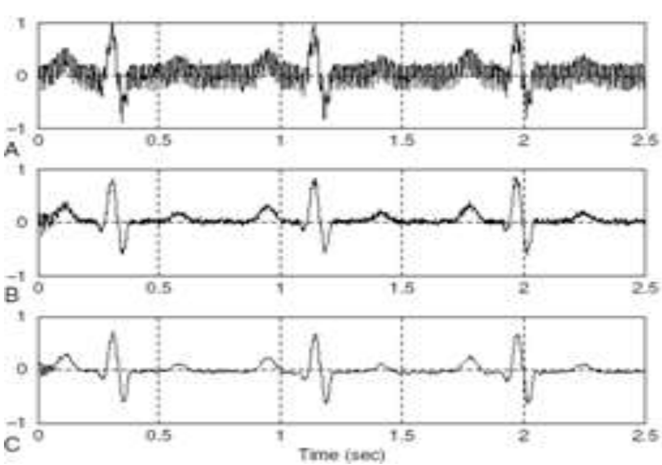

Fig 6. Results of ECG signal processing prior to implementation of algorithm.

The first figure shows the ECG signal with Hum noise, the second one is the signal removed or filtered from the 60,120,180 Hz hum noise, the third one is the ECG signal filtered from the muscle noise.

6.2 Algorithm:

The ECG data after filtered with 3 stages of notch filters and finally sent through band pass filter is considered for the heart rate calculation using the zero cross algorithm.

After detecting the total number of zero crossings, the number of the peaks will be half the number of the zero crossings. The heart rate in terms of pulses per minute can be determined by

$$\text{Heart rate} = \frac{60}{\left(\frac{\textit{Number of enhanced ECG data}}{f_s}\right)} \times \left(\frac{\text{zero-crossing number}}{2}\right).$$

Eqn 1. Calculation of heart rate from the no of zero crossings, Where *fs* = Sampling frequency.

6.3 Results:

All results are with reference to data sets of different sampling frequency with Zero cross algorithm applied individually.

Table 1: Heart rate in beats per minute calculated using the zero cross algorithm for various disease cases

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Considered case of heart disease	Sampling frequency	No of zero crossings	Heart rate in beats/min
Congestive heart failure database	250	12	60
Long term ST database	250	14	70
Very subtle premature ventricular contraction	250	20	100
Maligant Ventricular ectopy database	250	28	56
Noramal sinus rythym database	165	38	125
AANSI AMI database	721	4	56
AF termination database	129	28	72
APNEA database	101	32	64
Long term ECG database	129	26	67
Sudden cardiac death hotler database	361	8	48
Poly somographic database	251	14	69
Postal ictal heart rate oscillations in partial epilepsy	201	18	72
Stress recognition in automobile drivers	16	16	46
AHA database	251	16	80
Congestive heart failure database	251	20	100
Intra cardiac atrial fibrillation	1001	4	80
MGH_MF Waveform database	361	6	86
CU ventricular tachyarrhythimia database	251	12	86
Wave alternas challenge database	501	6	60
PAF prediction challenge database	129	34	87

7. CONCLUSION:

Long Term ST Database with Manually corrected beat annotations with sampling frequency of 250 Hz (row 9 in table 1).

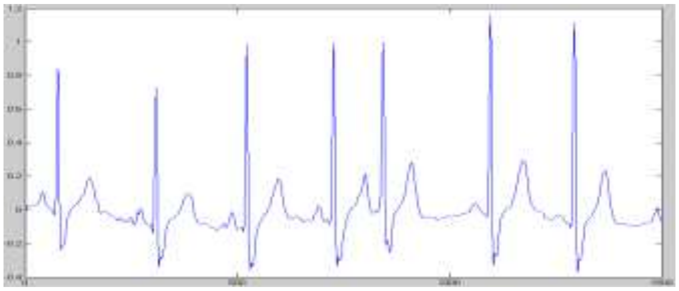

Fig7. Actual ECG signal

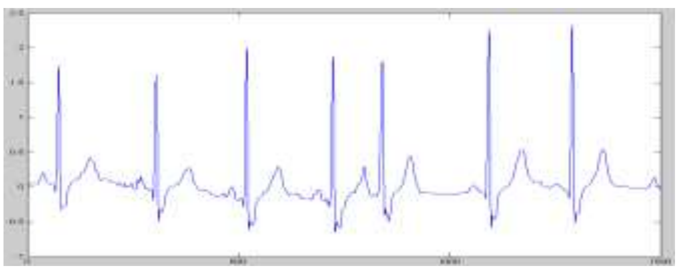

Fig8. ECG signal filtered for hum noise and muscle noise.

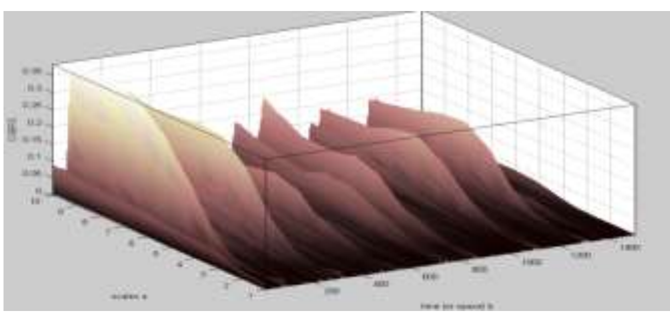

Fig9. Wavelet 3D plot for the above ECG.

Output of the Algorithm:

1) No of Zero Crossings = 14.
2) Heart Rate in (Beats/Min) = 17.

We conclude that the above implementation helps for the detailed analysis of the biomedical data for finding the diseases and severity.

7. REFERENCES:

[1] Juan Pablo Martínez, Rute Almeida, Salvador Olmos, Ana Paula Rocha, and Pablo Laguna, A Wavelet-Based ECG Delineator: Evaluation on Standard Databases, *IEEE*

[2] Digital Signal Processing Fundamentals by Li Tan Copyright 2008.

[3] Thakor N.V, Webster, J.G. and Tompkins W.J. 1984.Estimation of QRS complex power spectra for design of QRS filter, IEEE Trans. Biomed. Eng. 31: 702-706.

[4] Karel J.M.H., Peeters R.L.M., Westra R.L., Moermans K.M.S., Haddad S.A.P. and Serdijn W.A. 2005.Optimal discrete wavelet design for cardiac signal processing, Proceedings of the IEEE, Engineering in Medicine and Biology 27th Annual Conference.

[5] Soman K.P., Ramachandran K.I. 2004. Insight into wavelets from theory to practice. Prentice-Hall of India.

[6] Cuiwei Li, Chongxun Zheng, and Changfeng Tai.1995. Detection of ECG characteristic points using wavelet transforms.IEEETrans. Biomed. Eng. 42(1):21-28, January.

[7] MiniMed website: http://www.minimed.com/doctors/md_products_cgms_ov_completepic.shtml