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ECG Signal Processing and Abnormality Classification Using Fuzzy.

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ABSTRACT

Signal Processing has become a mandatory tool in processing signals to make the acquired signals more useful for interpretation. In our paper, we would like to propose an efficient tool in signal processing of Electro Cardiogram (ECG) signals. The major issues with ECG are the presence of baseline wanders, power line interferences (due to the electrodes) and artifacts. Medical specialists are able to analyze the signals based on their experience and there is no reference available for standard comparison. In order to overcome these difficulties the ECG signals are processed, de-noised and filtered using signal processing techniques.

Keywords: Electrocardiogram, baseline wandering, power line interference, signal processing, wavelet denoisier, trend and detrend.

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INTRODUCTION

ECG machine is used for to show the signals which are produced by the heart rate or bioelectrical effect. These kind of signals produced because of closing and opening functions of the valves. The valve names are **aortic valve, mitral valve,** tricuspid **valve, bicuspid valve.** Basically few problems aroused while measuring the signals. The main problem is baseline wandering and power line interference. If the noise signal such as baseline wander occurs in the signal the normal PQRST wave form will be changed. Because of these problems sometimes we are not able to identify the disease easily. To reduce these kind of noise which is occurring in ECG signals, we are using UWT method which is under the wavelet transform method. Previously discrete wavelet transform is used for this noise reduction process. This DWT method takes less time to filter the input signal. Anyway, its having drawback of lesser accuracy. So that we are using UWT here. This de-noised signals are given to the fuzzy classifier for the classification process. And afterwards this classifier shows the diseases in the correct manner.

Table :1

PHASE	DURATION	AMPLITUDE
P WAVE	0.06-0.11	<0.25
PR INTERVAL	0.12-0.2	
PR SEGMENT	0.08	
QRS COMPLEX	<0.12	0.8-1.2
ST SEGMENT	0.12	
T WAVE	0.16	<0.5
QT INTERVAL	0.36-0.44	

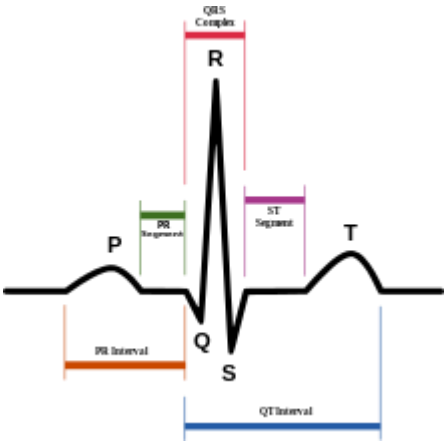

Fig. A. normal ECG Image

Real time image

ECG SENSOR:

ECG is a diagnostic tool that is used to measure the bioelectrical signal of the heartbeat. The output signal will be an analog. This sensor is used to find the problem which is present in the heart, like myocardial ischemic and infarction. We are using AD8232 single lead heart rate monitor which act as op-amp. Essentially noise will arise while taking the ECG signal to avoid some of these noises we are go with this type of sensor kit. By using this kit we can smoothly measure the PR and QT intervals. It is depict to bring out, amplify and filtersmall bio-electrical signalsin the presence of noisy state, which is generated by motion of the electrode placement.

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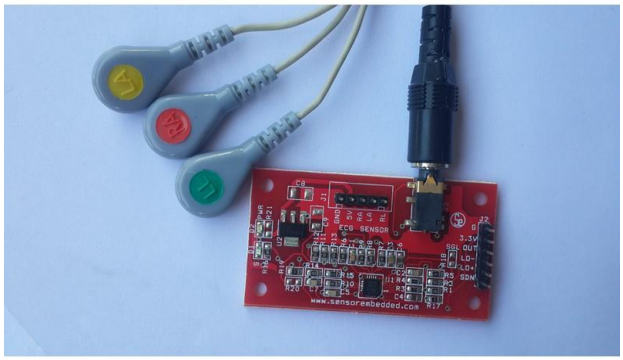

Fig. B. ECG Sensor Kit

SDN, LO+, LO-, OUTPUT, 3.3V, GND these are the essential pins which is used to operate the sensor kit. Arduino board is used for the interfacing purpose.Besides this we can use other board for the interfacing. On this board RA (Right Arm), LA (Left Arm), and RL (Right Leg) pins are attached from the sensor kit.And also it contains an LED indicator that will pulsate to the rhythm of a heartbeat.

Features:

- Operating Voltage - 3.3V
- Analog Output
- Leads-Off Detection
- Shutdown Pin
- LED Indicator
- 3.5mm Jack for Biomedical Pad Connection or Use 3 pin header

REQUIREMENT:

Hardware:

1. Arduino Uno/Mega/Nano
2. ECG Module (AD8232)
3. ECG Electrodes 3 pieces
4. ECG Electrode Connector 3.5mm
5. Power supply
6. Connecting Wires

Software:

1) Arduino IDE Download from (https://www.arduino.cc)
2)Processing IDE Download from (https://www.processing.org (https://www.processing.org))

CONNECTION OF KIT WITH ARDUINO:

Arduino 3.3V -- 3.3V pin
Arduino pin 10 -- L0+
Arduino Pin 11-- L0
Arduino Analog 1 (A1) -- Output
Arduino Gnd – Gnd
AD8232 INPUT PINS:

RA – Input 1

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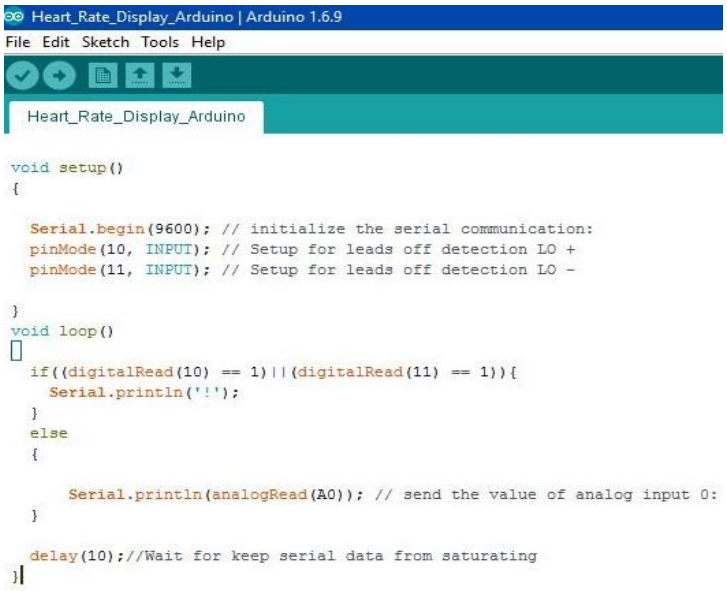
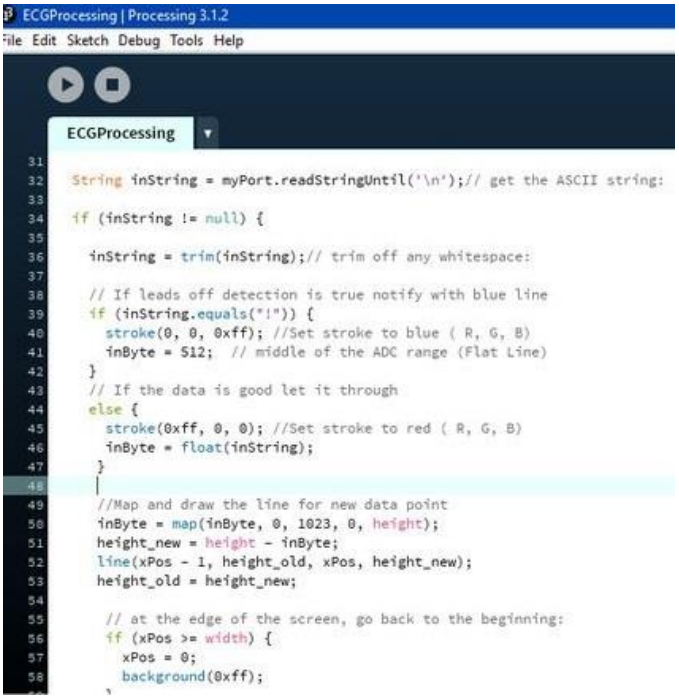
LA – Input 2
RL – Input 3

Arduino coding:



ECG Processing coding:



METHODS

It includes the real time ECG sample signals. These signals are processed using wavelet analysis to get the denoised output of the signal, that will help to obtain the abnormalities in the ECG.

Techniques

Wavelet Transform

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The wavelet transform produce the output according to the frequency and time. ECG signals are produced to be the electrical signal of the heart beat and this is measured through the relation between the time and frequency. So that the wavelet transform is used here for noise reducing process. Many types of wavelet transforms are there such as Discrete Wavelet Transform, Continuous Wavelet Transform, Undecimated Wavelet Transform. The UWT used here for the de-noising process.

WA detrend

The spectral attribution of the trending must be unambiguously known in advance for a proper cutoff frequency. It is a kind of technique which is used to resolve the input signal into a part such as linear and non-linear. After removing the higher frequency of the original signal a set of particular signals will be there, this particular signal is called as a trend. The trend signal is also called as linear signal. The De - trend is used for to remove the trend signal from the given input signal. It is often a necessary step to obtain the best result.

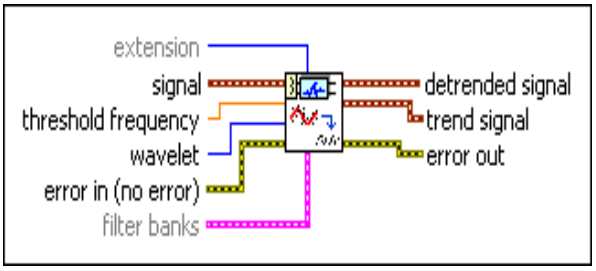

Fig. C. WA Detrend

Wavelet Denoisior

In de-noising technique input signals are resolved into constituent parts by using the wavelet de-noisier. The noised signals re recognized through this method. Most often this method is used for the de-noising process. Because the scale value will represent the finest output signal. So that the result will be in natural term.

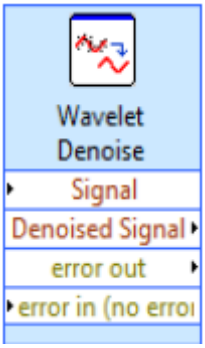

Fig. D. WA Denoisier

Pre-processing

Basically the ECG signals consist of noise signals which is known as baseline wandering, power line interference, motion artifacts, Electrode contact noise. These noised are removed by using wavelet analysis. The real time samples are given to the detrend tool. The trend signals are removed by the detrend, then the output of the detrend is given to the wavelet denoisier and the denoised signal is displayed.

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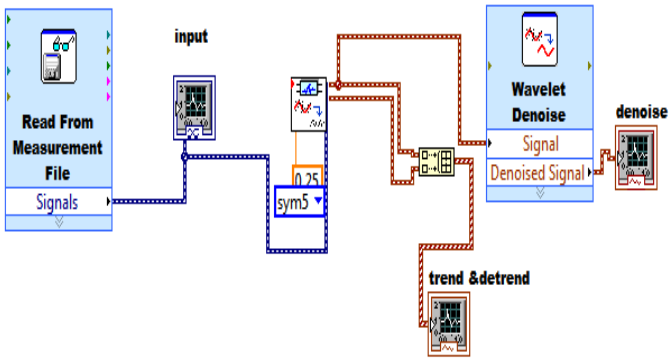
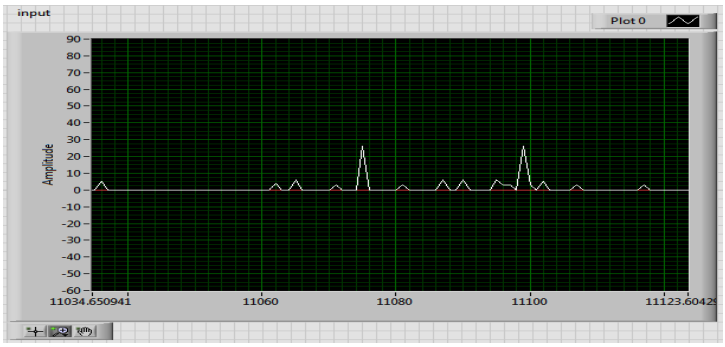
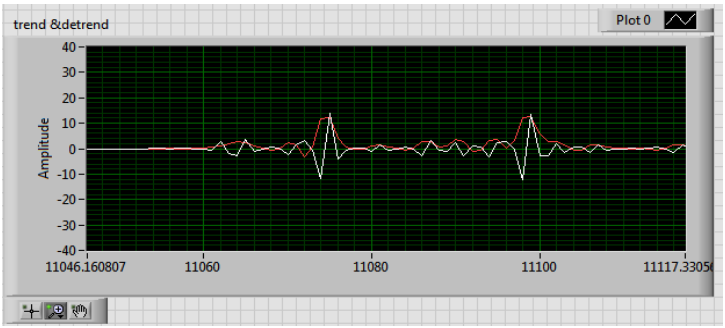


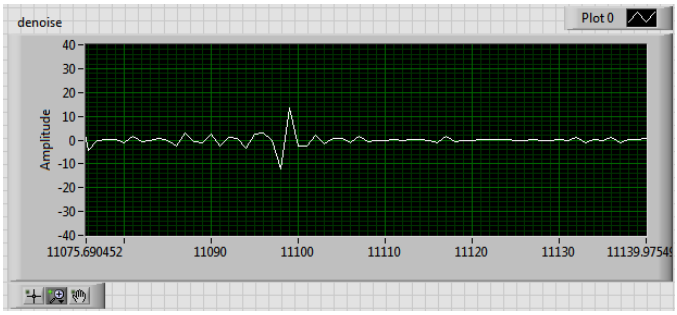
Fig. E. ECG signal Denoising



(a) Ecg signal



(b) Trend and Detrend



(c) Denoised output

FEATURE EXTRACTION:

Multiresolution analysis with 8level Dabuchies (db06) used or perish the ECG signal. After that the signal is given to the multiresolution peak detection to detect the peaks presents in the ECG signal. By applying reference threshold and width values for P,R and T values.

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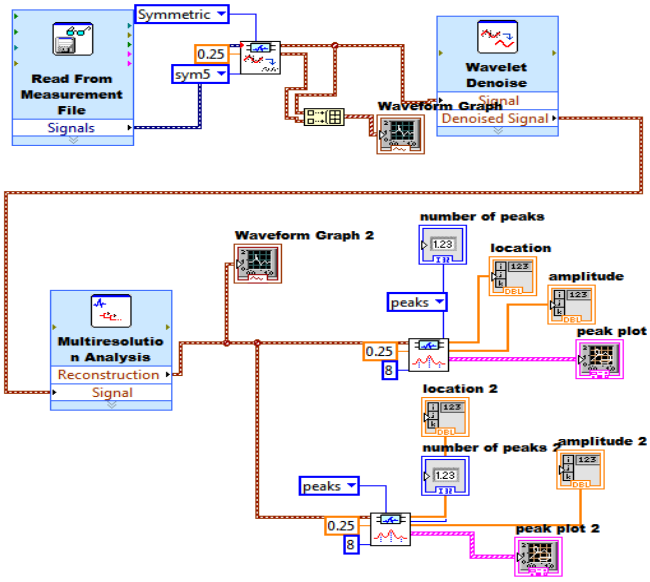
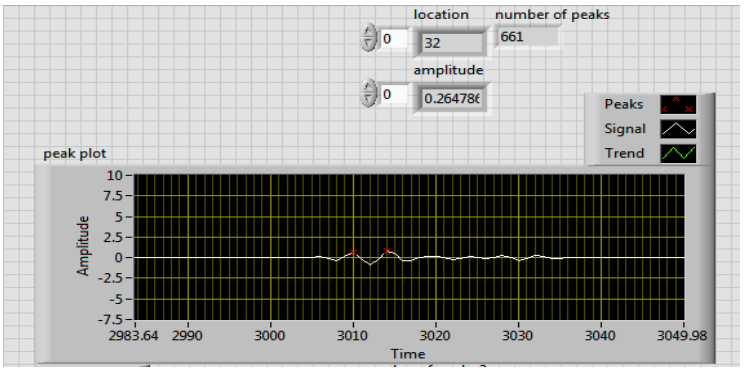
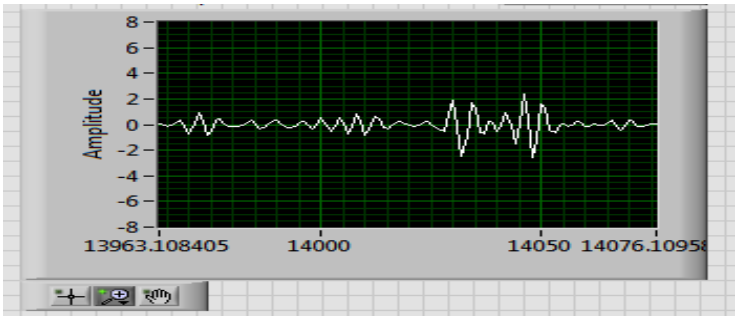


Fig. F. Peak detection block



(a) Peak detection :



(b) resolution graph:

Multiresolution analysis :

Multiresolution analysis is the method which is mostly used partially in the wavelet transform for the justification. Mainly, it is used for DWT. Through this method we can extract the peak values of the input signal. For that peak tool is used here.

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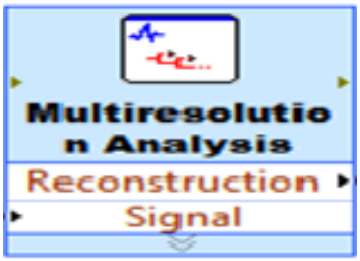

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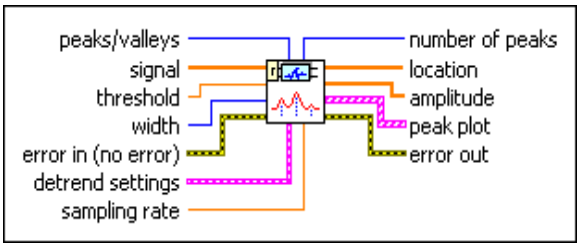
Multiresolution peak:



The denoised signal which is comes from the wavelet denoisier is given into the multiresolution analysis for the peak analysis process. It detect the peaks of the denoised signal.

FUZZY

Fuzzy logic is a form of the multi-valued logic in which the true values of variables may be any real number between 0and 1. This is based on the Boolean logic. This may be considering as true or false method. This logic is used to talk over the concept of partial truth where the true values may be come between thoroughly true and false. All the time human cannot sometimes they are not able to find the exact position or value of the object. In that situation we need to go with some other better option such as fuzzy.

Because fuzzy rule may be reduce our work while calculating the values. Recently this methods is used for the controlling process here we are using fuzzy as a classifier. It classifies the output signals according to the diseases which are identified through the amplitude values of the signal.

Table:2

1.Fuzzy Table

	P	R	T	ST
Normal	0.664	2.196	1.125	-
Anterior wall MI	0.25	1.89	1.68	6
Inferior wall MI	-	2.267	0.418	5
Antrolateral MI	1.454	2.246	-	3
Inferior latreal MI	0.513	2.216	-	1
Premature atrial complex	0.3051	2.809	-	2
Atrial flutter	1.3542	2.499	0.619	-

(a) Fuzzy Variables:

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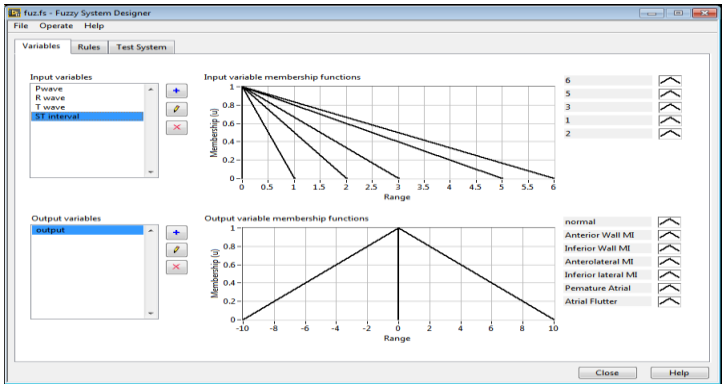

CONCLUSION

Because of the noise signals medical experts are facing difficulties in finding the diseases. In this paper focused on to reduce the noise which is present in the ECG signals through the signal processing.The wavelet transform is used for processing the signals. The detrend tool is used to remove the baseline wandering and the denoisier is used to remove the other unwanted signals. So that, the medical experts can easily recognize the diseases. The denoised signals are given into the fuzzy classifier to classify the diseases based on the rules it will classify the signals.

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