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Comparative Review Study of 4-Channel Data Acquisition System using Lab VIEW

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***Abstract*-The increased performance of personal computers and their reduced cost has made it possible for development of PC based signal processing systems. These systems are efficient and cost-effective for acquiring and analysing signals for example Acoustic emission signal, biomedical signal. Virtual instrument technology is used to achieve the purpose of physiological measurement has several benefits. Utilizing this technology will largely decrease the cost and increase the flexibility of the instruments. This work aims at designing a virtual instrument for acquiring and processing of signal using LabVIEW.**

Keywords: Data acquisition system, LabVIEW, MATLAB.

I. INTRODUCTION

PC based signal acquisition and analysis is an efficient and cost effective method for signal acquisition and monitoring. Since the signal (e.g. acoustic emission, biomedical signal) level is very low, amplification of signals is important. Hence, a PC based system consists of additional circuits for isolation and amplification of the signals. Virtual instrumentation technology for physiological measurements is an upcoming technology that is currently rising up at a faster rate. National Instrument's LabVIEW is a platform and development environment for a visual programming. The purpose of such programming is automating the usage of processing and measuring equipment in any laboratory setup. Controls and indicators on the front panel allow an operator to input data into or extract data from a running virtual instrument. A key benefit of LabVIEW over other development environments is the extensive support for accessing instrumentation hardware. [1] The paper is organized as follows: Section I gives introduction to virtual instrumentation and need of current work. Section II discuss the data acquisition system. Section III discusses construction and challenges in design. Also designing steps of four channel DAQ system are mentioned. Section IV discusses the differences between LABVIEW and embedded software. Section V discusses the results. Section VI concludes the paper followed by references used.

II. DATA ACQUISITION SYSTEM

Data acquisition is simply the process of measuring a real-world signal, such as a voltage, and bringing that information into the computer for processing, analysis, storage Data acquisition and conversion systems are used to acquire analog signals from one or more sources and convert these signals into digital form for analysis or transmission by devices such as digital computers, recorders, or communications networks. The analog signal inputs to data acquisition systems are most often generated from sensors and transducers which convert real-world parameters such as pressure, temperature, stress or strain, flow, etc., into equivalent electrical signals. The electrically equivalent signals are then converted by the data acquisition system and are then utilized by the end devices in digital form. [2]

III. DESIGN OF FOUR CHANNEL DATA ACQUISITION SYSTEM

A. *Construction of DAQ System*

The main objective of the current work carried on is to take signal from MAX (measurement and automation explorer), perform noise elimination and amplification. Acquiring signal using NI DAQ, designing the suitable low cost amplifier for amplification was done. The acquired signal was displayed using LabVIEW front panel. The front panel and block diagram have been designed. The basic block diagram of data acquisition system is as shown in figure 1.

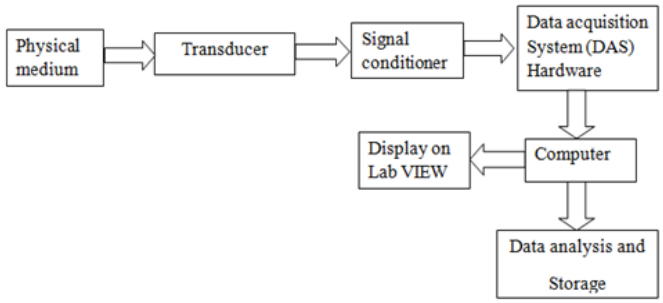


Fig 1: Block diagram of data acquisition system

- ***Physical medium:*** Physical phenomenon like Temperature, voltage, pressure, force, light etc. are to be measured using data acquisition system.
- ***Transducer:*** Provides actual interface between the real world and data acquisition system by converting physical phenomenon into electrical signals that signal conditioning and for data acquisition hardware can accept.
- ***Signal conditioning:*** Electrical signals generated by transducers often need to be converted to a form acceptable to the data acquisition hardware particularly A/D converter which converts signal data to required digital format.
- ***Data acquisition system Hardware:*** Data Acquisition uses three types of hardware: a terminal block, a cable, and a DAQ device.
- ***Computer:*** All DAQ devices use the PC as a platform.
- ***LabVIEW software:*** LabVIEW uses dataflow programming, where the flow of data determines execution order.
- ***Data analysis and Storage:*** data can be analyzed by using post processing methods like FFT processing, IIR processing etc. and saved in computer.

B. Advantages of LABVIEW over MATLAB

The data acquisition system can be designed using LABVIEW or MATLAB software. Here data acquisition system is designed using LABVIEW because

- The programming language used in LabVIEW is a dataflow programming language. This means user writes a program by creating and connecting the graph of data that flows between each step but Programming language used in MATLAB is a text based programming language. This means user write a program by using commands and run the system. Sometimes in text based programming program gets complex but LabVIEW is mainly designed for complex programs.
- In LabVIEW the parameters can be changed at the time of execution of the program but in MATLAB the parameters cannot be changed at the time of execution of the program.
- In LabVIEW analysis of all types of Filters (LP, HP, BP, and BS) is possible in single program but In MATLAB analysis of all type of filters (LP, HP, BP, and BS) having separate programs.
- LabVIEW can command data acquisition devices to acquire or generate analog or digital signals. Once the data has acquired or received LabVIEW can use many analysis VI's to process and manipulate data but a problem with designing in MATLAB being that, hardware gets complicated if software is easy and hardware gets easy if software is complicated.

C. Flow graph of design of four channel data acquisition system

The flow graph of steps of design of four channel data acquisition system is shown in fig.2

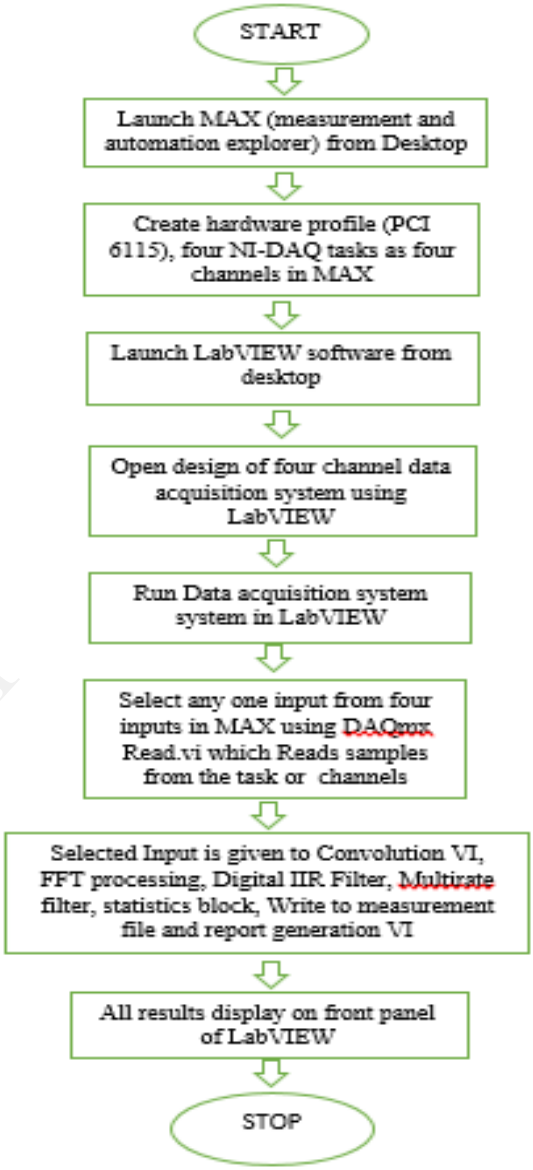


Fig 2: flow chart of four channel data acquisition system

D. Block diagram Design

In block diagram designing, event structure is used to create six event cases. First event case is shown in Fig 3. First event case shows designing of FFT Processing using FIR filtering and ststistics block. Second event case shows wiring diagram of Digital IIR filter VI and DFD MRate filtering for single block VI. Here input signal is providing by creating local variable. Third, fourth and fifth event cases includes write to measurement file VI which used to write data in text TDMS and HTML format and report VI which is used to generate report. Last event case is stop which stops the whole program.

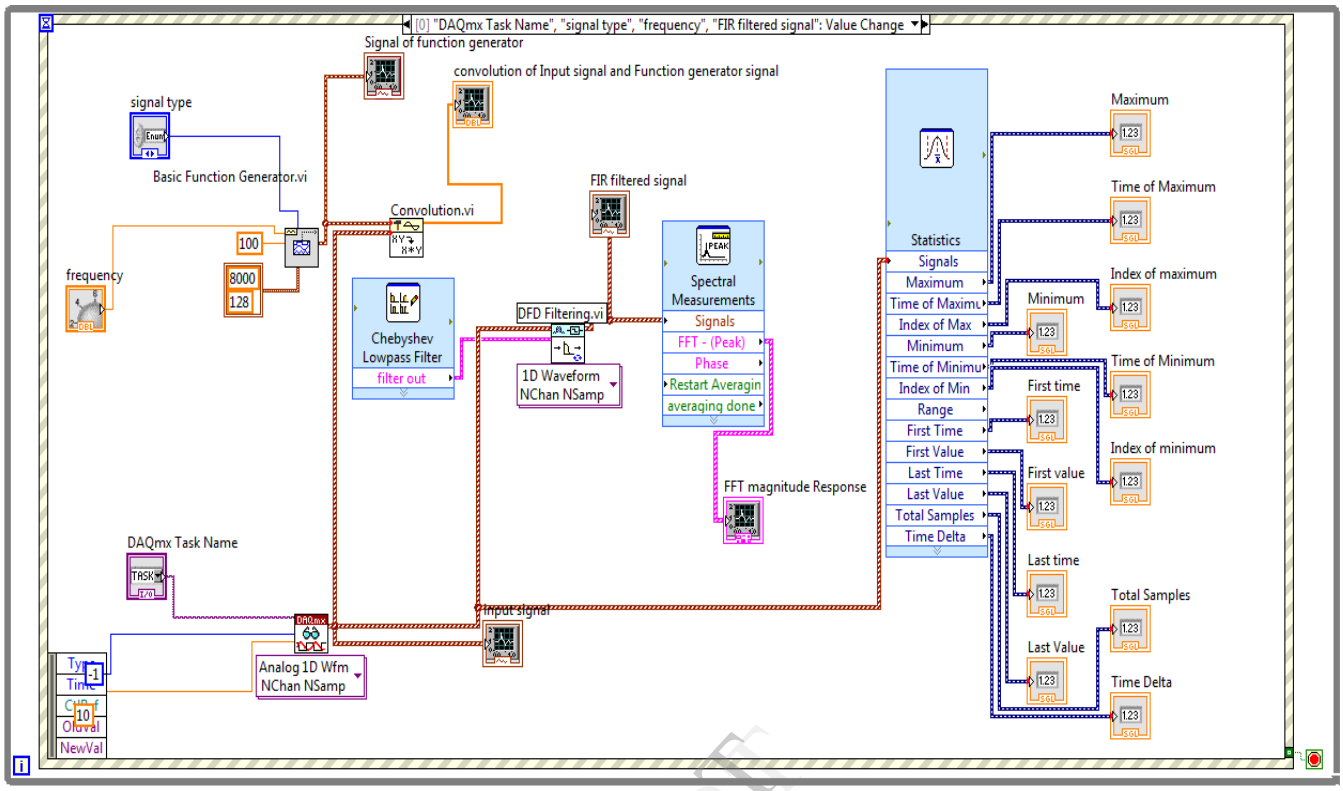
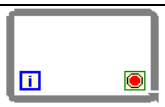
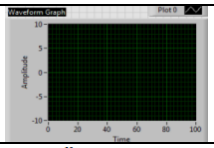
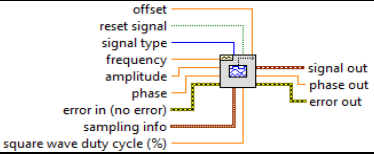
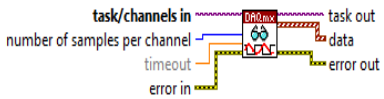
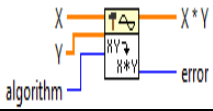
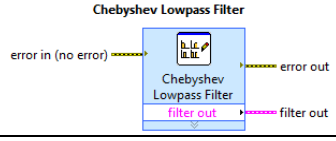
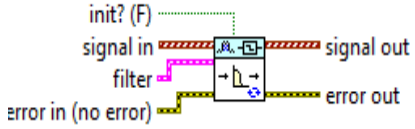
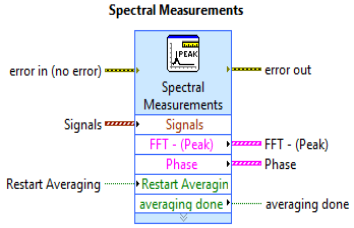
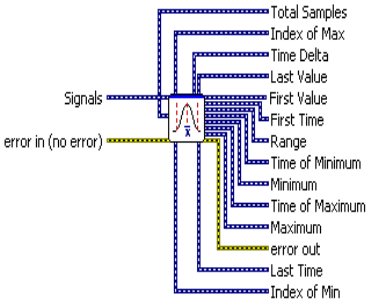
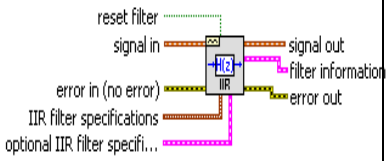
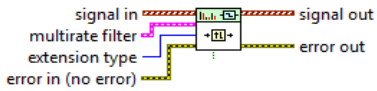
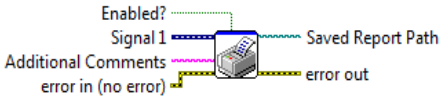


Fig 3: block diagram design using LabVIEW

TABLE I shows blocks used to design DAQ system are as follows.

Sr. No.	Name of block	Description of blocks	Structure of block
1	*Event Structure*	Has one or more a subdiagram, or event cases, exactly one of which executes when the structure executes. The Event structure waits until an event happens, then executes the appropriate case to handle that event.	
2	*While loop*	Repeats the sub-diagram inside it until the conditional terminal, an input terminal, receives a particular Boolean value.	
3	*Waveform graph*	The waveform graph displays one or more plots of evenly sampled measurements.	
4	*Basic function Generator VI*	Creates an output waveform based on signal type	
5	*DAQmx Read VI*	Reads samples from the task or virtual channels you specify. It consist parameters Task/channels in and no. of samples.	

6	*Convolution VI*	Computes the convolution of the input sequences X and Y. Wire data to the X and Y inputs to determine the polymorphic instance to use or manually select the instance.	
7	*Classical Filter Design Express VI*	Creates a lowpass, highpass, bandpass, or bandstop filter interactively.	
8	*DFD filtering VI*	Filters an input signal continuously.	
9	*Spectral measurements express VI*	Performs FFT-based spectral measurements, such as the averaged magnitude spectrum, power spectrum, and phase spectrum on a signal.	
10	*Statistics Block*	Statistics block returns the selected parameter of the first signal in waveform. It intakes the signal and displays the parameter of the signal. The parameters used in our VI include total sample, index of maximum and minimum, range, last and first value, time of maximum and minimum etc.	
11	*Digital IIR Filter*	Digital IIR Filter is available for either single or multiple waveforms. We have used single waveform in our VI. The input and output of the Filter block consists of reset filter, signal in, filter specifications and optional IIR specifications.	
12	*DFD MRate Filtering for Single Block VI*	Filters a single-block signal with a multirate filter. Wire data to the signal in input to determine the polymorphic instance to use.	
`13	*Local variable*	Use local variable to read or write to one of the controls or indicators on the front panel of a VI.	
14	*Report*	This block generates a preformatted report that contains VI documentation, data the VI returns, and report properties, such as the report title, author name etc.The inputs and the outputs to this block are enabled, signal, saved report path etc.	

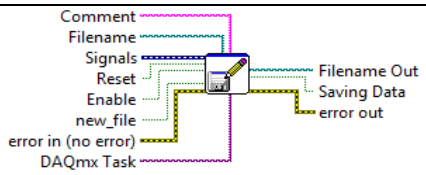
15	*Write to Measurement File*	This block writes data to text-based measurement files (.lvm) or binary measurement files (.tdm or .tdms).The inputs and outputs of this block consists of input signal, reset, file name out.	

Table 1: Blocks used to design four channel data acquisition system

IV. RESULTS AND DISCUSSION

The four channel data acquisition system contains FFT magnitude response of input signal, filtering methods like FIR, digital IIR and multirate processing used to filter input signal, statistics block which provides signal parameters of input signal. Also report, write to measurement file in used for report generation and saving the results. The function generator is also designed to provide the various type of signals. These signals are used in convolution process to show convolution of input signal and function generator signal is shown in Fig 4.

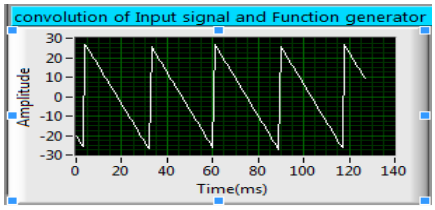


Fig 4: convolution of input signal and function generator signal

The frequency analysis of input voltage signal is required. In order to do frequency analysis, a complex signal must first be broken down into frequency component. 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.so spectral measurement block is used to show FFT based magnitude spectrum which shows energy spreading into frequencies that were not present in original signal. FFT magnitude spectrum is shown in Fig 5.

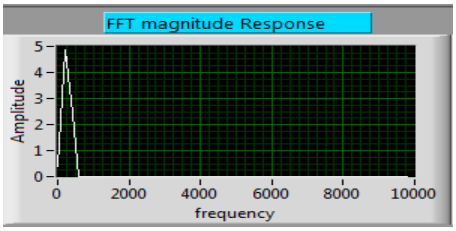


Fig 5: FFT magnitude response

With a few adjustments digital filters can be configured for almost any design that is needed. The input signal is filtered by digital filters of type IIR, FIR and Multirate filter block which provides filtered signal. In multirate filtering system decimation and interpolation filters are used to remove and add sampling frequency of signal that improves signal to noise ratio. Fig 6 shows the output of Digital IIR filter. Fig 7 shows the output of FIR filter and Fig 8 shows the output of multirate filter output.

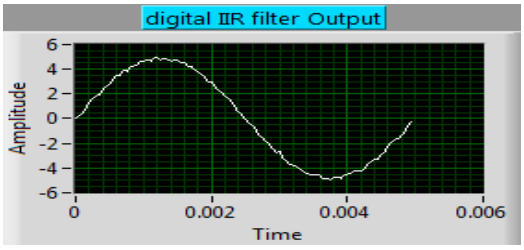


Fig 6: Digital IIR Filter output

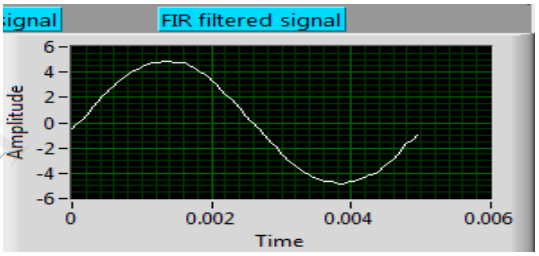


Fig 7: FIR filter output

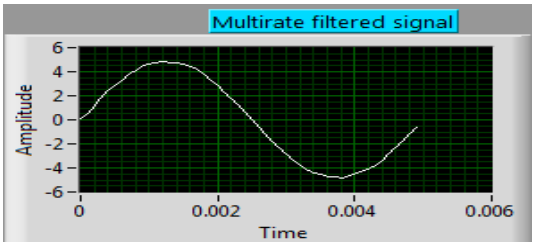


Fig 8: Multirate filter output

Statistics block used in designing returns the selected parameter of the input voltage signal in a waveform as shown in Fig 9.

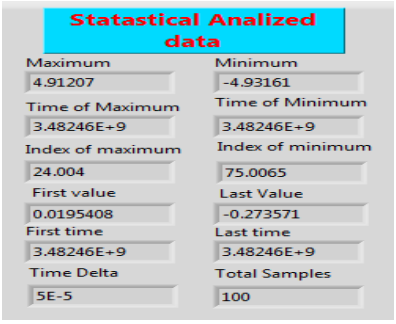


Fig 9: Statistical analyzed data

The parameters of input voltage signal which can be measured are as follows
Total samples: Returns the total no. of samples in signal.

First value: Returns the first value in signal.
Time of Min.: Returns the time of the lowest pt. of values in signal.
Minimum: Returns the lowest pt. in a set of values in signal.
Time of Max.: Returns the time of the highest pt. of values in signal.
Maximum: Returns the highest pt. in a set of values in signal.
First time: Returns the first time value in signal.
Last time: Returns the last time value in signal.

Front panel view of four channel data acquisition system

All the results are commonly displayed on front panel of four channel data acquisition system. The input parameters like DAQmx task, function generator signal type and frequency are selected from front panel. Also IIR filter characteristics can be changed using filter characteristics. All the results are displayed on front panel. Front panel is shown in Fig 10

V. CONCLUSION AND FUTURE SCOPE

Developing PC based systems using LabVIEW is an efficient alternative to stand alone systems. Here conclusion is that data acquired by four channel data acquisition system was amplified, filtered and observed on the front panel. All processing like FFT processing using FIR response, digital IIR filtering, generalized report etc. were visualized. But the system developed has certain limitations in terms of accuracy

Index of Max.: Returns the index value of the highest value of the highest pt. of the values in signal.
Index of Min.: Returns the index value of the lowest pt. of the values in signal.
Last value: Returns the last value in signal. and features. LabVIEW has many advantages over MATLAB but it is the cost which has restricted LabVIEW to only large scale applications.

The four channel data acquisition system is mainly designed to acquire acoustic emission signals. The acoustic emission system are capable of using multiple sensors/channels during testing, allowing them to record a hit from a single Acoustic emission event. This event can be detected on several channels. Through the analysis and processing of acquired AE signal any defects inside the material could be detected.

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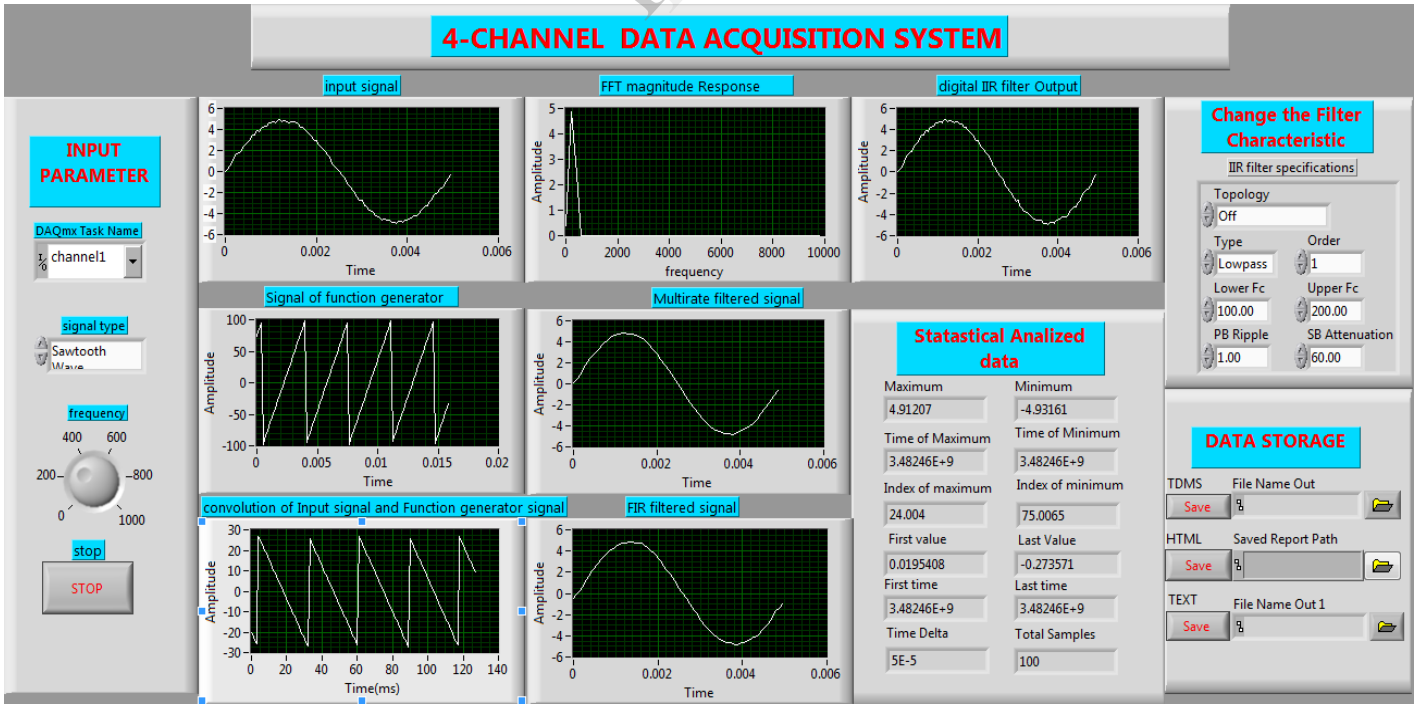

Fig 10: Front panel design