Calculate ECG Parameters through Labview

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ABSTRACT
This paper gives an insight to labview software tools which helps in analysis of ECG signals. The raw ECG data are taken from MIT-BIH Arrhythmia database. Study of ECG signal includes filtering & preprocessing which removes the baseline wandering and noise due to breathing through wavelet transform technique. ECG features extraction VI will use for extracting various features viz P onset, P offset, QRS onset , QRS offset, T onset, T offset, R , P & T wave, with which we can calculate various parameters like Heart rate, QRS amplitude and their time duration.

Keywords
ECG, Baseline wander, Labview, Biomedical, Advance Signal Processing Toolkit

1. INTRODUCTION
The method to monitor and record electric current generated due to the contraction and expansion of atria and ventricles of the heart is known as Electrocardiography and the device used for these is called as electrocardiogram. ECG is most commonly used instead of electrocardiogram. For the recording and measuring these electrical signals electrodes are placed on the skin of subject (patient)[1]. Locations are specified for picking up the signals through electrode are between muscles on the upper arms and lower legs. The waveform so obtained after connecting electrodes through ECG could be traced out on computer or paper plot. The result helps the specialist in observing the condition of heart and diagnosis the problem associated with the various heart activity of the subject. A normal ECG tracing is shown in Figure 1 and the various components of the ECG are shown in Figure 2.

Figure 1. A normal ECG signal

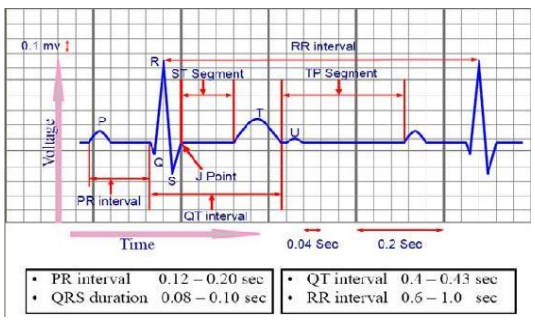

Figure 2. Different segments of a single waveform and time duration.

ECG signal consists of a recurrent wave sequence of P-wave, QRS-complex and T-wave associated with each beat. P wave is caused by the depolarization of atria before contraction, QRS complex formed due to ventricle depolarization before contraction and T is because of the re polarization of ventricles. Isoelectric line is basically the baseline voltage of ECG and it is measured as the portion of the tracing following the T wave and preceding the next P wave. ECG is considered to be potential measuring device i;e voltmeter .To measure the different potential 12 different leads (electrodes) are used. Placement of these leads on the body of subject follows Einthoven's triangle principle Figure 3 shows it. The electrical signal is very small (normally 0.0001 to 0.003 volt). These signals are within the frequency range of 0.05 to 100 Hertz (Hz.) or cycles per second.

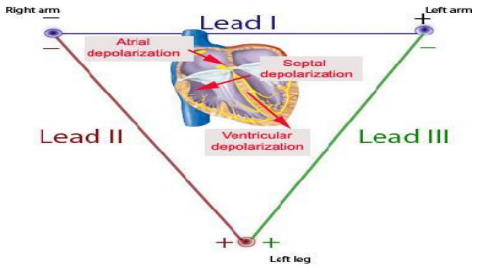

Figure 3. Einthoven's Triangle.

The LABVIEW has the facility to read ECG signals from external files that can be downloaded from MIT-BIH Arrhythmia Database. The signal taken can be processed with the help of Advanced Signal Processing tool kit and Biomedical tool kit of Labview to extract various features of ECG viz P onset, P offset, QRS onset , QRS offset, T onset, T offset, R , P & T wave, with which we can calculate various parameters like Heart rate, QRS amplitude and their time duration.

2. ECG SIGNAL PROCESSING
The recorded ECG signal is most often contaminated with noise and artifacts. To process that contaminated signal will give incorrect information about the patient which may lead to dangerous condition. To circumvent such situation processing of raw ECG is necessitates.

To process the raw ECG functionally signal processing is divided into two parts: preprocessing and feature extraction. During the preprocessing stage the unwanted noise suppresses from ECG signal and feature extractor process gives lead to diagnostic information while extracting the various features of ECG wave. [5].

With the help of Labview and its tool kits Advanced Signal Processing, Digital filter Design and Biomedical we can do the needful for ECG signal. Figure 4 shows the flowchart of ECG signal processing.

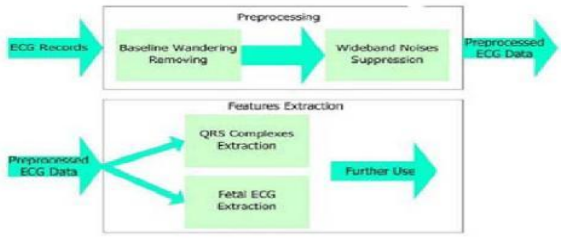

Figure 4. Flow Chart of ECG signal Processing

ECG can be contaminated with power line interference, contact noise or electrode pop, patient–electrode motion artifacts ,electromyography (EMG) noise, baseline wandering. ECG signal analysis can be strongly affected by the power line interference and the baseline wandering amongst all noises. The ECG signal also gets distorted with other noises which could be wideband and usually a complex stochastic process except for these two noises. The power line interference is narrow-band noise centered at 60 Hz (or 50 Hz) with a bandwidth of less than 1 Hz. Power line interference from ECG signal can be removed during acquisition of signal through hardware. A more powerful and feasible software scheme is used to remove the baseline wandering and other wideband noises which are not easy to be suppressed by hardware equipments [3][4].

3. REMOVAL OF BASE LINE WANDERING

A digital high pass filter can be used to suppress baseline wandering from ECG signal which usually comes from respiration at frequencies wandering between 0.15 and 0.3 Hz. Wavelet transform is another approach to remove baseline wandering by eliminating the trend of the ECG signal. In this with the help of wavelet transform approach we are removing low frequency trend of a signal. For this WA Detrend VI we are using as shown in figure 5[6].

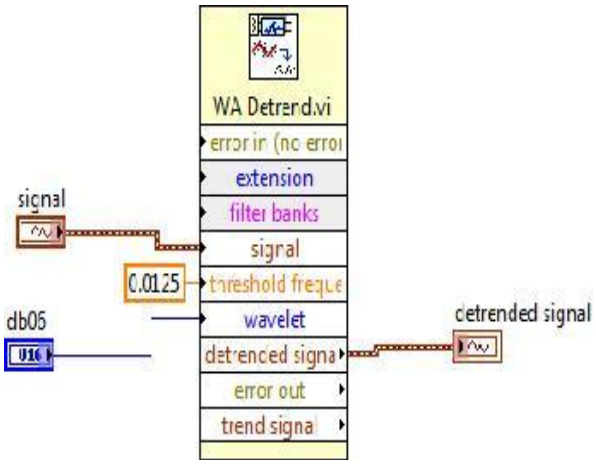

Figure 5 . WA Detrend VI

4. REMOVING WIDEBAND NOISE

Once the baseline wandering is removed the resulting de trend signal is more stationary and explicit than the original signal. Instead feature extraction of the ECG signal may get affected by some other types of noise. This may be wideband noise, and such noise could not be removed by traditional filters so Wavelet Denoise Express VI we are using for the purpose. The function of this Express VI is to first first decomposes the ECG signal into several sub-bands by applying the wavelet transform approach, and then modifies each wavelet coefficient by applying a threshold or shrinkage function, and finally reconstructs the denoised signal. Figure 6 shows ECG raw signal, detrend and denoised signal.

Figure 6 . WA Denoise VI, ECG raw signal, detrend and denoised signal.

5. WAVELET TRANSFORM

For the representation and analysis of physiological waveforms wavelet transform is better approach than Fourier transform. Fourier method is based on sinusoids of infinite duration whereas wavelets are of finite duration. Digital filters help in understanding and developing the wavelet theory. These are basically the meeting point between wavelets and sub band coding and the origin of two different nomenclatures for the same concepts. In fact, wavelet transform and sub band coding are so closely connected that both terms are often used interchangeably. Filter banks are structures that allow a signal to be decomposed into sub signals through digital filters, typically at lower sampling figure 7 shows a two-band filter bank [2].

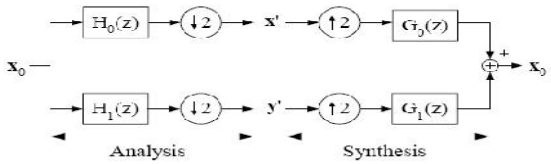

Figure 7 . One level two band perfect reconstruction filter.

The Discreet Wavelet Transform (DWT) analyses the signal at different resolution (hence, multiresolution) through the decomposition of the signal into several successive frequency bands. The DWT utilizes two set of functions ø(t) and Ψ(t), each associated with the low pass and the high pass filters respectively.These functions have a property that they can be obtained as the weighted sum of the scale (Dilated) and shifted version of the scaling function itself:

$$\emptyset(t) = \Sigma n\, h[n]\emptyset(2t-n)$$
$$\varphi(t) = \Sigma n\, g[n]\emptyset(2t-n)$$

Here, h[n] and g[n] are the half band low pass filter and high pass filter respectively [2].

6. ECG FEATURE EXTRACTOR

ECG various features information, helps in diagnosis of cardiac diseases. We often need to extract various features from the preprocessed ECG data for the diagnosis purposes it includes QRS amplitude, QRS intervals, PR intervals etc. These features provide information about the hearts various abnormalities, heart rate, the conduction velocity, the condition of tissues within the heart as well as various abnormalities. We have used LabView Feature Extractor VI of Biomedical tool kit for extracting various parameters. We can select whether to detect QRS only or to detect all supported ECG features, including R position, R amplitude, iso level, QRS onset,

QRS offset, P onset, P offset, T onset and T offset. Figure 8 shows VI in which we have extracted various features and calculate various parameters of ECG signal [3].

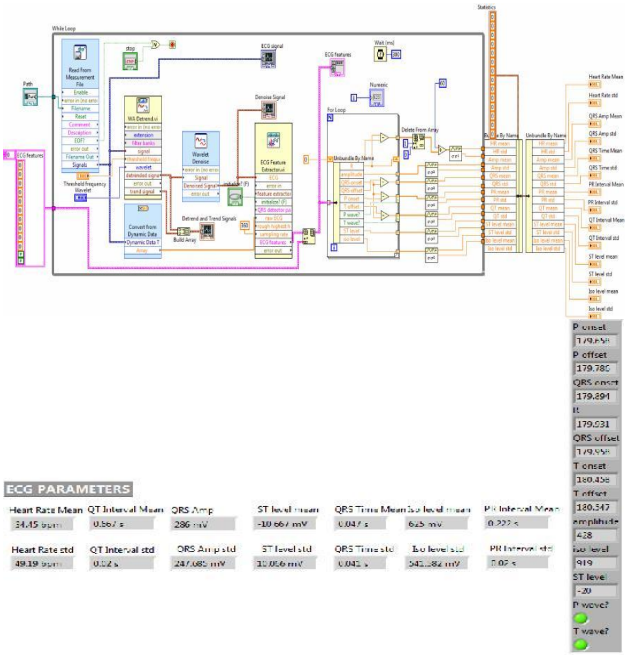

Figure 8 Front Panel and Block diagram of Calculating ECG parameter

7. CONCLUSION

In this paper we see that LabView has immense effect on signal processing. By using Lab View WA detrend VI and Wavelet Denoise Express VI of Advanced Signal Processing tool Kit the baseline wandering and wideband noise in ECG signal data taken from MIT-BIH database 100,101 and 103[7] has been successfully removed. Due to varied of algorithm, large diversified waveform not universally accepted solution has been found which can extract ECG features. The advantage of LABVIEW graphical programming language is that, it provides a robust and efficient environment and tool for generating very fast, less complex and useful algorithms.

8. REFERENCES

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