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Design of Low Cost Compact Electro Cardio Gram Machine Using LabVIEW with E-mobile Interface

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ABSTRACT

Different methods have been projected and used for ECG feature extraction with a substantial percentage of precise detection. However, the problem remains exposed especially regarding higher detection precision in noisy ECG. In this work, we have developed an algorithm based using LabVIEW 8.5. LabVIEW (Laboratory Virtual Instrument Engineering Workbench) is a graphical user interface design language that uses icons in its place of lines of text to generate programs. Firstly, it detects the ECG signal from the ECG amplifier system and preprocesses (denoises) the signal to eradicate the noise from the ECG signal. Then it detects QRS complex and their onsets and offsets. LabVIEW and the related toolkits, advanced signal processing toolkit are used to build the graphical program for both the stages. The algorithm is evaluated with ECG data collected from normal volunteers, recorded at a sampling rate of 512Hz using NI USB 6008. Finally, a program was designed to send the report of the subject via email to his/her email id. Thus this work aims to develop a compact ECG analyzing the device.

Key word: Data Acquisition, ECG, Feature Extraction, LabVIEW, Mobile Interface.

I INTRODUCTION

Electrocardiogram (ECG) is the system which records the heart's electrical signal or function. It is primarily used to find out the operative and competence of the heart. ECG is principallyapatterned electrical signal which fluctuates as per the functioning of the heart and if recorded, can be used to examine the condition of the heart.The most critical and important part of the electrocardiogram (ECG) is the QRS complex. Its form and occurrence time holds much information and statistics about the heart function. Since it takes a notable shape, QRS recognition is the major part of almost all automated ECG analysis algorithms such as heart rate variability and cardiac cycle classification. A typical ECG waveform is shown in Fig.1.[1]

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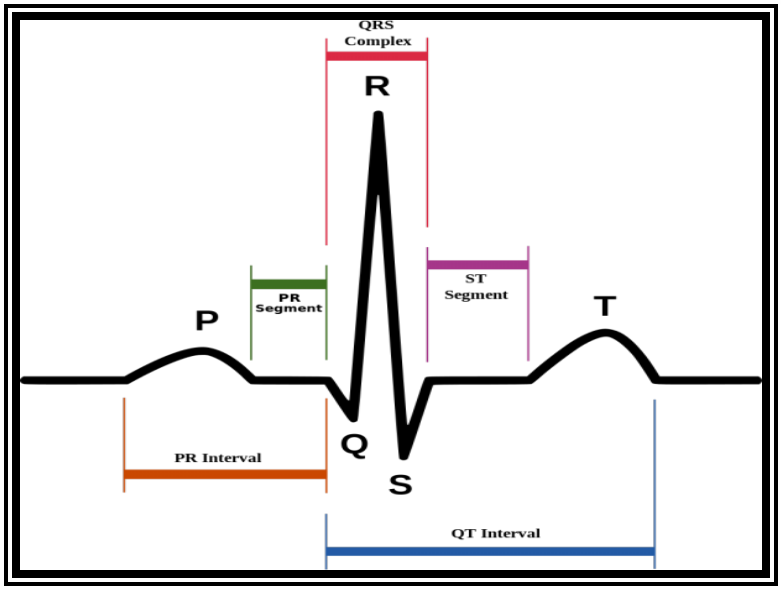

Fig: 1. Normal ECG Waveform

An ideal QRS detection process generally consists of two phases: preprocessing and decision [2].Widely, the former comprises some category of filtering [3], whereas the latter attempts to postulate the site of QRS complexes in the ECG signal. Till date, a far-reaching variety of techniques such as linear filtering, neural networks [4], mathematical morphology and wavelet transforms have been suggested by the investigators of QRS detection. In addition, numerous number of combinatory algorithms were previously projected, to be benefitted of the linear filtering and wavelet transform. Predominantly, QRS detection is a not a slight task. It may probably be malformed by noise affected by the electrode artifact, baseline drift, and power line interference [5]. Almost always, the ECG signal may distortdue to the unreasonable or obsessive deviations, e.g. signals with minor QRS complexes or unexpectedly variable levels. Henceforth, to deliver a trustworthy and a well-grounded QRS detection algorithm is still an unsolvable exposed problem.

In this paper we have designed an ECG amplification system and used LabVIEW 8.5 to denoise the signal and extract features from the signal and finally a program was included to send the report to a respective email hence notifying the status of the signal which was processed.

II METHODOLOGY

The National Instruments USB-6008 is an affordable, multifunction data acquisition device (DAQ). It has 8 analog inputs, 2 analog outputs, and 12 digital input/outputs. The digital channels are divided into two

ports. When one or more channels on each port is set to either input or output, the port is locked into that particular mode. The USB-6008 uses the NI-DAQmx driver software and is compatible with LabVIEW.The LabVIEW program [Fig: 2]offered in this section is applied directly at the ECG signals which are available as data files. The algorithm is divided into two parts.

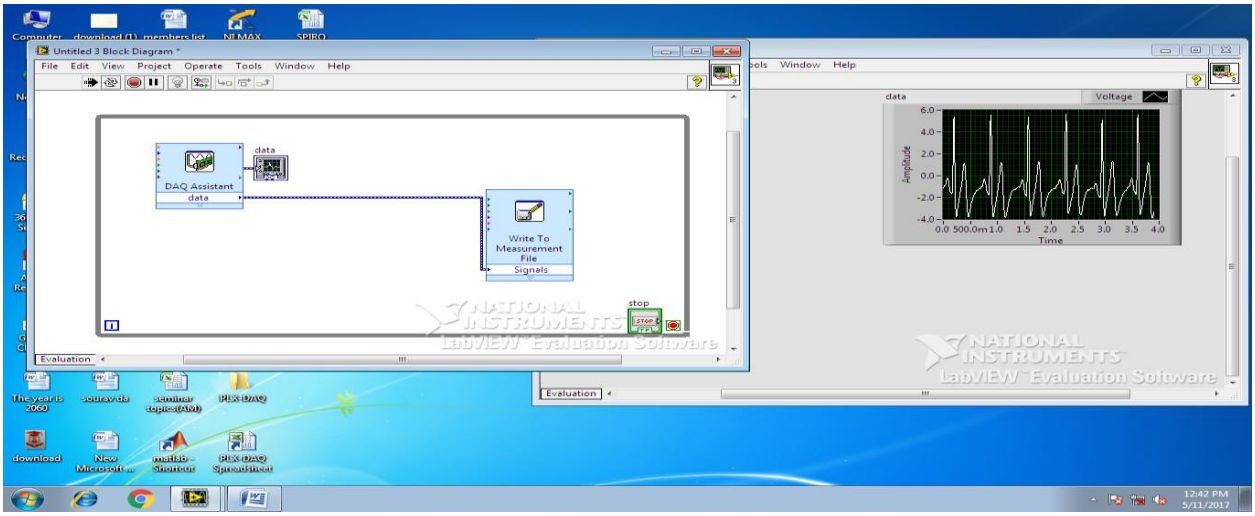

Fig: 2. LabVIEW Program for Acquisition of ECG data.

A. Preprocessing of the ECG signal (Denoising).

B. Feature extraction of the ECG signal

The recorded ECG signal is often contaminated by noise and artifacts that can be within the frequency band of interest and manifest with similar features as the ECG signal itself is a low frequency signal. In order to extract valuable information from the noisy ECG signal, we need to processes the raw ECG signal [Fig: 3]. Preprocessing of ECG signals remove contaminants from the ECG signals.

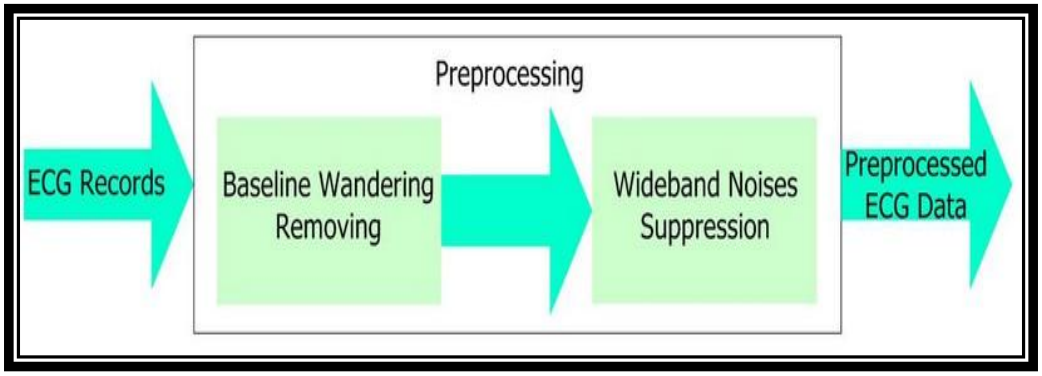

Fig: 3. Preprocessing of ECG Signal

Baseline wandering typically 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 LabVIEW ASPT (Advanced signal processing toolkit) [6] provides the WA Detrend virtual instrument which removes the low frequency trend of the signal. The WA detrend virtual instrument has an option to specify the wavelet type used for the discrete wavelet analysis. The one carefully chosen here is Daubechies(db06) wavelet since this wavelet is similar to the real ECG.After eliminating baseline wander the subsequent ECG signal is more static and explicit than the original signal. Nevertheless, some other types of noise might still disturb the feature extraction of the ECG signal. The noise may be complex stochastic processes within a wideband, so one cannot remove them by using traditional digital filters. To remove the wideband noises, the Wavelet Denoise Express Virtual instrument is used here. The Virtual instrument offers an option to select either discrete wavelet transform or undecimated wavelet transform to denoise the signal[7]. 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.For the purpose of diagnosis, we often need to extractvarious features [Fig:4] from the preprocessed (denoised) ECG data,such as peaks of P,T and QRS waves and their onsets and offsets.

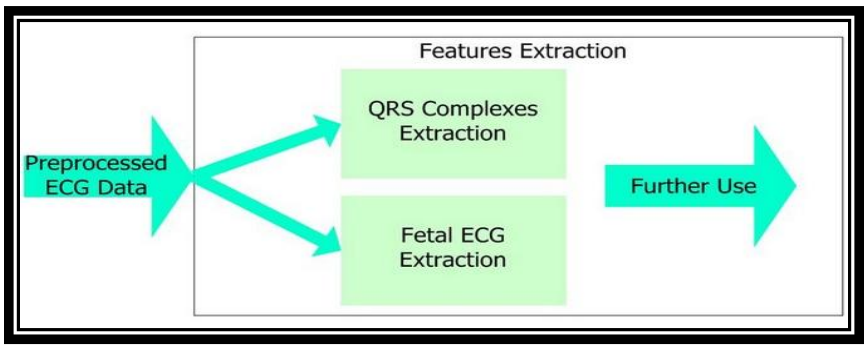

Fig: 4. Feature Extraction of ECG Signal

Multi resolution express virtual instrument is used in this algorithm to decompose the ECG signal by 8 level Daubechies (db06) wavelets and then the signal is recreated from the approximation coefficients and the detail coefficients of all the frequency bands. After multiresolution analysis peak/valley detection is done. WAmultiscale peak detection virtual instrument is used in peak detecting mode to detect P, R, and T points by specifying proper width and threshold. Width specifies the width in number of samples. Threshold specifies the value, which the virtual instrument uses to reject peaks of a particular size.

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Once all the peaks are detected [Fig: 5], these are taken as the references and an optimum window width is selected and the waves are scanned on both the sides of the peaks to get the zero crossing points for obtaining onsets and offsets. Mathscriptis used to evaluate onsets and offsets. The peak values sensed using LabVIEW are carried to the mathscript node as inputs [Fig: 6] and zero crossing points or least values (onsets and offsets) are taken as outputs from the mathscriptnode [8].

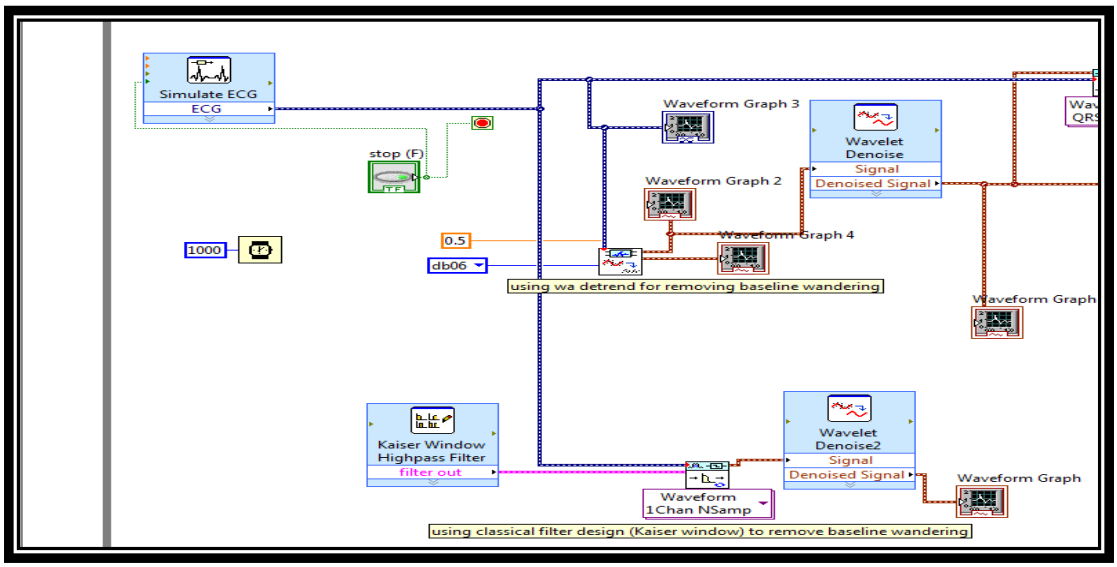

Fig: 5. Code for Preprocessing of Simulated ECG Signal

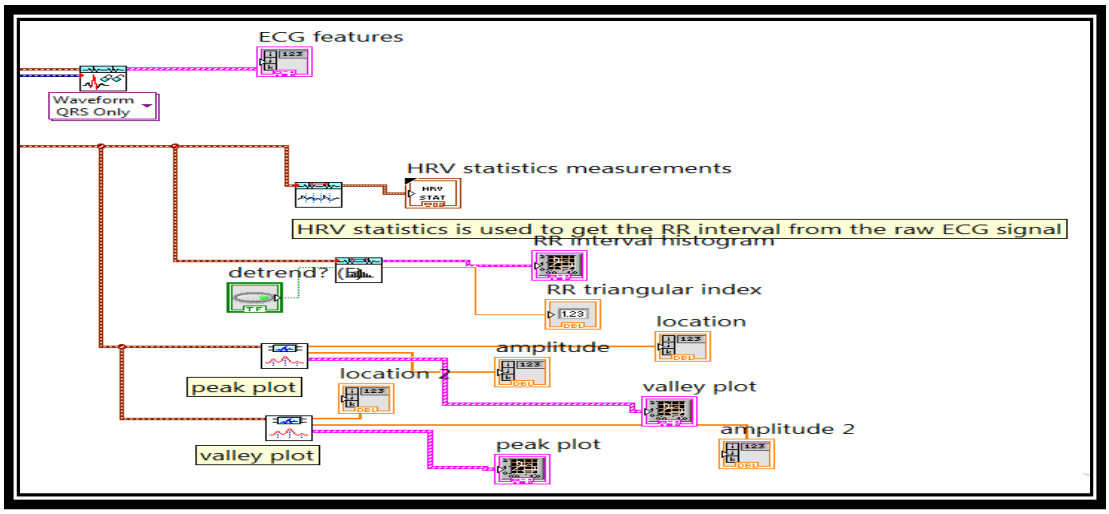

Fig: 6. Code for Feature Extraction of ECG Signal

Finally a Code was constructed to generate the report after all the analysis and finally send the report to send an email id.

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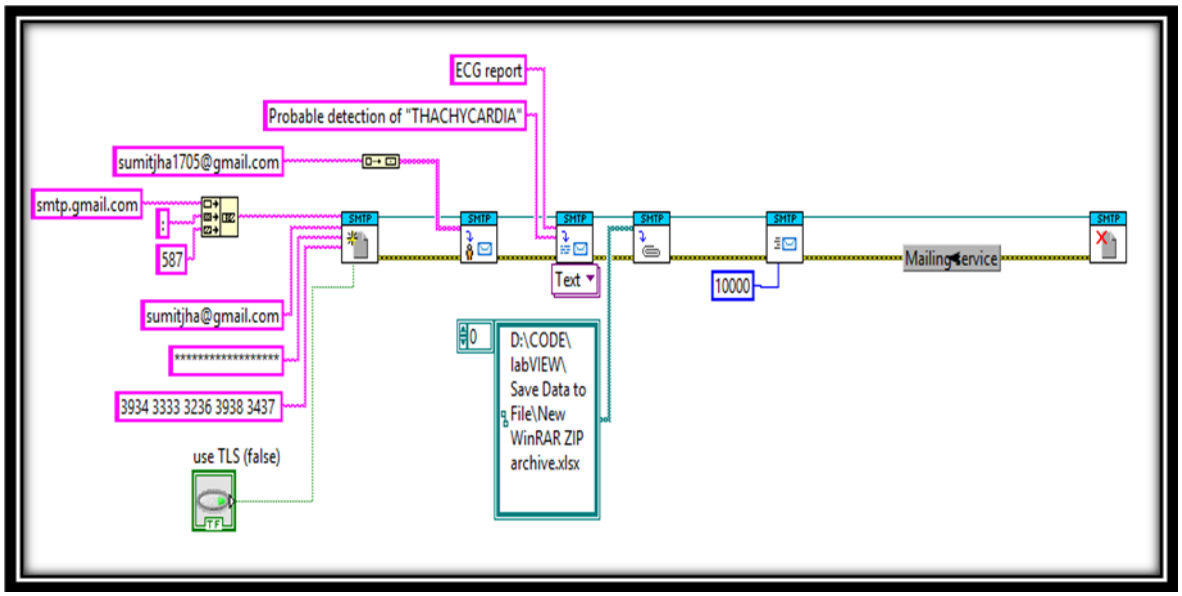

Fig: 7. LabVIEW Code for Sending an Email

III RESULTS AND DISCUSSIONS

The ECG signal has been acquired from the subject/patient by placing the clamp electrodes over the surface of the skin. The process of collection of data using LabVIEW is depicted in Fig; 2. ECG signal analysis has been done using LabVIEW software and the input signal is collected from the read from measurement file. The VI is designed to remove noise, R-peak detection, calculate the heart rate and it is found that all the heart rate lie in normal region in 60 to 100 bpm. The total process for feature extraction is depicted in Fig: 8, Fig: 9 and Fig: 10.

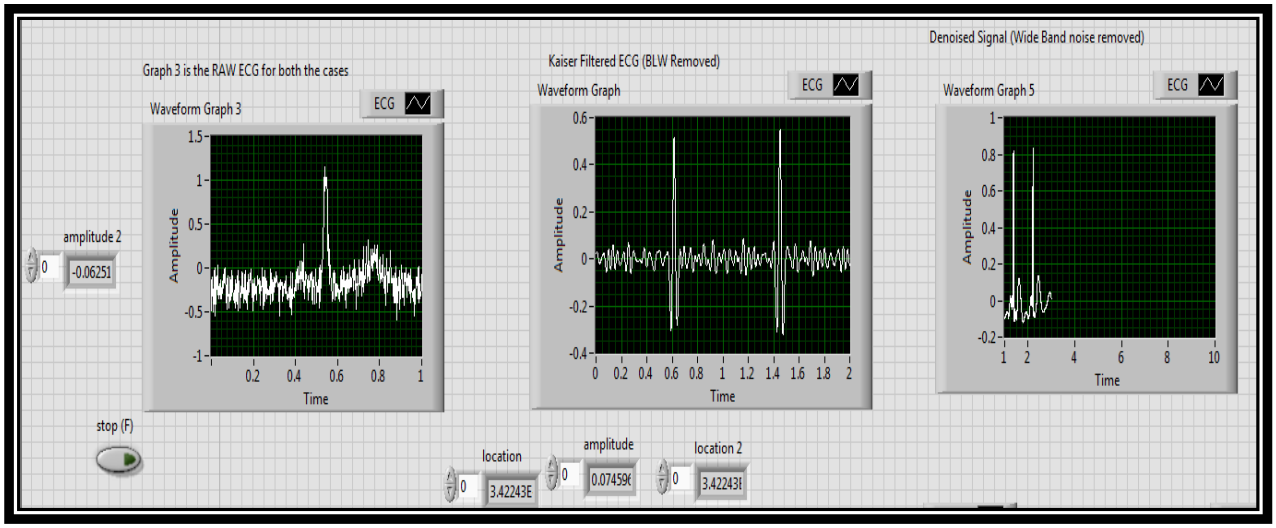

Fig: 8. using Preprocessing of ECG Signal LabVIEW

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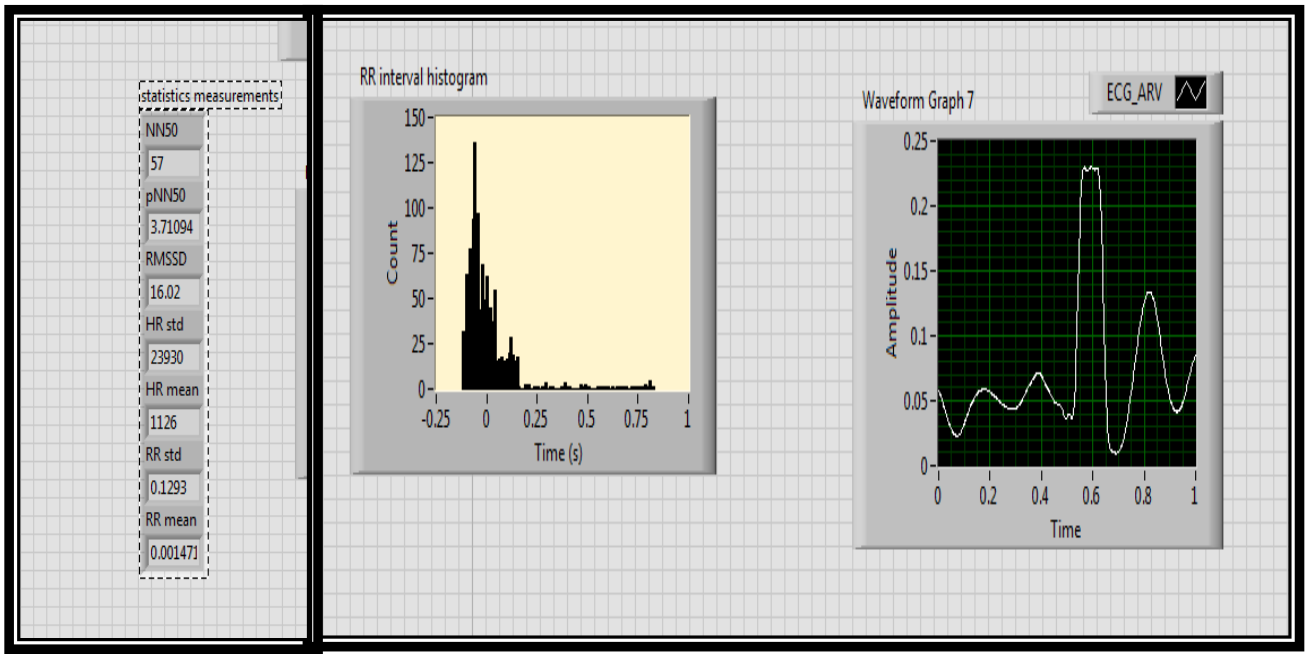

Fig: 9. Feature Extraction of ECG Signal Step-I

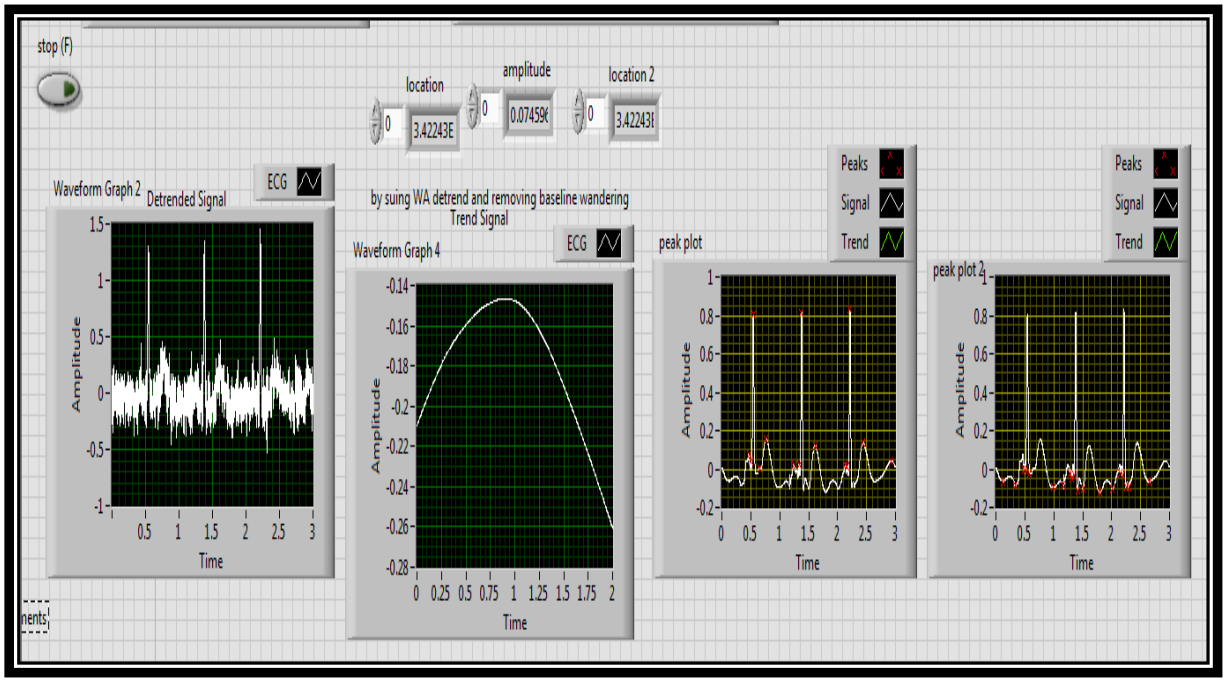

Fig: 10. Feature Extraction of ECG Signal Step-II

Finally the report generated was send to the recipient E-mail id which under progress and depicted in Fig: 11.

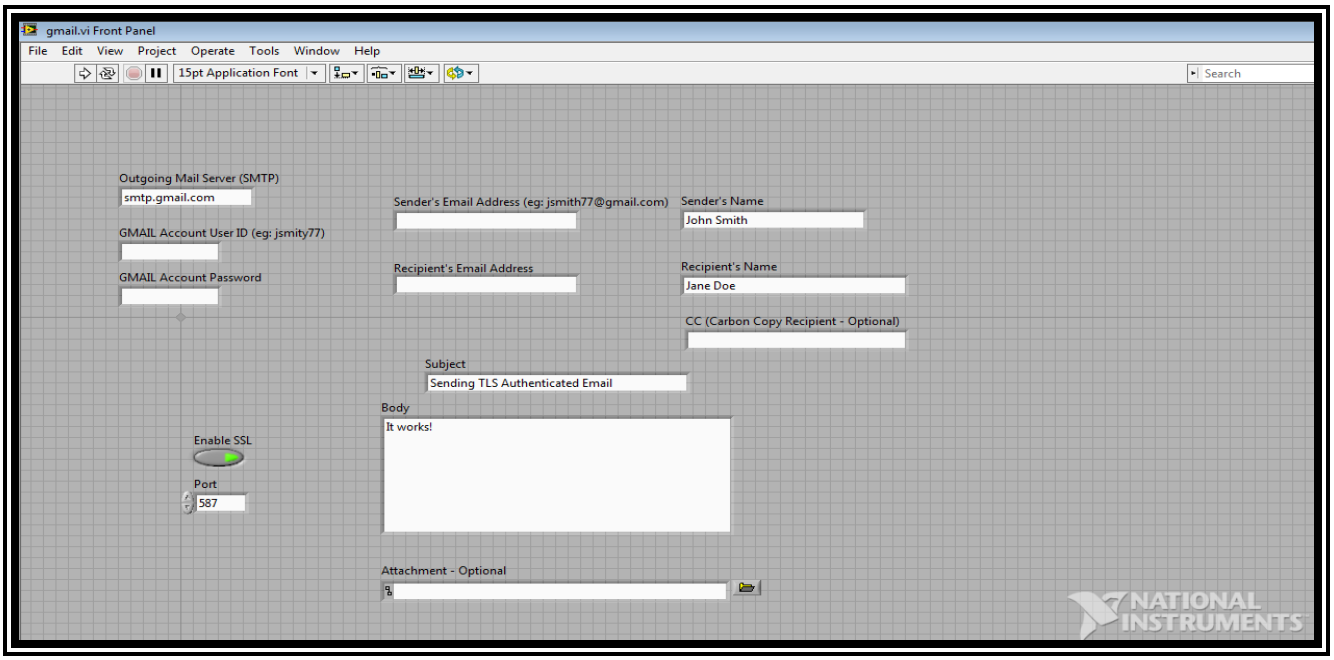

Fig: 11. Experimental Process for sending output via E-mail

IV CONCLUSION

The present work is under progress. We have design the ECG circuit by our own methodology and very cheaper with respect to other available system in the market. We have not depicted the circuit diagram of our system as it will be apply for patent. The feature extraction of the collected data using NI USB 6008 has shown excellence output using our own LabVIEW based program and depicted in Fig: 8, Fig: 9 and Fig: 10. Another algorithm also developed by for feature extraction using Lab-VIEW data in MATLAB which is not depicted here. The output of the result will be send via Lab-VIEW program depicted in Fig: 11 in an E-mail. This work is under process and will be published very shortly.

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