

Web based Design for Collection and Filtering of ECG Signal

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ABSTRACT

This paper describes the collection of ECG signal using three lead set-up and further removal of noise with filtrations. Being low frequency signals, the ECG facilitate the filtration of most of the high frequency noise. The circuit, for collection of signals and removal of noise, can be controlled and supervised from any remote location using web publishing tool, available in LabVIEW. Interface of hardware and software is carried out by making use of NI ELVIS kit.

Keywords: ECG, ELVIS, Filtering.

1. INTRODUCTION

Today, laboratories are well equipped with resources for real time designing as well as plenty of simulation tools. But a big gap between real time designing and simulation tools can also be seen. Laboratories, has acquired an integral and versatile position in all engineering and science education programs. This further has become an essential part of the education experience. Not only do laboratories demonstrate course concepts and ideas, but they also bring the course theory alive so students can see how unexpected events and natural phenomena affect real-world measurements and control algorithms.

The earlier prevailing methods for development and testing of circuits have lost their significance in the present accelerated technological developing environment. These are having a lot of disadvantages, like use of a simple breadboard has inherent problem of wear and tear and softwares like PSpice are far away from real time testing or measuring[8].

So a necessity is identified to bridge up the gap between real time circuit designing and simulation. Therefore, to incorporate these available resources, a model which is a combination of DAQ, prototyping board and the LabVIEW has been developed by NI. With this combination, it is easy to see the response of electronic circuit on VI based measuring instruments. And also we can web publish the circuit with the help of web publishing tool in LabVIEW[6], so that the circuit can be remotely accessed and measurements can be done [3],[4].

In this paper the collection and filtering of ECG signal is done using the designed hardware .Analog filter uses band pass filter in the range of 0.5 to 150 Hz. This cutoff frequency can also be changed using resistances across reed relay that can be controlled from software using LABVIEW. This GUI can be web published and made accessible from any remote location [5].

2. METHODOLOGY

A. Collecting ECG signal: Hardware

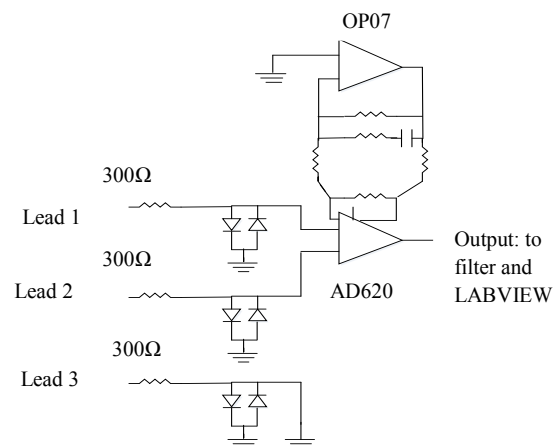


Fig1: ECG signal collection circuit

Using NI ELVIS breadboard and data acquisition system, the ECG signal is collected from three leads. Lead 1 is connected to right arm, lead 2 is connected to left arm and lead 3 is connected to right ankle. [1]

The diodes placed between the input leads and rest of the circuit is to protect the patient from any backflow current. In NI LABVIEW, the data acquisition is used to collect the signal after preliminary band pass filtering. The data is sampled at a rate of 1 kHz.

B. Signal Conditioning

Signal filtering is necessary to help for isolation of the frequencies found in ECG signal from noise. With a three lead system the majority of noise comes from electrical activity in muscles of arms or EMG noise. EMG signal are present in wide frequency band which overlaps with ECG signal in lower frequencies. Therefore, with this set up, it is impossible to completely remove EMG noise from ECG signal. In addition 60 Hz power line interference noise is also present in the signal.

C. Analog Band Pass Filter Design

The first stage of filtering is an analog filter as shown in Figure.2, built on NI ELVIS breadboard. It is band pass filter with cut off frequencies of 0.5 and 150 Hz. This will eliminate noise from muscles before the signal gets amplified [10].

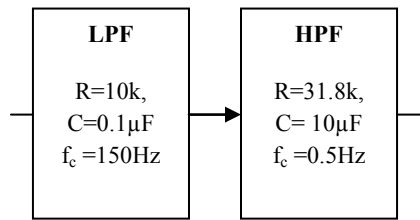


Fig 2: Analog band pass filter

D. Digital Filter using LabVIEW

Once the signal is acquired by DAQ assistant into LABVIEW, it is processed by two additional filters and amplification of 100 times. The first one is a band stop filter for eliminating power line interference frequencies of 48-52 Hz. A third order butterworth IIR filter is used to implement this filter because this is low order and has good frequency response.

The second one is a 10th order butterworth low pass filter. The cut off frequency of this filter is 80 Hz to further eliminate EMG noise. The ECG signal is located between 0.5 and about 70-80Hz depending on the individual.

E. Varying the parameter

For this purpose we will make use of 8 pin, 5V reed relays. This relay will be controlled by digital output of DAQ card, the resistances connected across the relay will change the frequency band of bandpass filter

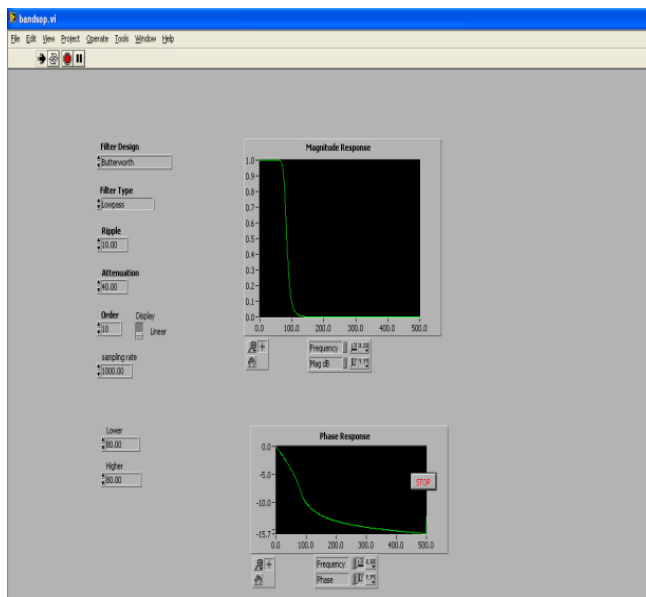


Fig 3: Response of LPF 1

F. Graphical user interface (GUI)

The resulting signal after filtrations is displayed in real time in the graphical user interface designed in LabVIEW[6],[8].

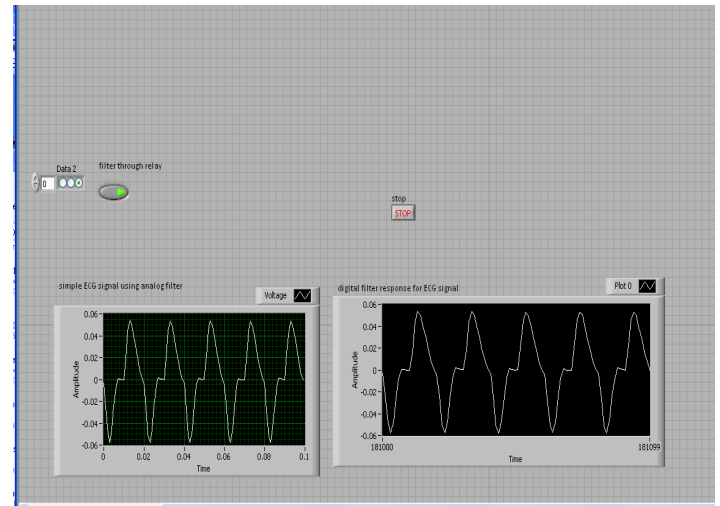


Fig 4: Output of circuit at a remote location

Figure 4 shows that as the combination of resistors changes the filtered waveform appearing on GUI also changes. This GUI appears at the remote location.

3. RESULTS

Collection of signal is done using the amplification circuit. The amplification can be seen on oscilloscope as shown in Figure 5.

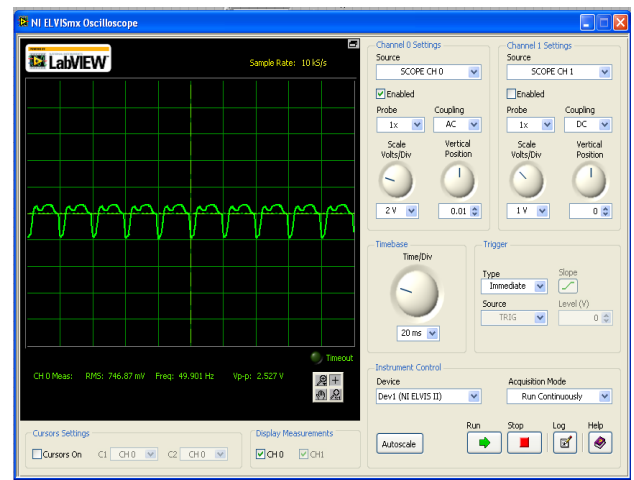


Fig 5: ECG signal on ELVIS SPF

On using analog filter the following bode plot as shown in Figure 6 is obtained in bode SPF of ELVISmax. Figure shows the response of low pass filter and the cut off frequency. As we change combination of resistors change in cut-off frequency is observed.

The frequency of circuit can be controlled from the remote location using digital output provided on ELVIS board and LabVIEW. [9]

The web published front panel as shown in Figure 6 is used to change the relay combinations. Here we have used three relays so 8 combinations are possible to change the frequency of filter.

Figure 7 shows that the cut off frequency can be changed using combination of digital output signals and this changes

the combination of resistors and finally the cut off frequency of analog filter.

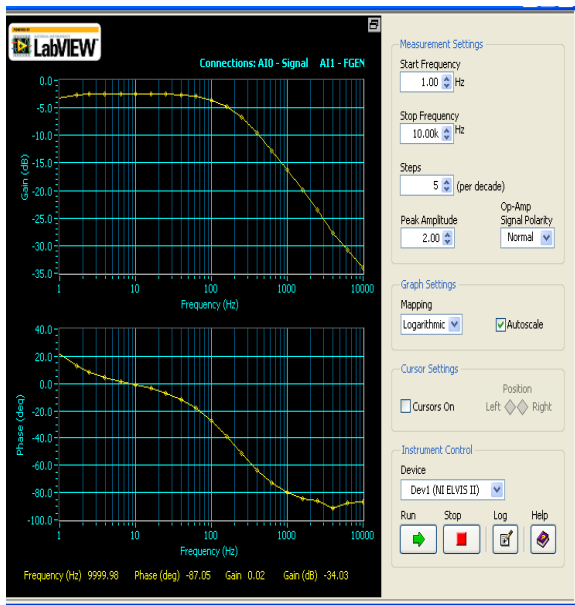


Fig 6: Response of circuit at different

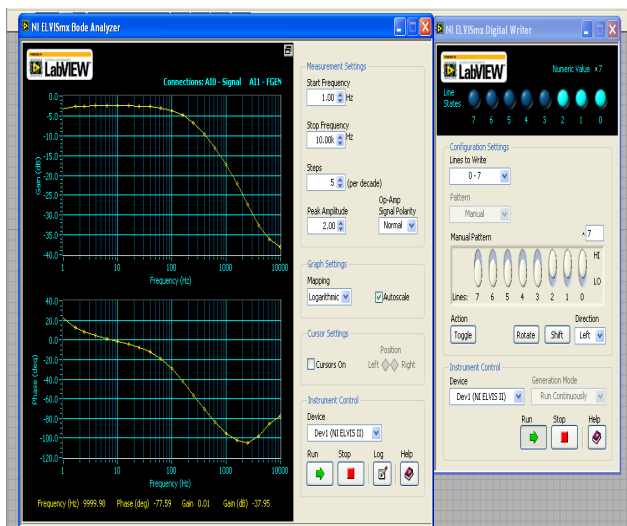


Fig 7: Bode plot with 3 relays in NC

4. COMPARISON:

As compared to other filtering techniques like microprocessor does not provide web based design. This method provides two way communications. We can change the value of cut-off frequency from remote location as well as place of actual set up. This method is very much useful for providing real time experimentation in colleges where proper lab set up is not available.

5. CONCLUSION

NI ELVIS instruments are based on the LabVIEW graphical system design environment. LabVIEW takes a graphical block diagram and dataflow approach to programming, allowing customizable application and flexible measurement.

In this project we have designed the hardware, acquired the signal in software and again with the help of data acquisition card and relays hardware is controlled by software.

So here it can be concluded that by placing a large number of relays many parameters like resistance capacitance can be varied and finally the variation in filtered response can be applied to the ECG signal.

So we can state that by making use of NI ELVIS kit we are able to design the circuits on the board and vary the parameters from the remote location. NI ELVIS and LabVIEW can be easily used to set up distance learning platforms. With remote panels in LabVIEW, educators can make VIs available online through the Internet, making them accessible to students everywhere and, as a result, make it easy to demonstrate concepts and perform experiments in a distance learning setting.

6. REFERENCES

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