An ECG Biotelemetry system with NI ELVIS-II DAQ

Akash Kumar Bhoi[1], ShishirSrivastava[2], PrasantBasnett[3], AnubhavBajpai[4]

[1,2,3,4] Department of AE&I Engg, Sikkim Manipal Institute of Technology (SMIT), Majitar

Email:[1]akash730@gmail.com, [2]shishir.2091@gmail.com, [3]ande_arpan@yahoo.co.in,[4]anubhavbajpaiun@gmail.com

Abstract:Telemetry is the highly automated communications process by which measurements are made and other data collected at remote or inaccessible points and transmitted to receiving equipment for monitoring. The two most common forms of multiplexing are time domain multiplex (TDM) and frequency domain multiplex (FDM). Multiplexing only occurs intentionally. Frequency division multiplexing (FDM) Frequency spectrum is divided into several non-overlapping frequency bands. Each user uses a unique band and to interleave or simultaneously transmit two or more messages on a single channel. Here we have proposed FDM for transmitting ECG signals (i.e. aVF & V1). Our proposed biotelemetry system is comprises of ECG simulators which generated all 12 leads configuration signals and processing of these signals by FDM module. We have designed a LPD (H/W & S/W) in NIELVIS-II platform and Lab view. The filtered signals were acquired through the Data acquisition system i.e. NI ELVIS-II. This hardware gives us another platform i.e. further analysis of ECG signal in Lab View which will provide anaramous research oppurtunities

Keywords: TDM, FDM, ECG, NI ELVIS-II, Labview

1. INTRODUCTION

In India 60-70% of the population lives in rural villages. The rural population suffers from a burden of disease and disorders due to the non-availability of appropriate healthcare personnel and facilities. Since 1950, The Indian government has responded with a series of five-year plans but has been unable to address the lack of healthcare professionals prepared to work in isolated rural areas. The developmentof biotelemetry in India will improve healthcare for the rural and remote population and ease the effects of the storage of rural healthcare professionals. However a number of questions remain and require further consideration. [1]

Biotelemetry is defined as transmitting biological or physiological data to a remote location that has the capability to interpret the data and affect decision-making. Biomedical telemetry is a special field of biomedical instrumentation that often enables transmission of biological information from an inaccessible location to a remote monitoring site. Telemetry is the science of gathering information from a distant location and then transmitting the data to a convenient location to be examined and recorded. Telemetry is a process by which transmission of objects or environments characteristics via different transmission channels is conducted. Air, space for satellite application, coaxial cable or fiber optic cables are used as transmission channels. Wireless telemetry systems are used when the measurement point is far from the monitoring place or there is a risk for work safety. Wireless telemetry systems are preferred at biotelemetry application because of the fact that biological signals can be observed in natural living surrounding. [2][7]

As the population ages and the risk of chronic disease increases, the cost of healthcare will rise. Technology for mobile telemetry could reduce cost and improve the efficiency of treatment. In order to achieve these goals, we need to overcome several technical challenges, including sufficient system lifetime, high signal fidelity, and adequate security. The design, implementation, and evaluation of a Mobile Biotelemetric System (MBS) that addresses these remote medical monitoring challenges. MBS comprises a custom low-power sensor node that accurately collects and analyzes electrocardiogram

(ECG) data, a client service with a multifaceted policy engine that evaluates the data, and a web portal interface for visualizing ECG data streams. MBS differs from other remote monitoring systems primarily in the policy engine's ability to provide exible, robust, and precise system communication from end-to-endand to enable tradeoffs in metrics such as power and transmission frequency. [3][5][8]

2. ELECTROCARDIOGRAM

ECG consists of graphical recording of electrical activity of the heart over time. It is most recognized biological signal, and with non- invasive method; it is commonly used for diagnosis of some diseases by inferring the signal. Cardiovascular diseases and abnormalities alter the ECG wave shape; each portion of the ECG waveform carries information that is relevant to the clinician in arriving at a proper diagnosis. The electrocardiograph signal taken from a patient is generally get corrupted by external noises, hence necessitating the need of a proper noise free ECG signal. A signal acquisition system, consist of several stages, including: signal acquisition though hardware and software instrumentation, noise or other characteristics filtering and processing for the extraction of information. Electrocardiography signals recorded on a long timescale (i.e., several days) for the purpose of identifying intermittently occurring disturbances in the heart rhythm. Simple ECG waveform as shown in Fig.1. It is a combination of P, T, U wave, and a QRS complex. The complete waveform is called an electrocardiogram with labels P, Q, R, S, and T indicating its distinctive features.

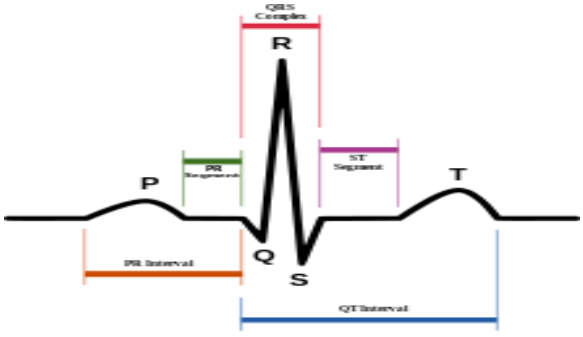

Fig1. ECG waveform

Improving the signal quality without disturbing the tiny features of the ECG signal i.e., improving the signal to noise ratio. This allows the cardiologist to observe the ECG with high resolution and better diagnosis. . Reducing the computational complexity of the adaptive filter. Complexity reduction of the noise cancelation system, particularly, in applications such as wireless biotelemetry system is very important. This is because of the fact that with increase in the ECG data transmission rate, the channel impulse response length increases and thus the order of the filter increase. The resulting increase in complexity makes the real time operation of the biotelemetry system difficult, especially in view of simultaneous shortening of the symbol period, which means that lesser and lesser time will be available to carry out the computations while the volume of computations goes on increasing. [2]

3. DATA ACQUISITION SYSTEM

Data Acquisition is defined as the process of taking a real-world signal as input, such as DAQ a voltage or current any electrical input, into the computer, for processing, analysis, storage or other data manipulation or conditioning. A Physical phenomenon represents the real-world signal we are trying to measure. Today, most scientists and engineers are using personal computers with ISA, EISA, PCI or PCMCIA bus for data acquisition in laboratory, research, test and measurement, and industrial automation applications. Many applications use plug-in boards to acquire data and transfer it directly to computer memory. Others use DAQ hardware remote from the PC that is coupled via parallel port, serial port, GPIB-Bus or Net operates. Typically, DAQ plug-in boards are general-purpose data acquisition device that are well suited for measuring voltage signals. However, many real-world sensors and transducers output signals that must be conditioned before a DAQ board or device can effectively and correctly acquire the signal. This front-end pre-processing, which is generally referred to as signal conditioning, includes functions such as signal amplification, filtering, electrical isolation, and multiplexing. After all, many transducers require excitation currents or voltages, bridge completion, linearization, or high amplification for proper and accurate operation.

3.1. Introduction to DrDAQ :-

Thanks to the power of DrDAQ we were able to use it as an oscilloscope or spectrum analyzer. We use DrDAQ as a single-channel scope with a 100 kHz bandwidth, 8-bit resolution and the ability to measure voltages of up to ±10 volts. DrDAQ also includes four digital input/outputs. In input mode these give you even more monitoring options. When used as outputs they enable you to use your DrDAQ to control external devices. Two of the digital I/Os include a pulse-counting function when used as inputs, and a pulse-width modulation (PWM) output capability.

Fig2. Dr DAQ

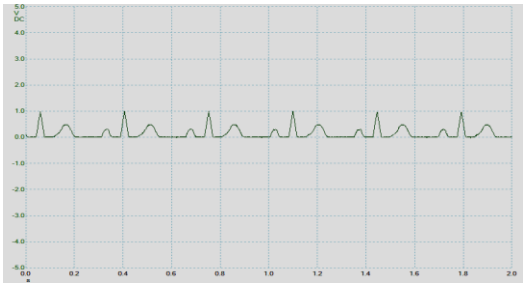

Fig3. Acquired ECG (aVF) with Dr DAQ

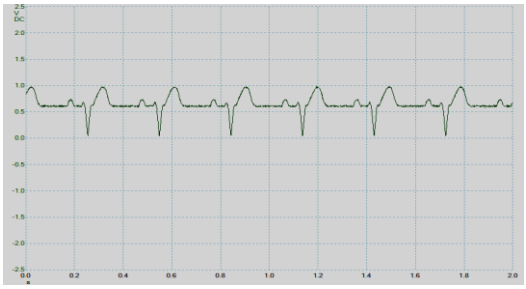

Fig4. Acquired ECG (V1) with Dr DAQ

3.2. NI-ELVIS II:-

The National Instruments Educational Laboratory Virtual Instrumentation Suite (NI ELVIS) delivers hands-on lab ex with an integrated suite of more than 12 of the most commonly used instruments in one compact form factor specifically designed for education. Based on industry-standard NI Lab VIEW graphical system design software, NI ELVIS, with powerful data acquisition and USB plug-and-play capabilities, offers the flexibility of virtual instrumentation and allows for quick and easy measurement acquisition and instrumentation across multiple disciplines. Educators can use the NI Educational Laboratory Virtual Instrumentation Suite (NI ELVIS) to teach concepts in circuit design, instrumentation, controls, telecommunications, and embedded/MCU theory. Now featuring a 100MS/s oscilloscope on NI ELVIS II+, exploring higher-frequency components, characterizing circuits, and investigating rise times has never been easier.

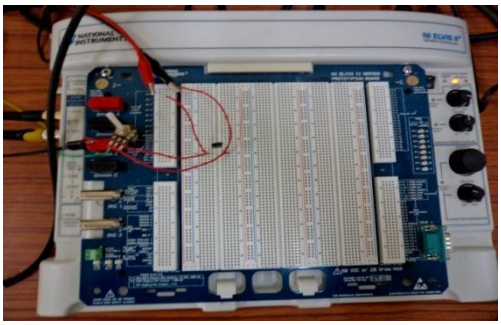

Fig5. NI ELVIS-II

Bioinstrumentation, a required course for all biomedical engineering students focusing on teaching the theory, design, and prototyping of circuits and working with sensors and instrumentation. NI ELVIS II and its integration with Multisim 10.1, including features such as 3D NI ELVIS II and simulated/real instruments in Multisim 10.1, provides the ideal platform for teaching and research of bioinstrumentation.

PROPOSED METHODOLOGY

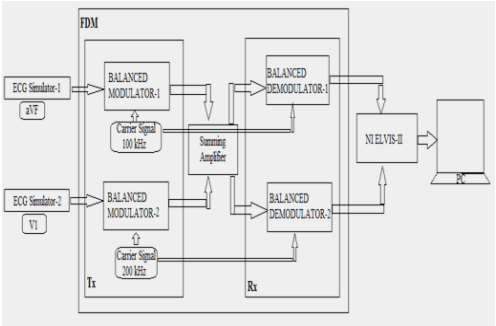

Fig6. Block diagram of proposed methodology

In the following below sections each block is discussed and the relevant results also being plotted which will help in understanding the flow of our work.

4.1 ECG Simulation

12 Lead ECG Simulator ST2352A provides a quick, accurate measurement of all 12 Leads including both Unipolar and Bipolar Configurations for verifying the performance of real time ECG monitoring, Heart-rate Monitoring. ST2352Aillustrates the fundamentals of standard limbs (unipolar and bipolar) and chest Leads interpretation and rhythm recognition in an easy-to-use, ECG rhythms produced by ST2352A can be changed in specific boundaries (Heart rate, Amplitude). ST2352A also demonstrates ECG observation comprising P, Q, R, S, T, U (U wave is only for Lead II) waves in different Leads arrangements. This trainer is compatibleWith Heart-rate monitor cum ECG Trainer ST2351 which receives the ECG signals generated by ST2352A and measure the heart-rate as number of heart beats per minute.

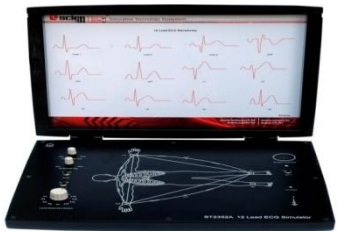

Fig7. 12 Lead ECG Simulator.

4.2. FREQUENCY DIVISION MULTIPLEXING

Frequency-division multiplexing (FDM) is a scheme in which numerous signals are combined for transmission on a single communications line or channel. Each signal is assigned a different frequency (sub channel) within the main channel. There are various parts in FDM :-

1. Carrier Signal.
2. Balanced Modulator 1&2.
3. Summing Amplifier.
4. Balanced De-Modulator 1&2.
5. Low Pass Filter.

4.2.1 Carrier signal:-

In communications, a carrier signal, carrier wave, or just carrier, is a waveform (usually sinusoidal) that is modulated (modified) with an input signal for the purpose of conveying information. This carrier wave is usually a much higher frequency than the input signal. Here the frequency used is 100 kHz & 200 kHz.

4.2.2. Balanced Modulator

A balanced modulator is a device that modifies a signal; usually in the form of amplitude modulated (AM) radio signal. It takes the original signal that has both sidebands and a carrier signal, and then modulates it so that only the sideband signals come through the output modulator. This creates a balanced signal

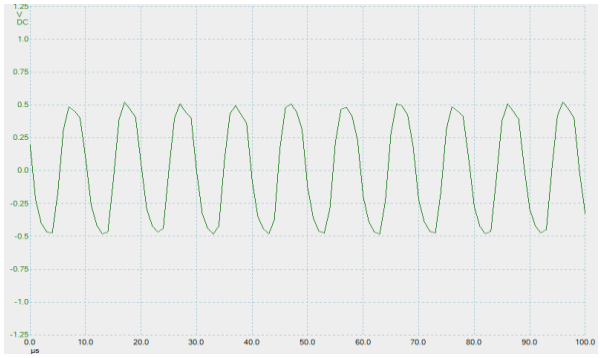

Fig8. Output of Balanced Modulator-1

4.2.3. Summing Amplifier

A summing amplifier is an electrical circuit layout that allows for the addition of more than one signal, creating a sum of all the circuits combined. The idea behind it is to incorporate multiple sources of input, while keeping each source separate to avoid one of the input sources affecting another. The amplifier allows the user to achieve a voltage sum at output that is calculated at the same rate mathematically as all of the input sources added up. Essentially, this means the amplifier creates an operational amplifier because when more than one input voltage is entered into a circuit and added together through the course of the circuit, the output voltage is a constant of the sum of all of the input voltages. The resultant of both the balanced

modulator is given to the summing amplifier and below is the result of it.

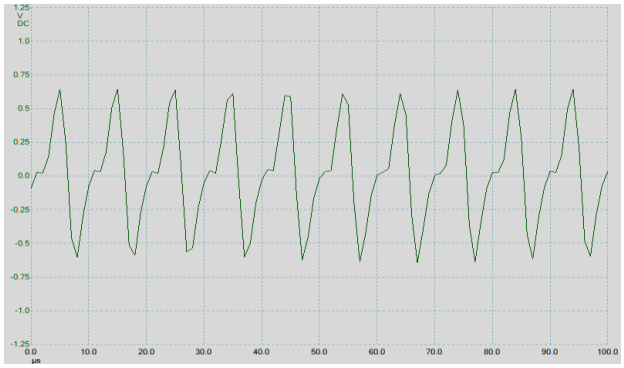

Fig9. Output of summing amplifier

4.2.4. Balanced Demodulator

A demodulator is a circuit that is used in amplitude modulation and frequency modulation receivers in order to separate the information that was modulated onto the carrier from the carrier itself. A demodulator is the analog part of the modulator. A modulator puts the information onto a carrier wave at the transmitter end and then a demodulator pulls it so it can be processed and used on the receiver end.

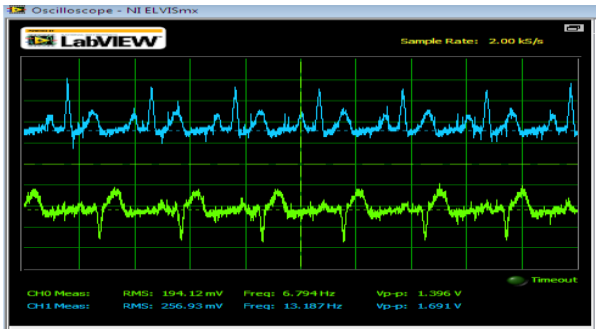

Fig10. Graph Of Balanced Demodulator-1(BDM1)(avF) And Balanced Demodulator-2(BDM2)(V1) From NI ELVIS II

Here NI Elvis-II performed as DAQ for real-time acquiring ECG (aVF & V1) signal to PC.

4. CONCLUSION

The result or output of each block of the system is being acquired by DAQ (Dr DAQ) which helps in evaluating during processing of signal from one block to another for each transmission and receiving part of the FDM telemetry unit. During our analysis we have studied various DAQ systems and NI ELVIS-II was found to be more suitable for bio signal acquisition and real-time analysis of signal in Lab View. Our further research involves in real-time filtering and extraction of significant features from ECG signals.

REFERENCES

1. Biotelemetry: Could Technological Developments Assist Healthcare In Rural India. By: K Singh (Indian institute Of Technology, New Delhi, India.) Rural and Remote Health 5:234 (online) 2005
2. ECG Wireless Telemetry by M.SRINAGESH, P. SARALA, K.DURGA APARNA, International Journal of Engineering and Innovative Technology (IJEIT) Volume 2, Issue 8, February 2013
3. Mobile Health Monitoring Through Biotelemetry Andrew D. Jurik_, Jonathan F. Bolusy, Alfred C. Weaver_, Benton H. Calhouny, and Travis N. Blalocky, ’09 April
4. 4. Patrick O. B. et al,(2004):Electrocardiogram (EKG) Data Acquisition and Wireless Transmission.” supported by a grant from U.S. National Science Foundation, grant # EIA-0219547
5. 5. Pedro R.,Gomes, Filomena O. Soares and Correia, J. H.(2007): ECG Self Diagnosis System at P- R Interval. Proceedings of VIPIMAGE, pp 287-290
6. 5. Pinheiro, E.,Postolache, O. Pereira, J.M.D.(2007):A Practical Approach Concerning Heart Rate Variability Measurement and Arrhythmia Detection Based on Virtual Instrumentation, pp. 112 - 115,
7. 6. Sornmo, L., and Laguna, P (2006): Electrocardiogram Signal Processing, Wiley Encyclopedia of Biomedical Engineering.
8. 7. Yatindra K., Malik G.K., (2010): Performance Analysis of different Filters for Power Line Interface Reduction in ECG Signal, International Journal of Computer Applications, Vol-3, No.7.

9. 8. Heyoung Lee et al, (2008): A 24-hour health monitoring system in a smart house, www.gerontechjournal.net, January 2008, Vol7, No1. 4