Biomedical Signal Acquisition Using "Labview"

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Abstract

Biomedical signal acquisition has greatly advanced over the years, encompassing many different technologies. With the increasing performance of the personal computer, PC based signal processing systems are becoming an efficient and cost-effective way of acquiring and analyzing these signals. The advanced analysis techniques available on the PC are becoming invaluable to the practicing physician. This paper describes a PC based signal acquisition, processing, and analysis system using Labview, a graphics based programming language for engineering applications.

Introduction

Personal Computers (PCs) are becoming ever more popular in the medical community as prices decrease while performance increases. In fact, many practitioners use PCs for patient records and information. In light of this fact, it is obvious that PC based signal acquisition, and analysis is an efficient and cost effective method of patient biomedical signal acquisition and monitoring. A PC based system consists of a few external hardware components for isolation and amplification of the signals, a data acquisition card (or parallel port), and a software analysis package as shown in Figure 1. PC based instrumentation can bypass the need for stand alone instruments by using the PCs currently available and some inexpensive acquisition equipment.

There are many software packages available for the acquisition and display of electrical signals in general. Of these packages Labview, by National Instruments, is one of the most popular and powerful tools available. Acquisition of the signal can be handled through built-in procedures, and Labview's ability to easily create a user interface is second to none. Analysis of the signal received can be readily performed by ready made procedures which can be obtained from National Instruments or, for the more industrious, a intermediate programmer. In all, for an intermediate programmer, Labview provides a clear and easy-to-use method for obtaining, analyzing, and displaying the signal desired.

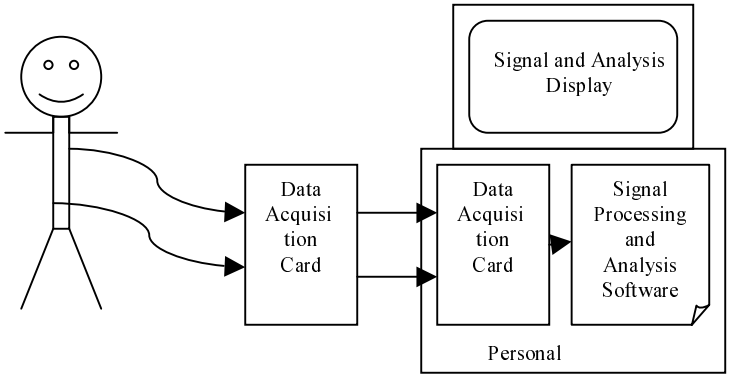

Figure 1 PC-based Biomedical Signal Acquisition and Analysis System

Data acquisition

Labview can acquire Biomedical signals in several ways, including the parallel port or the use of a data acquisition (DAQ)card. Parallel port acquisition is easily accomplished, but the parallel port input can only directly handle 8-bit digital signals. In order to use the parallel port, the analog biomedical signal needs to be digitized before sending it to the computer. Also, for professional use a number of different types of biomedical signals may need to be processed. These signals could include electrocardiography, phonocardiography, pneumography, blood pressure, temperature, and oximetry. For a comprehensive system, the parallel port is not as effective as a DAQ card.

A wide range of data acquisition cards is available from National Instruments. These cards provide for multiple (two to sixty four) channels of analog data input as well as output. These channels accept the analog signals directly to facilitate the acquisition of signals. In addition, Labview comes with ready-made libraries for interfacing with these DAQ cards. Using these libraries, programs for the data acquisition are quickly and easily made allowing more time to be spent on the processing and analysis of the acquired signals.

Signal processing

The biomedical signals acquired from the human body are frequently very small, often in the millivolt range, and each has its own processing needs. For instance, electroencephalography signals are in the microvolt range and have many frequency components. Obviously these biomedical signals require processing before they can be analyzed. Labview contains the tools, from fast Fourier transforms (FFTs) to digital filters, to do the job.

In order to do frequency analysis a complex signal must first be broken down into its frequency components. One of the most common ways to do this is with an FFT. In order to facilitate this type of analysis, Labview comes with built in FFTs that make the process of component separation quick and easy. In addition, biomedical signals, being extremely small in amplitude, are prone to being overwhelmed by noise. To combat this,

it is necessary to run the acquired signal through a set of filters. This can be done external to the computer using standard hardware filtering devices. However, after the signal reaches the computer, it can still contain noise. Another way to solve the noise problem is to use the digital filters provided with Labview. Labview offers the choice of Butterworth, Bessel, Chebyshev, and Chebyshev II digital filters. With a few adjustments, these filters can be configured for almost any design that is needed.

PC based analysis/display

In order to bypass the stand-alone monitoring equipment that is currently in use, a PC based system has to provide the ability to analyze and display the desired biomedical signals. This ability is where Labview really shines. It is quick and easy to make a user interface in Labview. Labview's panel design is totally graphical, with the programmer just using common drag and drop methods to place graphs, indicators, buttons, etc, anywhere on the screen. In fact, a front panel to acquire 8 different biomedical signals and display them, with their analysis, can be done in less than 10 minutes by an intermediate Labview programmer. A simple two-channel data acquisition program in Labview is shown in Figure 2.

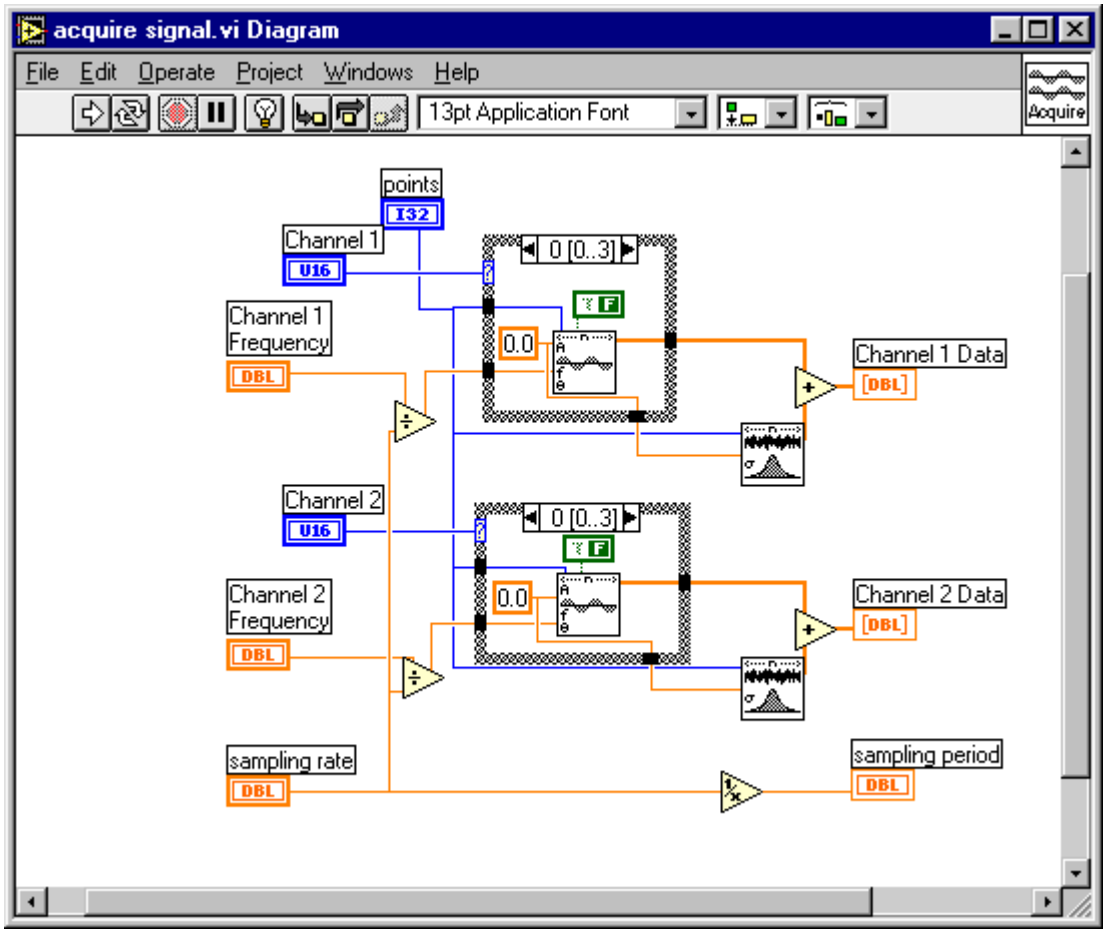

Figure 2. Two Channel Data Acquisition System Program

For the signal display, several signals can be displayed on the same chart, or separate charts can be configured for each signal. Available charts are sweep, scope, and strip. A sweep chart sends a vertical line along with the signal from left to right so that the new data is to the left of the line, while the old is on the right. With a scope chart the signal travels from left to right and when it reaches the right edge, the chart screen is refreshed. Perhaps the most common chart type for biomedical signals, however, is the strip chart. Strip charts bring the new data in on the right side of the screen, while the old travels off the left. One of the greatest benefits of this type of chart is the ability to view past data using a scrollbar attached to the chart.

Analysis of the biomedical signals can also be easily done in Labview. The graphical nature of Labview allows even the beginning programmer to easily write programs to analyze data without having to worry about the syntax problems associated with most programming languages. Once again, the user just drags prebuilt subprograms onto the diagram screen to set up a working program. These prebuilt modules can be configured to do any kind of manipulation required with just a few clicks of a mouse button. In addition to the analysis modules that the programmer writes, National Instruments offers a wide variety of analysis libraries, including ones for biomedical signals. A sample acquired signal and simple analysis can be seen in the phonocardiography signal shown in Figure 3.

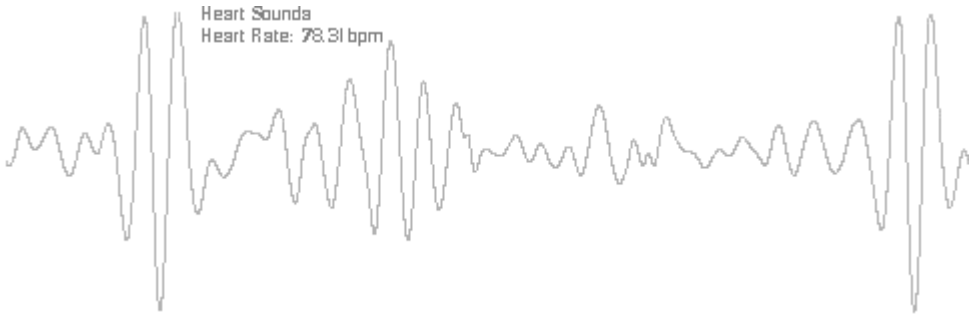

Figure 3 Sample Phonocardiography Signal/Analysis

In addition to the current biomedical measurements being taken from the patient, often past medical records need to be compared to the data received. File access capabilities allow Labview to access a patient's past medical record and provide a comparison to the current data. This allows physicians to see, for example, whether a person's heart murmur is getting worse. This can help physicians to develop a health trend analysis and determine where their patient's health status lies.

Conclusion

As the performance to cost ratios for PCs continues to grow, there will be a great need for PC based acquisition/analysis systems. These systems can be an inexpensive replacement for the costly stand-alone, signal specific, systems currently in use. The components necessary for a Labview based acquisition and analysis system are inexpensive, and readily available. The experience necessary to program this type of system in Labview is small, and the number of libraries available from National Instruments is growing. These developments show that a PC based system using Labview can be an efficient alternative to stand alone equipment, and as the speed and reliability of the PC increases, there will be more and more of these systems available.

References

1. Isselbacher, Principles of Internal Medicine, Mcgraw-Hill international book company, Tokyo, Japan, 1980.

2. Geddes, L. A., Principles of applied biomedical instrumentation , Wiley, New York, 1989.

3. Cooney, David O. ed., Advances in biomedical engineering, Marcel Dekker, New York, 1980

4. Lab-PC+ User Manual, National Instruments Corporation, 1994.