Advancement of virtual instrument for Bio signal measurement using LabVIEW Environment

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***Abstract*--The expanded execution of PCs and their diminished cost has made it feasible for advancement of PC based signal acquiring and analyzing systems. Hospitals require a few estimation frameworks that can measure physiological parameters of the patients. Although various diagnostic healthcare instruments have been generally utilized, consolidating virtual instrument innovation to accomplish the reason for physiological estimation has a several advantages. These frameworks are proficient and practical for acquiring and analyzing biomedical signals. Using virtual instrumentation (LabVIEW) to accomplish physiological estimation will to a great extent diminish the cost and increment the adaptability of the instruments. This work aims at planning a virtual instrument for getting and preparing of Electrocardiogram signal. Electrocardiography (ECG) is a method for estimating the Electrical activity of the Heart.**

Keywords—Physiological Estimation, Virtual Instruments, LabVIEW, Signal Processing

I. INTRODUCTION

Healing facilities require a few estimation frameworks that can quantify physiological parameters of the patient. Estimation frameworks ought to have the capacity to compute precisely the vitals of patient like heart conditions, body temperature, electrical action of the heart, electrical action of the cerebrum and so on. This data ought to be promptly accessible to the specialists for finding and legitimate treatment. PC based signal procurement, and examination is a proficient and cost compelling technique for biomedical signal procurement and observing. Isolation of the subject from the electronic hardware is essential [1]. Additionally, since the bio signal level is low, signal amplification is more imperative. Subsequently, a PC based framework comprises of extra circuits for segregation and amplification of the signals. Combining virtual instrumentation innovation for physiological estimations is a forthcoming innovation that is right now ascending at a quicker rate. The expense can be definitely brought down and the adaptability can be expanded by utilization of virtual instrumentation.

National Instrument's LabVIEW is a platform and improvement environment for a visual programming. The reason for such writing computer programs is mechanizing the utilization of preparing and estimating equipment in any research center setup[1][3]. Controls and indicators on the front panel allow an operator to input information into or separate information from a running virtual instrument. A key advantage of LabVIEW over other development environments is the broad help for getting to instrumentation equipment.

The program Execution is controlled by using the structure in form of graphical block diagram on which the programmer has to be connects various function nodes with the use of connecting wires [4]. National Instruments LabVIEW is an industry-driving programming apparatus for designing test, estimation, and control frameworks. By utilizing the incorporated LabVIEW environment to interface with real world signals, dissect information for important data, and share results.

LabVIEW is a graphical programming dialect that utilizes symbols rather than lines of content to make applications. In difference to content based programming dialects, where guidelines decide program execution, LabVIEW uses dataflow programming, where the stream of information decides execution order. LabVIEW programs are called Virtual Instruments, or VIs, because of their appearance and task emulate physical instruments [5].

LabVIEW software contains comprehensive sets of tools for acquiring, analyzing as well as displaying and storing data and also it has various tools to help troubleshooting of our code. LabVIEW contains more than 850 built-in analysis functions to simplify development for a broad range of applications [2][4].

II. ECG- BIOELECTRIC SIGNAL

Electrocardiogram is a non intrusive strategy to investigate the electrical action of heart when it siphons blood to the lungs and rest of the body. The ECG is clinically performed to evaluate heart rhythm, heart abnormalities like chamber enlargement, heart assault finding and so forth.

Generally, during the ECG recording process, various noises affect the signal heavily and ECG signals gathered from various individuals are heterogeneous. All types of clamor incorporates baseline wandering, EMG clamor, movement artifact, power line interference and contact noise may happen all the while and erratically. Generally the Electrocardiogram signal acquisition hardware can expel the main power line interference; however the baseline wandering and other wideband noise are difficult to be stifled by equipment hardware.

ECG signals are procured by placing electrodes on patient body. 12 lead systems are utilized in basic circumstance where extremely exact and definite examination is required while generally 3 lead configuration system is utilized for clinical purpose. In three electrode system the electrodes are attached on left arm, right arm and left leg to form an Einthoven triangle. The signals subsequently procured from these electrodes should be amplified and molded to be made valuable for investigation. Subsequently the signal is made to go through amplifier, low pass and high pass filter before it is digitized and transferred to a PC for analysis

purposes. LabVIEW is used for finding out the periodicity, frequency and amplitudes of P, QRS complex, S and T wavelets.

A few works have been done in the zone of ECG denoising and beat location. Spatial filters have been utilized as conventional technique for expelling clamor from signal. These filters normally smooth the information to diminish the noises from signals. In the latest decade, a couple of new systems have been built up that enhance spatial filters by expelling the noises even more effectively while protecting the peak information.

Wavelet transform is a very proficient method for a non-stationary signal processing. It can be used to decompose the signal in the time domain and/or frequency domain. There are various application domains of wavelet transform like as Data compression, peak Point recognition, and detection of noise reduction.

Various techniques used for the preservation of phase information of biological signal using LabVIEW. The cubic spline wavelet transform and interpolation techniques are also used for the detection of accurate QRS complex. They infer that wavelet functions give the most astounding exactness on the ECG reading in MIT-BIH arrhythmia database. Despite the way that the wavelet transforms approach does not isolate between the signals and noises coefficients of the wavelet disintegration at low SNRs and it isn't appropriate at the point at the point when high unwavering quality is required. There are various tools available, which are very conveniently for the usage at home, and it's depending on decimated Wavelet transforms.

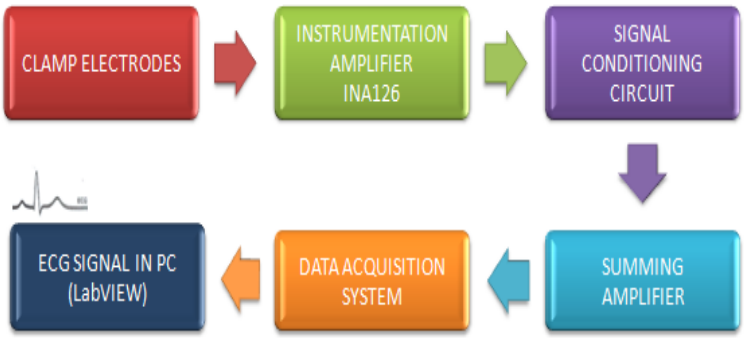
SYSTEM REPRESENTATION

The fundamental target of the current work is to develop a virtual instrument which can get the ECG signal, perform noise elimination and amplification. The structure of this framework comprised of three parts: Electrodes, Signal Conditioning circuit, and Interfacing Hardware with Graphical user interface (GUI) in LabVIEW.

First part consisted of acquiring the ECG signal from body using Clamp Electrodes or Disposable Ag/Agcl electrodes. The second part consisted of processing the signals obtained from the Electrodes. This was achieved by designing of suitable low cost amplifier for amplification and implementation of low pass and high pass filters for noise removal from the ECG Signal. The acquired signal was transferred to the Data Acquisition system and then the final part focused on development of a GUI to display the real time ECG in the LabVIEW environment.

A. ECG Signal Acquisition and Processing

The basic block diagram of the ECG Acquisition system is as shown in figure:

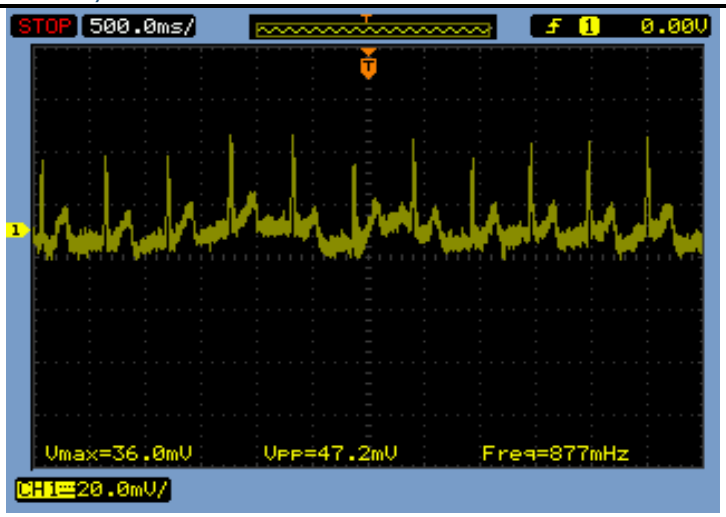


[Figure: ECG Signal Acquisition system]

As per Einthoven triangle, Clamp electrode is attached on patient body for acquiring of raw ECG signal. The initial step is amplification of ECG signal for extracting the useful information. INA126 IC is used for amplifying the difference of the two signals obtained from the electrodes at two arms with respect to the ground electrode which connected to the left leg.

The ECG signal is superimposed with a variety of noise from Electrical Line Interference and magnetic effect of circuit. Thus, the signal conditioning circuit consisted of Bandpass filter to eliminate the noise from that signal.

The Cut off frequency of High pass filter is 35.38 Hz and cut off frequency of Low pass filter is 0.54 Hz. Having amplified and filtered the ECG signal, it needs to be digitized for analysis purpose. However, before digitization, the signal can be viewed on CRO (figure).



[Figure: ECG Signal Acquisition in CRO]

Digitization is important for the communication of the signals to PC. For Digitization sampling frequency is kept at 1000 Hz. In this way, the DAQ consists of ADC0804, Microcontroller AT89c51 and MAX232. Moreover it is a low power chips which work on +5V. After digitizing, the ECG information is transferred to the PC using RS232 to USB converter cable. The digitized encoded signal is recreated in an analog ECG signal in LabVIEW where its processing is finished. The whole system hardware setup is shown in figure.

[Figure: ECG Signal Acquisition Hardware setup]

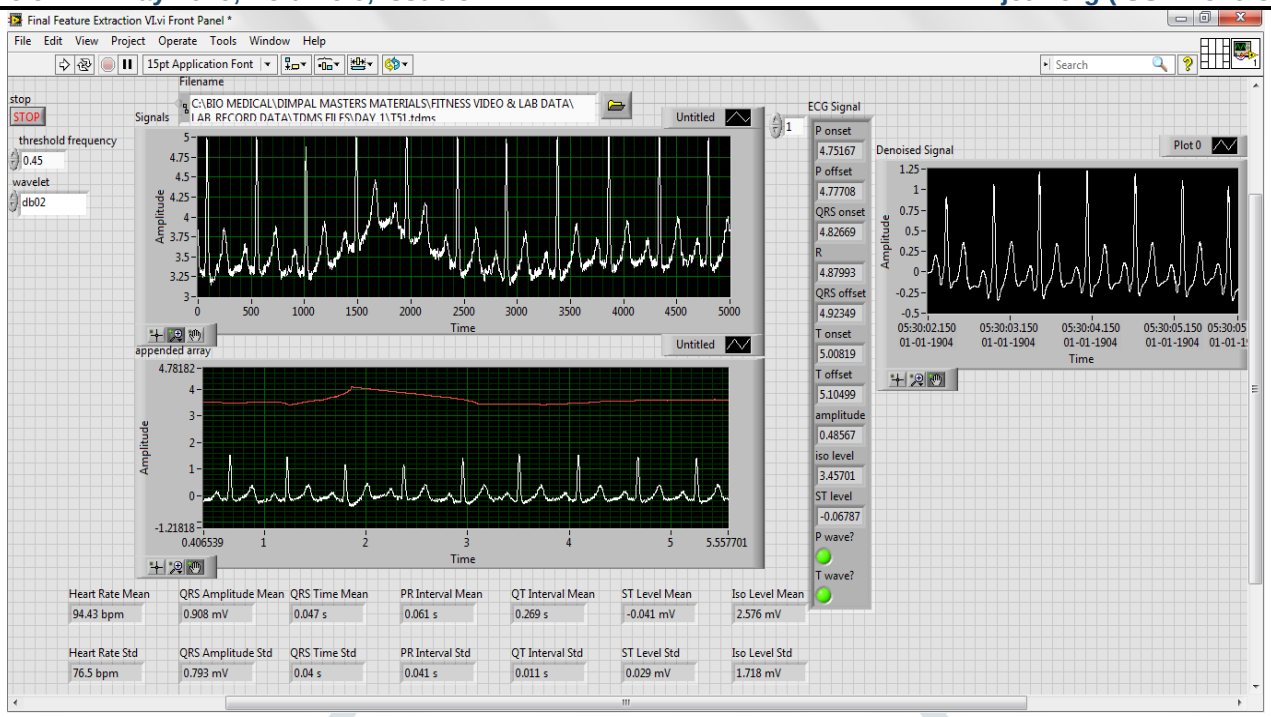
B. Front Panel Designing in LabVIEW

Signal Processing is divided into two parts for the processing of raw ECG signal: pre-processing and feature extraction. With the assistance of LabVIEW and its toolkits like Digital filter Design, Advanced Signal Processing, and Biomedical toolkits are needful for the extraction of various features of ECG signal.

A Digital high pass filter can be used to smother baseline wandering from ECG signal which generally originates from respiration at frequencies wandering somewhere in the range of 0.15 and 0.3 Hz. Wavelet transform is another approach to remove that baseline wandering. In this with the assistance of wavelet transform approach we are evacuating low recurrence pattern of a signal. For this purpose WA Detrend VI is used.

After removal of baseline wandering, the subsequent detrend signal is more understandable and stationary than the original signal. Thus, the feature extraction of ECG signal may get affected by some different types of noise. This might be wideband noise, and/or such types of noises couldn't be evacuated by using conventional filters. So, for this reason we are using Wavelet Denoise Express VI.

We regularly need to separate different features from the pre-processed ECG information for the cardiac disease diagnosis purposes which incorporate QRS amplitude, PR intervals, QRS intervals etc. These features provide the information about the hearts different abnormalities, the conduction velocity, heart rate, the state of tissues inside the heart. We have used Biomedical Toolkit in LabVIEW for Feature Extraction of ECG waves. Figure indicates front panel of ECG feature extraction.



[Figure: Front Panel of ECG Feature Extraction VI]

IV. RESULTS AND DISCUSSION

The biomedical signals Collected from the human body are mostly very small, often in the millivolt or microvolt range. Electro-cardiography signals are in the millivolt range and have numerous recurrence components. The biomedical signal processing is necessary before analysis. LabVIEW contains the various tools, from FFT to Digital Filters for complex analysis of bio signals. With the use of LabVIEW, we can successfully obtain a time-domain signal, which measures the frequency component, and convert that result into real world units.

WA detrend and WA denoise are a mathematical tools that decomposes a particular signal into a representation which shows the signals detailed information. The Wavelet transform is generally used because of its High computation speed. Thus, the LabVIEW is very effective software for the suppression of various noises and also it is very helpful for the extraction of various features from the bio signals. The LabVIEW based ECG feature Extraction information is shown in table.

[Table I: ECG Feature Extraction Data for 10 Subjects]

No. of Subject	HR mean (bpm)	QRS Amplitude Mean (mV)	QRS Time Mean (Sec)	PR Interval Mean (Sec)	QT Interval Mean (Sec)	ST Level Mean (mV)	ISO Level Mean (mV)
Subject 1	91.62	1.533	0.036	0.11	0.401	0.048	3.204
Subject 2	96.54	1.462	0.045	0.096	0.485	-0.013	3.216
Subject 3	88.42	1.526	0.063	0.209	0.529	-0.332	3.421
Subject 4	102.41	1.347	0.044	0.099	0.359	-0.102	3.287
Subject 5	115.43	1.348	0.034	0.103	0.37	-0.008	3.197
Subject 6	117.11	0.88	0.049	0.088	0.3	-0.076	3.821
Subject 7	84.13	1.794	0.061	0.211	0.473	-0.158	3.145
Subject 8	79.87	0.937	0.023	0.067	0.279	-0.053	2.688
Subject 9	106.55	0.82	0.042	0.064	0.264	-0.053	2.966
Subject 10	109.83	0.406	0.069	0.054	0.263	-0.101	2.908

V. CONCLUSION

The execution of PCs has been consistently expanding and the expense has been diminishing. This has encouraged the advancement PC based Signal Acquisition and analysis system. The fundamental components are promptly available and also inexpensive for an acquisition and analysis of biological signal using LabVIEW Environment. Here, the necessities of a PC based body signal acquisition and analysis system have been examined. ECG Signal information acquired, amplified, filtered and extraction of various features analyzed in front panel. Thus, the LabVIEW is a graphical programming language tool and it gives a powerful and systematic environment for acquisition and analysis of Bio-signals.

ACKNOWLEDGEMENT

First and foremost we would like to express our sincere thanks to all those people who supported us. we would like to thanks Mr. Manish shah, Fitness centre at Valsad who permitting us to conduct the experiment for data collection and also grateful to all the subjects who have cooperated in the experiment.

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