IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

CLASSIFICATION OF CARDIAC DISORDERS USING LABIEW

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***Abstract*—** Cardiovascular diseases are the largest cause of death in world accounting for more than a third of all deaths. In this paper we are going to interpret ECG signals into various cardiac disorders on the basis of statistic data obtained by using Labview Biomedical Toolkit 2013. Using feature extraction parameters such as P wave, T wave, PR interval, QT interval, QRS complex, ST segment are used to evaluate the different types of cardiac disorders.

Keywords*— *Cardiovascular disease, ECG, Feature extraction, Biomedical toolkit, cardiac disorders.

I. INTRODUCTION

Cardiovascular disease is the disease related to heart. Acute Myocardial Infarction (AMI) or commonly known as heart attack is one of the cardiovascular diseases. Because of the changing lifestyle the AMI rate is increasing day by day. AMI is a leading cause of death for both man and woman throughout the world. A heart attack happens if the flow of oxygen rich blood to a section of heart muscle suddenly becomes blocked and the heart cannot get oxygen. Early treatment for a heart attack can prevent or limit damage to a heart muscle otherwise it might further leads to arrhythmia. Acting fast at the first symptoms of heart attack, can save patient life. So, there is a necessity of new inventions in the field of healthcare which can give the early warning about diseases observance of prevention in the area of health as a significant impact on economic productivity and most important on quality of life of the common people. Understanding of cardiac disorders by ECG waveform is bit difficult by a normal person.It can be understood by only doctors. For making it easier to interpret the disorders by anyone we are going to classify the cardiac disorders on the basis of statistic data obtained such as P wave, T wave, PR interval, QRS interval, QT interval ,ST segment,etc.

Electrocardiography

Electrocardiography is a method of monitoring and recording the electric currents generated due to the alternating contraction of atria and ventricles of the heart. The device used to monitor and record these signals is an electrocardiogram, more commonly referred to as an ECG. The heart's electrical activity is represented by three basic waveforms, the P wave, QRS complex and T wave. Between the waveforms the following segments and intervals are present: PR interval, ST segment and QT interval. Sometimes U wave is also present. The P wave depicts atrial depolarization or the spread of SA node throughout the atria. Atrial depolarization causes atrial (both left and right) contraction, also known as atrial systole. The PR interval represents the time required for impulse to travel through the atria, AV node and to allow adequate filling of the ventricles before ventricular systole, usually between 0.12-0.20 seconds. The QRS complex represents ventricular depolarization or spread of impulse throughout the ventricles. Ventricular depolarization causes ventricular contraction, also known as ventricular systole. The ST segment represents the end of ventricular depolarization and the beginning of ventricular repolarization. The T wave represents the latter phase of ventricular repolarization. The U wave which is not always present may represent further repolarization of ventricles.
The QT interval represents both ventricular depolarization and repolarization.

II. BLOCK DIAGRAM

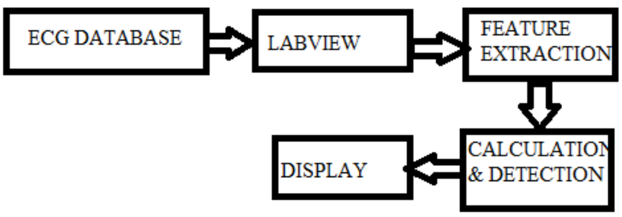


Fig.1. Block Diagram Of system

Figure shows block diagram of system where physionet MIT-BIH arrhythmia ECG database is used for feature extraction and detection of various abnormalities of heart using labview. Generally recorded data is contaminated by noise which destroys useful information. Therefore preprocessing of signal is necessary.

ECG Signal Pre-processing

Pre-processing of ECG signal helps us to remove the noise from ECG signal such as-

1. Baseline wandering
2. Power line interference
3. Wideband noise
4. EMG noise
5. Electrode pop noise
6. Patient electrode motion noise

Among of all the noises the baseline wandering noise and power line interference can strongly affect the ECG signal analysis. This types of noise could not be removed by traditional filters so wavelet denoise signal express VI is used to decompose ECG signal. Wavelet functions support symmetry and compactness and achieve the highest accuracy on the ECG reading in MIT-BIH arrhythmia database.

1. **Removing Baseline wandering**

It usually comes from respiration at frequencies 0.15 to 0.3 Hz and it can be suppressed by high pass digital filter. Wavelet transform can also be used to remove the baseline wandering by eliminating the trend of the ECG signal. The wavelet transform based approach is better because it introduces no latency and less distortion than the digital filter based approach. Trend level specifies the number of levels of the wavelet decomposition which is approximately-

Number of decomposition level = (1-trend level)* log(N)

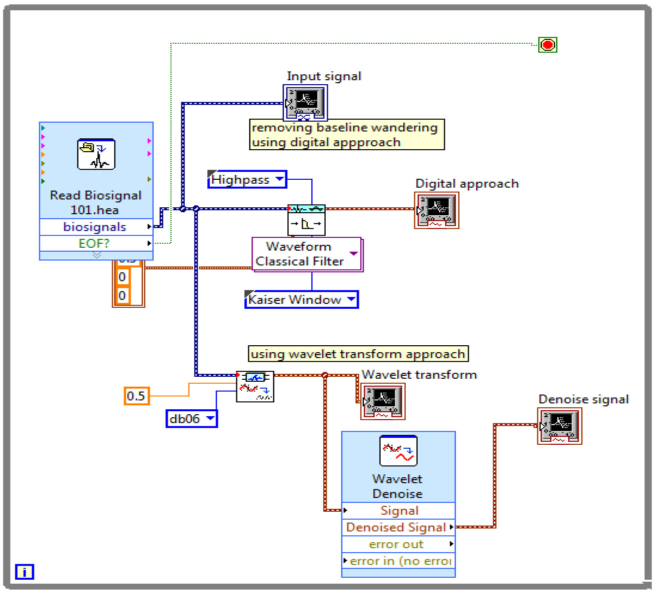


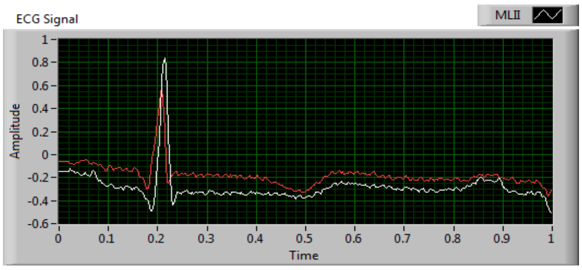
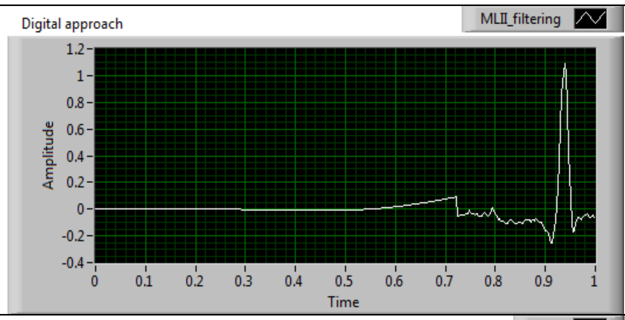
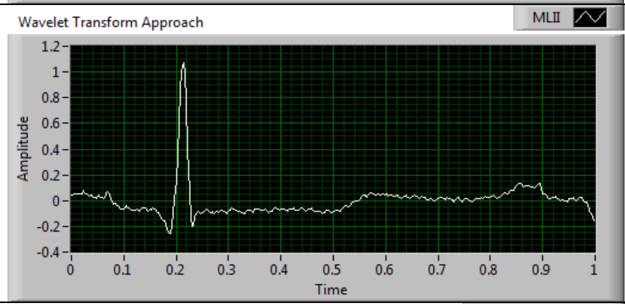
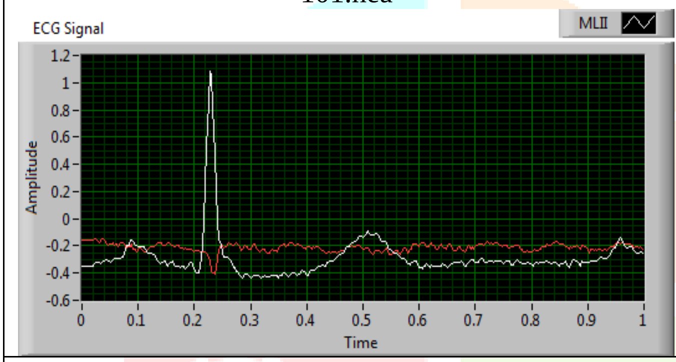
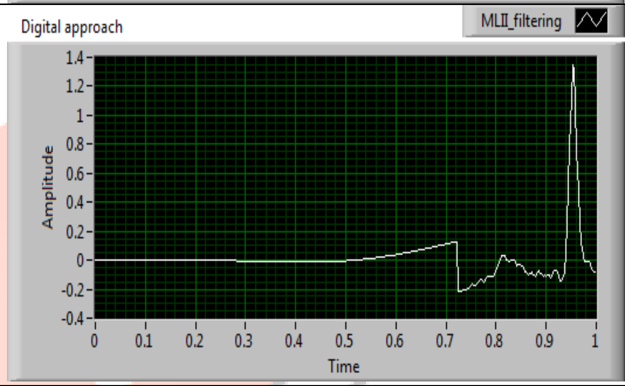
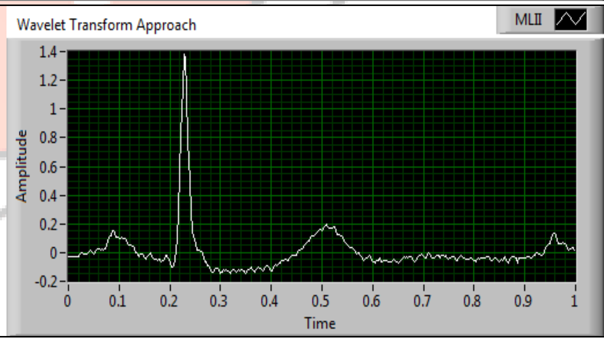
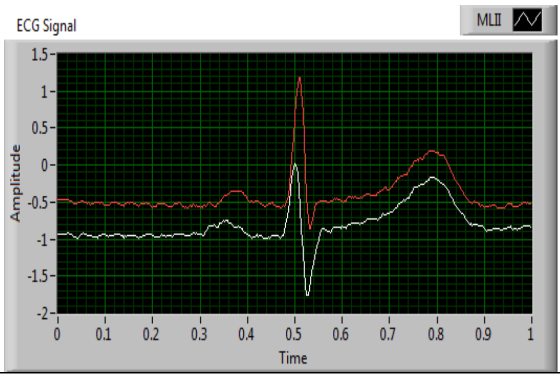
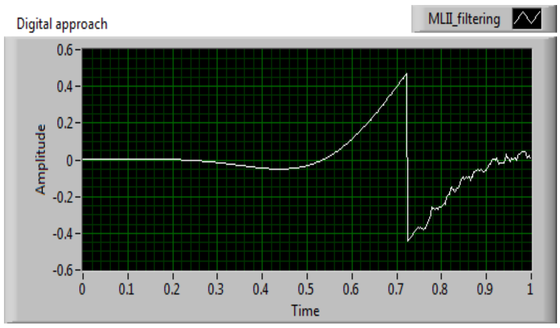
Fig.2. Block diagram of signal processing using different methods

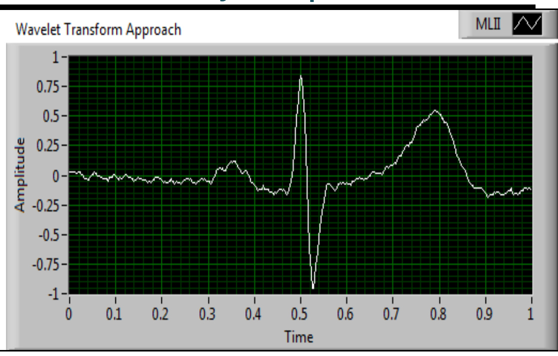
2. **Removal of wideband noise**

After removing baseline wander the resulting ECG signal is more stationary and explicit than the original signal. However some other types of noise might still affect feature extraction of ECG signal. The noise may be complex stochastic processes within a wideband, so one cannot remove them using traditional digital filters. To remove the wideband noises, the wavelet denoise express virtual instrument is used here.

The Express virtual instrument decomposes the ECG signal into several sub bands by applying the wavelet transform and then modifies each wavelet coefficient by applying a threshold or shrinking function and finally reconstructs denoised signal. From the threshold setting options available soft thresholding is selected and thresholding rule selected is ‘universal’ and the virtual instrument sets the threshold to sqrt(2*log(N)). The virtual instrument offers an option to select either discrete wavelet transform or undecimated wavelet transform to denoise the signal. The main drawback of DWT is translation invariant. Translation of the original signal leads to different wavelet co-efficient. UWT is used to overcome this and to get more comprehensive feature of analyzed signal. The UWT is redundant, linear and shift invariant, more robust and less sensitive to noise because this method involves finding zero crossings in multi-scale UWT coefficients. Table 1 below shows different methods used to remove noise from noisy signal.

Table.1: Different methods used to remove noise from noisy signal

Input Noisy signal	Method used	Image after noise removal
100.hea 	Digital approach	
	Wavelet transform approach	
101.hea 	Digital approach	
	Wavelet transform approach	
117.hea 	Digital approach	
	Wavelet transform approach	



From above table it is clear that wavelet transform approach gives highest accuracy, as wavelet function supports symmetry and compactness whereas discrete wavelet transform does not provide discrimination between noise and signal coefficients of wavelet decomposition at low SNRs.

ECG Feature Extraction

Feature Extraction is the important process to detect the cardiac disorders. For the purpose of diagnosis various features from preprocessed ECG data have to be extracted. These features provide information about heart rate, conduction velocity, the conditions of tissues within the heart as well as various abnormalities.

Labview biomedical toolkit provides ECG feature extractor where one can select whether to obtain QRS only or all parameters such as ST segment, QT segment, P onset, P offset, T onset, T offset,etc.

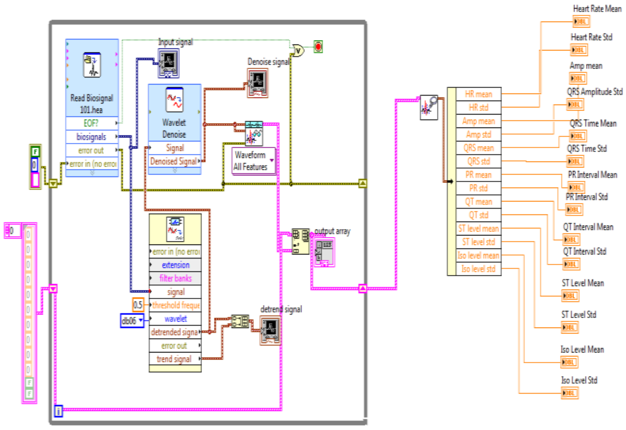


Fig 3. Feature Extraction of ECG signal

Table 2: Feature Extraction (without preprocessing)

Input signal	Gender	Age	Statistics	Heart Rate(bpm)	PR(s)	QT(s)	ST(s)	ISO Level	QRS(s)	QRS Amp(mv)
100.hea	M	69	Mean	77.578	0.149	0.387	-0.027	0.364	0.074	1.5283
			Std	15.376	0.0076	0.0503	0.0706	0.055	0.0209	0.193
104.hea	F	66	Mean	83.55	0.1518	0.463	0.016	-0.264	0.109	0.995
			Std	40.98	0.021	0.080	0.209	0.112	0.039	0.465
117.hea	M	69	Mean	168.608	0.0997	0.319	-0.032	-0.943	0.164	0.668
			Std	110.481	0.0295	0.122	0.295	0.160	0.180	0.646

Table 3: Feature Extraction (with preprocessing)

Input signal	Gender	Age	Statistics	Heart rate (bpm)	PR(s)	QT(s)	ST(s)	ISO level	QRS(s)	QRS Amp(mv)
100.hea	M	69	Mean	62.52	0.185	0.428	-0.054	-0.089	0.051	1.834
			Std	6.95	0.013	0.034	0.124	0.068	0.033	0.153
104.hea	F	66	Mean	75.03	0.157	0.416	-0.016	-0.025	0.088	1.0345
			Std	10.23	0.016	0.072	0.201	0.077	0.043	0.352
117.hea	M	69	Mean	53.47	0.222	0.484	0.004	-0.048	0.075	1.433
			Std	18.58	0.051	0.051	0.087	0.005	0.020	0.193

III RESULT

Normal sinus rhythm

Normal theoretical ranges for heart rate is 60-100bpm, QRS width is 80-120ms, PR interval is 120-200ms and QT interval is 300-430ms.QRS complex follows every P wave. Figure below shows Normal ECG.

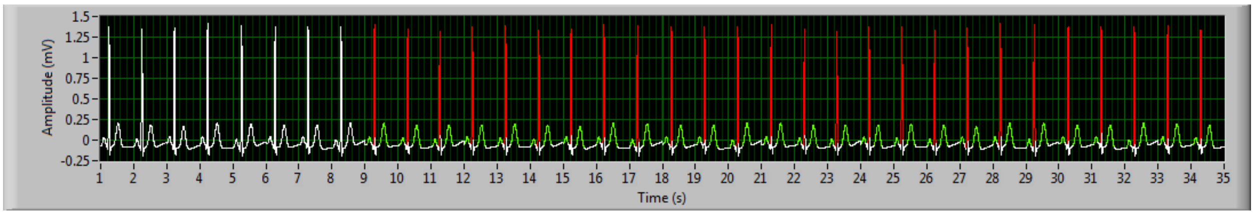


Figure 4. Normal ECG of patient

Hypokalemia

Table below shows characteristics of hypokalemia in which T wave becomes small and longer PR interval may represent conduction delay through digoxin toxicity. In 1st degree heart block PR interval lengthens with each beat until one P wave fails to produce a QRS complex. Figure below shows ECG of patient suffering from hypokalemia.

Table 4: Characteristics of hypokalemia

Feature of ECG signal	Feature extraction results	
PR	185ms	Greater than normal range
QRS	93ms	Greater than normal range
QT	428ms	Greater than normal range

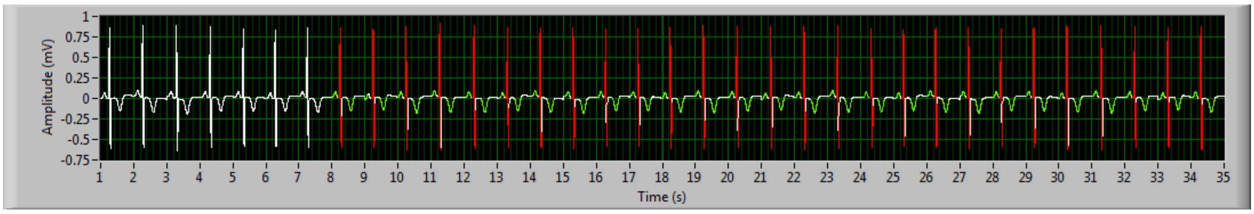


Fig 5. ECG of patient suffering from Hypokalemia

Hyperkalemia

Table below shows characteristics of hyperkalemia in which T wave widens up. It may also cause flattening and even loss of P wave, lengthning of PR interval, widening of QRS complex. Figure below shows ECG of patient suffering from hyperkalemia.

Table 5: Characteristics of hyperkalemia

Feature of ECG signal	Feature extraction parameter	
Heart rate	150.47bpm	Greater than normal range
PR	222ms	Greater than normal range
QT	484ms	Greater than normal range
QRS	132ms	Greater than normal range

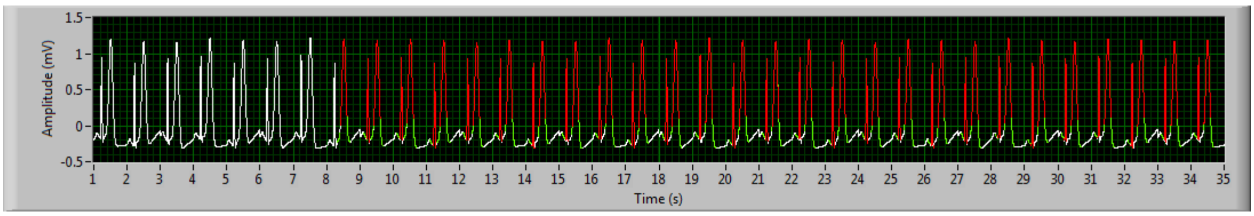


Fig 6. shows ECG of patient suffering from Hyperkalemia

Atrial Tachycardia

Table below shows characteristics of atrial tachycardia in which heart rate is greater than normal range that is 288.09bpm. PR interval is less than normal range and usually not visible. P waves are hidden in T waves as shown in fig below. This clearly shows features of atrial tachycardia. Atrial tachycardia is considered a type of supraventricular tachycardia.

Table 6 : Characteristics of Atrial Tachycardia

Feature of ECG signal	Feature Extraction parameter	
Heart rate	288.09bpm	Greater than normal range
PR	90ms	Less than normal range
QT	191ms	Less than normal range

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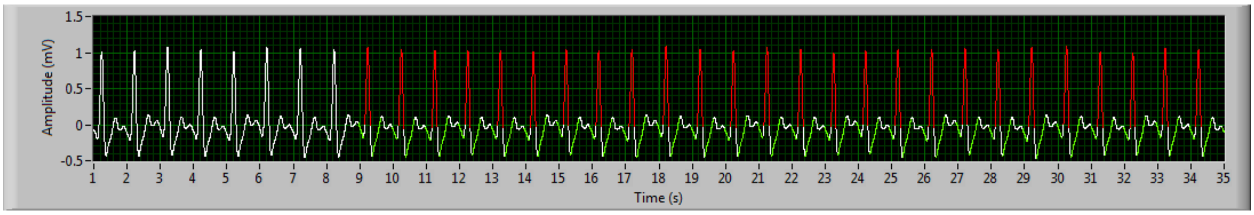

Figure 7. shows ECG of patient suffering from Atrial tachycardia

Acknowledgment

At the successful completion of my project work I take this opportunity to express sincere gratitude to many who have made the completion of my project possible. I would like to express my profound thanks to ECE Department of Deogiri Institute Of Engineering And Management Studies for the support, help and guidance throughout my project tenure. I extend my heartfelt thanks to my brother, sister and my parents, friends and well-wishers for their support and timely help.

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