

Lab VIEW Based Heart Disease Detection

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Abstract: — Electrocardiogram (ECG) signal shows the electrical activity of the heart and provides useful information that helps in analyzing the patient's heart condition. This paper gives an insight in to the LabVIEW software which helps in the analysis of ECG signals. LabVIEW (Laboratory Virtual Instrument Engineering Workbench) is a graphical programming language that uses icons instead of lines of text to create programs. Processing of an ECG signal is done in two stages, filtering & feature extraction. Filtering is done through wavelet transform technique to remove the baseline wandering and noise due to breathing. ECG feature extraction VI is used for extracting various features like P onset, P offset, QRS onset, QRS offset, T onset, T offset, R, P & T wave, with which we calculate various parameters like Heart rate, QRS amplitude and their time duration. Further the heart rate is used to detect tachycardia and bradycardia conditions, while QT mean values are used to diagnose various heart diseases such as atrial tachycardia and hyperkalemia. The obtained result is alerted to the doctor through wireless communication.

Index Terms—ECG, Wavelet Denoise, Detrend, ECG Feture Extractor, Disease Detection.

I. INTRODUCTION

Human body consists of different organs that are interconnected together for proper and efficient body function. Heart is one of the most critical organs in the human body because it supplies blood to different part of the body organs; therefore a need in the development of methods and systems for monitoring its functionality is very high. One of the most powerful diagnostic tools in medical application that is commonly used for the assessment of the functionality of the heart is Electrocardiography (ECG). The ECG is a real-time non-invasive and conventional method for interpretation of the electrical activity of the heart

The electrocardiogram signal is in the range of 2 mv having the bandwidth of 0.1hz to 120 hz. In normal conditions, electrocardiogram waveform is having expected duration, amplitude and direction. So that it can be easily recognized, assessed, identified and interpreted for usual or unusual functioning of the heart. The electrocardiogram signal and heart rate reveals the cardiac fitness of human. Any change in heart rate or variation in the morphological form of electrocardiogram signal is a sign of cardiac arrhythmia. It is noticed as analyzed by investigation of the recorded electrocardiogram waveform. The amplitude and duration of the p-q-r-s-t-u wave more specifically qrs discrete wavelet transform, fourier transform, discrete cosine transform, z-transform and so on. Transform domain enables operation on the frequency content of an image, and therefore high frequency content such as edges and other subtle information can easily be modified. Low frequency band consists of smooth region of an image and hence it contains more information of an image as compared to high frequency

band complex contains the first hand information of the heart disease.

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. This virtual instrument has three stages. First stage is to acquire an ECG signal. Here the acquired signal is taken from the LabVIEW biomedical toolkit using simulated ECG .This ECG is then passed through a filter to limit the frequency range and to remove baseline noise and power interference and denoises it using W A analysis. This filtered and denoised ECG signal is then passed through the ECG feature extractor to extract ECG parameters. Third stage includes comparing ECG signal parameters with the corresponding normal parameters and any mismatch indicates abnormality in the ECG. The processed data is sent to a mobile phone using Bluetooth services and can be send to the physician using mail services.

II. FILTERING OF ECG SIGNAL

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 filtering of raw ECG is necessitates.

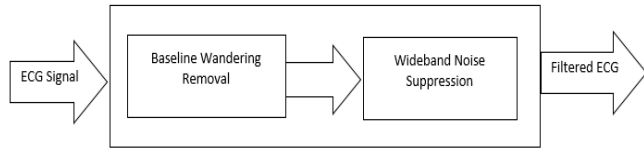


Fig 1. Flow Chart of ECG Signal Filtering

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 gets distorted due to noise that comes from respiration which is the base line wander, noise in electrodes and other motion noises.

A. Removal of Baseline Wandering

Baseline wandering usually comes from respiration at frequency wandering between 0.15Hz and 0.3Hz and it can be suppressed by a 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. 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 fig 2.

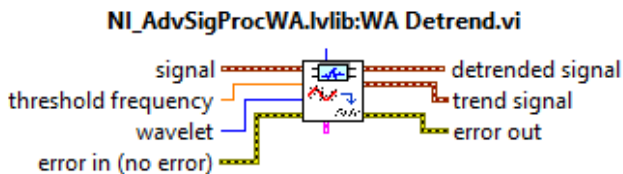


Fig 2. WA Detrend

B. Wideband Noise Suppression

Once the baseline wandering is removed the resulting de trend signal is more stationary and explicit than the original signal while 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 decompose 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.

Wavelet Denoise

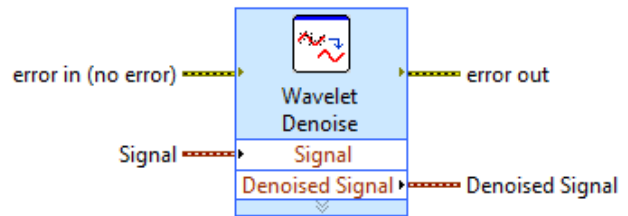


Fig 3. Wavelet Denoise

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 a function and finally reconstructs denoised signal. The Virtual instrument offers an option to select either discrete wavelet transform or undecimated wavelet transform to denoise the signal. The transform type used is undecimated wavelet Transform (UWT) to denoise the ECG signal. The UWT has a better balance between smoothness and accuracy than the discrete wavelet transform.

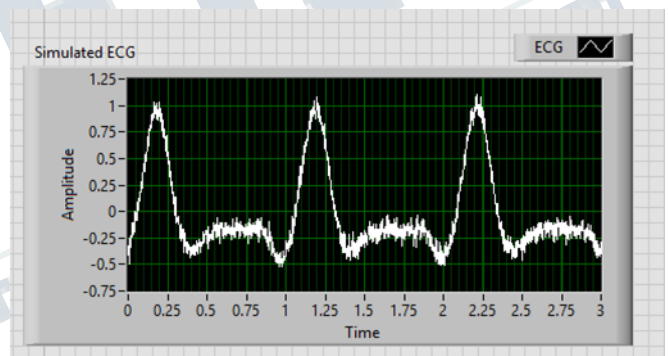


Fig 4(a). ECG Waveform before pre processing

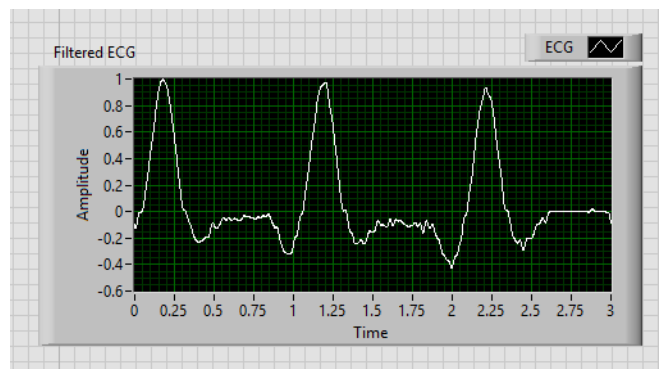


Fig 4(a). ECG Waveform after pre processing

III. FEATURE EXTRACTION

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.

NI_BMTK_Measurements.lvlib:ECG Feature Extractor (Waveform QRS).vi

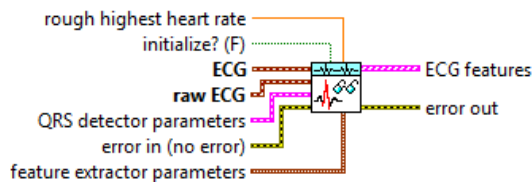


Fig 6. ECG Feature Extractor

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, T offset and various other features.

To calculate heart rate, the program will first find the maximum and minimum value from the processed signal in order to decide the threshold needed for the peak and valley detection. Virtual Instrument provides information about the peak and valley and thus the heart rate based on the peak and valley is obtained.

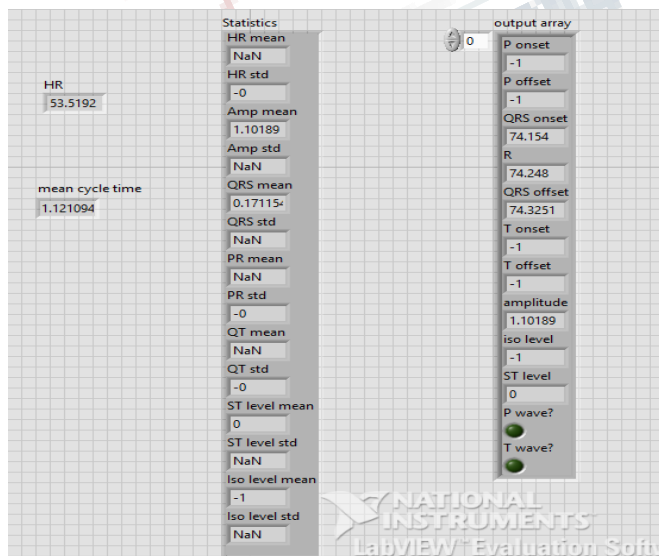


Fig 7. Front Panel of Calculating ECG Parameter

After heart rate calculation is done, this signal is passed to disease detection module which compares the ECG parameters with the normal parameter according to some rule specified and indicate the disease in front panel of virtual instrument. After that, the program loops to the first stage and start to collect the next data and repeats the above process up to the length of prediction period. It performs the whole process until the end of data or process stopped by the user to view the result.

IV. DISEASE DETECTION

After getting various parameters of ECG signal, these values are compared with the normal ECG parameters and if abnormality persists then it will indicate the disease most likely present in patient whose waveform is being analyzed.

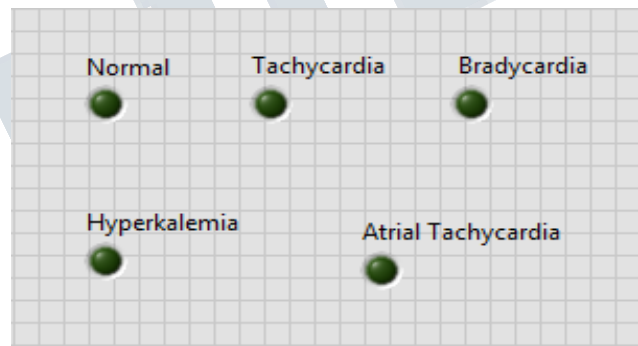


Fig 8. Indicating abnormalities present in the input signal

Detection of disease, on the basis of heart rate and other parameter deviation is done using the following rules:

1. If heart rate is less than 40 beats per minute (bpm) then it will indicate bradycardia.
2. If heart rate is greater than 100 bpm then it will indicate tachycardia.
3. If QT mean is greater than 0.5 sec, it indicates hyperkalemia.
4. If QT mean is between 0.4 sec and 0.5 sec, it indicates a normal ECG signal.
5. If QT mean is less than 0.4 sec then it indicates atrial tachycardia.

V. COMMUNICATION

The purpose of the communication system used here is to transmit the obtained result to the paramedics for immediate assistance in case of a disease detected. The communication system used here is Bluetooth transmission. The device to which the result is to be send is first paired with the source device and then using Bluetooth COM port the string

message is transmitted. The message indicates disease or no disease condition.

VI. RESULT

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 has been successfully removed. 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.

Table 1. Parameters of ECG signal

| Type of ECG | QRS mean | PR mean | QT mean | ST level mean | Iso level mean |
|-------------------------|----------|---------|---------|---------------|----------------|
| Normal | 0.03 | 0.35 | 0.64 | 0.076 | -0.120 |
| Atrial Tachycardia | 0.16 | 0.40 | 1.04 | -0.192 | 0.715 |
| Ventricular Tachycardia | 0.22 | 0.33 | 0.80 | 0.639 | 0.422 |

A Lab VIEW based system has been designed which acquires ECG data and processes it. This helps in finding the heart rate variability and consequent type of disease, The algorithm designed is able to acquire the data from measured file or simulate the ECG signal, processes the data, displays ECG waveform, displays heart rate and its abnormalities. This is indicated by blinking LEDs in Front Diagram of LabVIEW, This virtual instrument can be very effective for an early detection of critical disease and thus can save a patient from suffering.

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