International Journal of Engineering Research in Electronic and Communication Engineering (IJERECE) Vol 2, Issue 7, July 2015

Advanced Health Care System

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Abstract: **Modern healthcare systems, despite all its breakthroughs and giant leaps of innovations still struggle to achieve an effective response that above all, rises to be a time-effective technique to treat patients. Through this paper, we introduce a system that strives to integrate the existing medical techniques with innovations in electronics and present them on a common platform, thus enhancing the effectiveness and doctor-patient interaction experience. The domain of implementation of this project is NI LabView. The basic building block of programs written in LabVIEW is VI. VI stands for virtual instruments. It is similar to a function or subroutine in other programming language. It includes the front panel (containing controls and indicators), the block diagram (containing control terminals, wires and structures and various other object nodes), the VI's icon and its connector pane (as well as compiled executable code which is hidden behind the scenes). The various blocks for ECG generation and its signal processing steps including wide band noise removal and base line wandering reduction has been achieved on LabVIEW. Monitoring of this signal and mechanisms in case of atrial depolarization (beginning of heart attack) and other atrio ventricular problems have also been set up. Monitoring and alarm mechanisms for irregularity in BP have been implemented. The patient's body parameters are updated into a mainframe database called EMR (Electronic Medical Report) on a real-time basis. The NI LabView 2013 simulator provides a single platform to integrate different VI module executions.**

Keywords: **LabVIEW, ECG, NIBP**

I. INTRODUCTION

One of the major handicaps that the health care industry faces today is its inability to record and manage the various patient data that it receives in an efficient manner that is compatible with all the other data that it receives. This often results in loss of time which may prove fatal in critical medical cases. Many a times, it becomes very tiresome to properly categorise the various patient information like body parameters such as blood pressure, pulse rate etc. All of this often leads to delay in treatment of patients and thus compromises their recovery.

The Advanced Medical System primarily seeks to integrate the various patient-care technologies existing in the modern world using a common graphical user interface National Instruments Lab View. In this project, an effort to simulate the basic ECG signal and BP parameters of a normal human has been made. The sample blood pressure and ECG values are collected using a bio-chip sensor. These readings are input into the LabView software via Bluetooth. The ECG signal is then subjected to basic pre-processing steps- removal of base line wandering and wideband noise using the WA Detrend VI module and Wavelet Denoise Express VI respectively provided by the LabView software. The Blood Pressure measurement and analysis is facilitated by the Non Invasive Blood Pressure VI in the LabView. The modules have been designed such that any abnormality in the input parameters will generate an immediate alarm response and be registered at the Electronic Medical Records. The use of Lab View for the simulation provides a convenient and efficient tool for virtual implementation of various sub modules such as BP, ECG, monitoring access records of patient rooms etc. We aim to thus provide a time efficient method of patient care by integrating the various sub modules into a common platform as shown in Fig. 1.

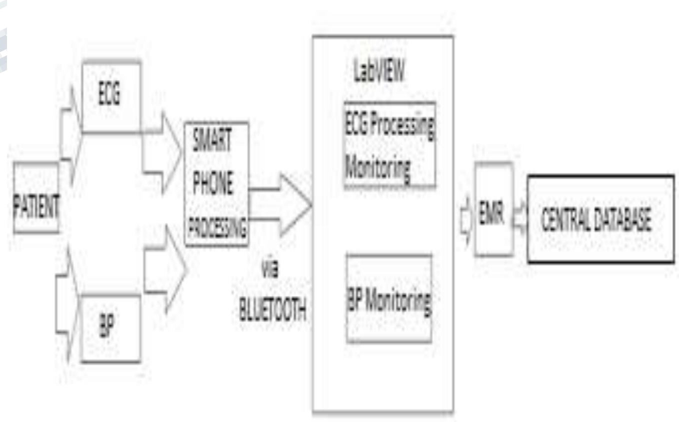

Fig. 1. Block Diagram of Proposed System

II. THE PROPOSED ADVANCED HEALTH CARE UNIT

A. LabVIEW

LabVIEW is a graphical programming language. It is mainly used for data acquisition, industrial automation, signal processing, etc. It has a dataflow programming approach. In this project LabVIEW is used to acquire ECG signals and Blood Pressure reading from external environment using DAQ. The obtained values are then pre-processed using the signal processing toolkit and biomedical toolkit. The processed signal is then displayed on the front panel. The block diagram and front panel windows are shown in Fig 2.

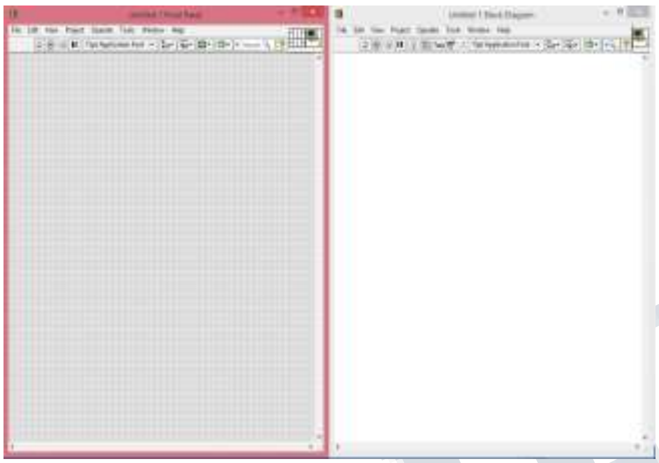

Fig 2. Block diagram and Front Panel

National Instruments [5] is increasingly focusing on the capability of deploying LabVIEW code onto an increasing number of targets including devices like Phar Lap or VxWorks OS based LabVIEW Real-Time controllers, FPGAs, PocketPCs, PDAs, wireless sensor network nodes, and even Lego Mindstorms NXT as shown in Fig. 3.

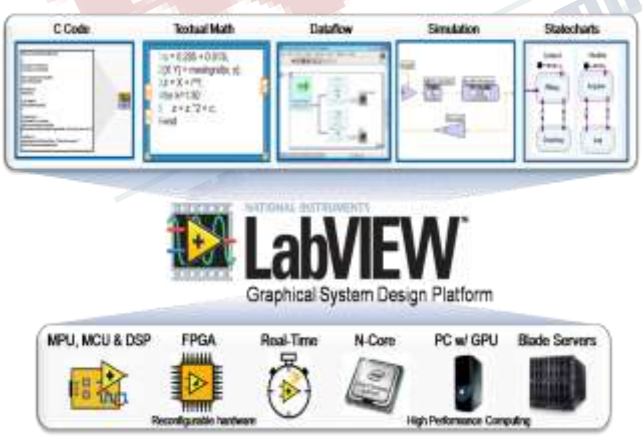

Fig.3. LabVIEW toolkit

B. ECG Generation

The electrocardiogram (ECG) [2] provides a physician with a view of the heart's activity through electrical signals generated during the cardiac cycle, and measured with external electrodes. Cardiac cells, in the normal state are electrically polarized. Their inner sides are negatively charged relative to their outer sides. These cardiac cells can lose their normal negativity in a process called depolarization, which is the fundamental electrical activity of the heart. This depolarization is propagated from cell to cell, producing a wave of depolarization that can be transmitted across the entire heart. This wave of depolarization produces a flow of electric current and it can be detected by keeping the electrodes on the surface of the body. Once the depolarization is complete, the cardiac cells are able to restore their normal polarity by a process called re-polarization. This is sensed by a biosensor chip and the resulting signal is then interfaced with LABVIEW via Bluetooth. This is then used to determine heart rate, investigate abnormal heart rhythms, and the beginning of heart attack. The most important ECG signal features in a single cardiac cycle are labelled (along with the physiological cause of that feature) in Fig. 4.

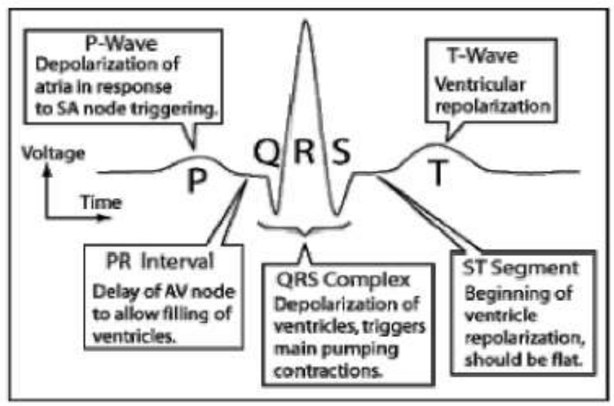

Fig. 4. A typical one cycle ECG tracing

ECG is used clinically in diagnosing various abnormalities and conditions associated with the heart. For the normal functioning of heart, duration of

P-R interval : 0.12 to 0.20 s
Q-T interval : 0.35 to 0.44 s
S-T interval : 0.05 to 0.15 s
P-wave interval : 0.11 s
QRS interval : 0.09 s

The normal value of heart beat lies in the range of 60 to 100 beats/minute. A slower rate than this is called bradycardia (Slow heart) and a higher rate is called tachycardia (Fast heart). If the cycles are not evenly spaced, an arrhythmia may be indicated. If the P-R interval is greater than 0.2 seconds, it may suggest blockage of the AV node. In our proposed system we have included the normal values to generate an ECG signal for a healthy person on LABVIEW and also the range of values which could lead to arrhythmia thus indicating the doctor to attend the patient as early as possible.

C. ECG Preprocessing

Generally, the recorded ECG signal is often contaminated by noise [4] and artifacts that can be within the frequency band of interest and manifest with similar characteristics as the ECG signal itself. In order to extract useful information from the noisy ECG signals, we need to process the raw ECG signals.

The preprocessing stage removes or suppresses noise from the raw ECG signal. This functionality is demonstrated in Fig. 4.

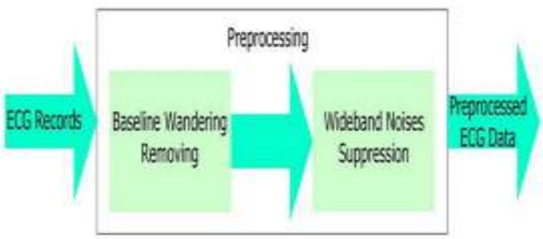

Fig. 5. Typical ECG Processing Flow chart

1) *Removing Baseline Wandering:* The LabVIEW ASPT provides the WA Detrend VI which can remove the low frequency trend of a signal. Baseline wandering can be removed by using the WA Detrend VI as shown in Fig. 6.

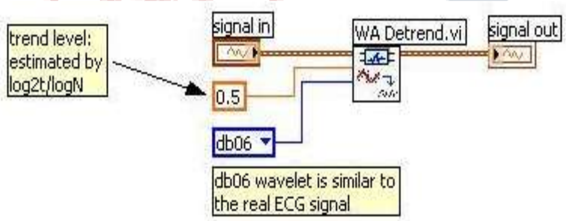

Fig. 6. Using the WA Detrend VI to remove baseline wandering

We have used the Daubechies6 (db06) wavelet because this wavelet is similar to the real ECG signal. In this example, the ECG signal has a sampling duration of 60 seconds, and 12000 sampling points in total, therefore the trend level is 0.5 according to the following equation:

$$trend\ level = \left[\frac{\log_2 2t}{\log_2 N}\right]$$

where t is the sampling duration and N is the number of sampling points.

The original ECG signal and the resulting ECG signals processed by wavelet transform-based approaches is shown in Fig. 7.

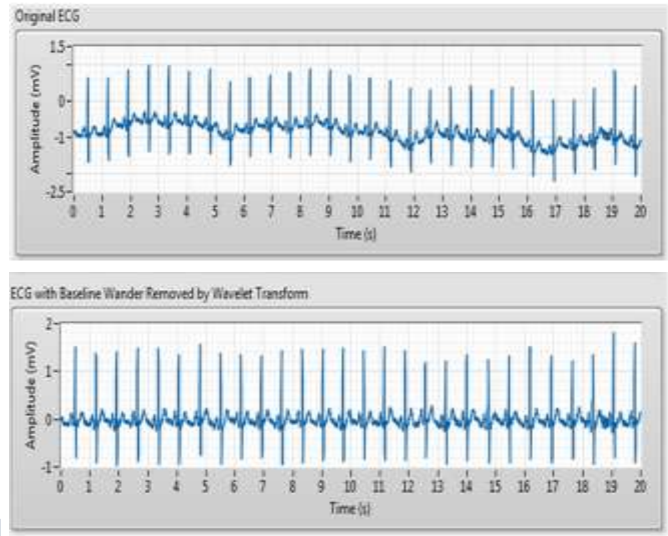

Fig. 7. Wavelet transform-based approaches

2) *Removing Wideband Noise:* After removing the baseline wandering, the resulting ECG signal is more stationary and explicit than the original signal [4]. Some other types of noise still affect the ECG signal. The noise may be complex stochastic processes within a wideband, so we cannot remove them by using traditional digital filters. To remove the wideband noises, we can use the Wavelet Denoise Express VI.

This LabVIEW based higher-level Express VI first decomposes the ECG signal into several sub bands by applying the wavelet transform, and then modifies each wavelet coefficient by applying a threshold or shrinkage function, and finally reconstructs the denoised signal. The application of undecimated wavelet transform (UWT) to the ECG signal is shown in Fig. 8.

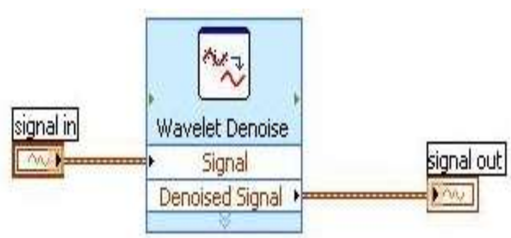

Fig.8. Removing wideband noises from an ECG signal by applying the UWT

The UWT has a better balance between smoothness and accuracy than the discrete wavelet transform (DWT). By comparing the de-noised ECG signal with the non-denoised

ECG signal, we can find that the wideband noises are strongly suppressed while almost all the details of the ECG signal are kept invariant as shown in Fig 9.

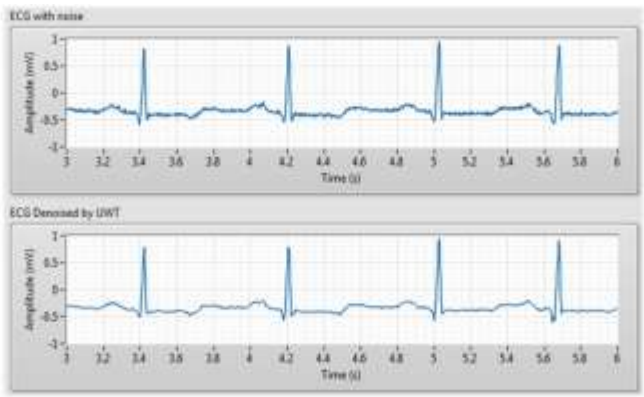

Fig.9. ECG signals before and after UWT denoising

D) Blood Pressure Monitoring

Blood pressure (BP) is the pressure exerted by circulating blood upon the walls of blood vessels and is one of the principal vital signs. Blood pressure usually refers to the arterial pressure of the systemic circulation, usually measured at a person's upper arm .Blood pressure varies from a peak pressure produced by the contraction of the left ventricle, to a low pressure produced by ventricular relaxation. The peak pressure is called systole, and the pressure that is maintained while the left ventricle is relaxing is called diastole. The average pressure is the mean arterial pressure or MAP. A person’s blood pressure is usually expressed in terms of the systolic pressure over diastolic pressure and is measured in millimetres of mercury (mm Hg). Normal resting blood pressure for an adult is approximately120/80 mm Hg and above140/90 is considered high blood pressure. Blood pressure chart for an adult is shown below Fig. 10.

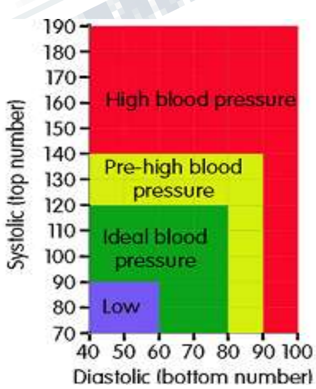

Fig.10. Blood Pressure Chart for Adults

Here we use a Vernier Blood Pressure Sensor, a non-invasive unit [7], and the resulting signal is given to NIBP analyzer in LabVIEW via Bluetooth and also systolic and diastolic threshold value for pressure is applied to the NIBP analyzer. Using noninvasive blood pressure VI, systolic, diastolic and mean average pressure is recorded as shown in Fig. 11.

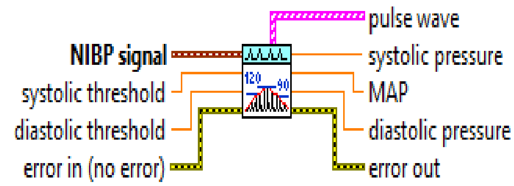

Fig.11.NIBP analyzer

CONCLUSION

The various modules of the health care system have been integrated and successful implementation of the same has been achieved. The Advanced Healthcare system thus brings the various aspects of modern day treatment under a single umbrella. Experimental data of ECG waveforms and Blood Pressure measurements have been acquired into the LabView simulation using a bio-chip sensor via Bluetooth. The analysis of these data for monitoring various medical conditions has also been implemented. Removal of base line wandering and wide band noise in the acquired ECG signal has been achieved using the WA Detrend VI module and Wavelet Denoise Express VI respectively provided by the LabView software. An alarm mechanism for atrial depolarization has also been demonstrated. Also, the monitoring and regulation of the Blood Pressure data has been implemented using the Non Invasive Blood Pressure VI. The Lab View software facilitates a convenient technique of monitoring all the patient data in an efficient manner. The user friendliness of its graphical user interface and compatibility to interface with a number of hardware inputs such as bar code scanner, ECG probe etc. helps improve the real time implementation of an efficient healthcare system.

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