INTRODUCTION TO LABORATORY CONTROL SOFTWARE

Goals: The goals of this laboratory are to introduce students to LabVIEW laboratory control software and to have students learn about the benefits and limitations of data acquisition systems.

Learning Objectives: After completing this laboratory, you should be able to:
1. Use LabVIEW to communicate with instrumentation and sensors and build interfaces independently.
2. Configure an instrument using drivers from the instrument driver library and be able to communicate with the instrument. This also includes communication with data acquisition cards used to read data directly from circuits or sensors.
3. Investigate the fundamental limitations of data acquisition systems.

Laboratory Preparation: In preparation for this laboratory, you should:
1. Attend the lecture session on Laboratory Control Software and read over this laboratory activity.
2. Find out about LabVIEW at National Instruments' website: http://www.ni.com/labview/
3. Read the **Getting Started with LabVIEW** manual found on the course website under files for Lab #2 (Printed copies are available in the lab for reference, so there is no need for you to print out a copy). Specifically, be familiar with the content found in Chapters 1-3, as the first portion of the lab will concentrate on this material.
4. Read Lesson 3 (pages 3-2 – 3-44) of the National Instrument's **Data Acquisition and Signal Conditioning Course Manual** found on the course web site. Though we will be using LabVIEW 8.2, not 6.1, the ideas that are covered carry over. (Printed copies are available in the lab for reference, so there is no need for you to print out a copy.)
5. Anticipate the practical issues that may arise in application of LabVIEW in a sensing application, by answering these questions:

   PQ1: What kinds of sensor data can LabVIEW read and interpret?
   PQ2: With what kinds of equipment will LabVIEW be useful?
   PQ3: Are there any speed limitations that are inherent to a measurement system that uses LabVIEW?

Laboratory Tasks and Questions: In this lab, you will become familiar with LabVIEW and develop some of their own LabVIEW programs.

1. Work through the Chapters 1-3 of **Getting Started with LabVIEW** manual that comes with LabVIEW (this is on the course website and can also be opened on the opening screen of LabVIEW). This should take about two hours.

2. Modify the VI that you made at the end of Chapter 3 in the **Getting Started with LabVIEW** manual to accommodate the following changes:
   - Add an additional function to calculate the "Autocorrelation" function of the data read/measured. Your VI should now calculate both "Mean" and "Autocorrelation" values.

- Save all the data (original data, mean values, and autocorrelation values) in ASCII format in a file.

3. Find and insert a DAQ assistant VI that can read the ASCII file your VI from Lab Step 2 created. Then, plot the data from the file using a graph from the functions palette. Experiment with displays and analysis options. Display the data in tabular form, with all the numerical values explicitly listed. Also, try at least two different kinds of graphical displays.

4. Convert some or all of your VIs into a sub-VI. Create a sub-VI with one input and one output. Consult the built-in LabVIEW help for guidance.

   Q1: When would it be useful to create a sub-VI?

5. Using the DAQ Assistant Express VI, create a buffered, continuously sampling analog input VI. Include a control on the front panel to set the sampling rate for the input signal as well as a waveform display.

6. **MINI-EXPERIMENT**: Input a 1 KHz sine wave from the function generator into the analog channel that you configured in the previous step. Modify the sampling rate of your analog input VI, and observe what happens to the sampled waveform. Try sampling rates of 250, 500, 2000, and 5000 Hz. Try waveforms of different shapes and different frequencies.
   Mini-Experiment Purpose
   Mini-Experiment Equipment and Setup
   Mini-Experiment Hypotheses
   Mini-Experiment Results
   Mini-Experiment Conclusions

   To help lead your Mini-Experiment write-up, consider the following questions…
   - In which of the tested frequencies does aliasing occur?
   - What happens to the LabVIEW signal as you increase the frequency of the input signal to the maximum output by the function generator? Explain.
   - What is the mathematical formula for the minimum sampling rate required to prevent aliasing?

7. Document your complete VIs and include this documentation when you hand in your laboratory report. In your report, make a note of what tasks you found easy, difficult, confusing, etc. **Be sure to save all of your VIs to your network directory for future use and reference.**

Student Post-Lab Questions and Conclusions

1. How is LabVIEW different from the conventional programming languages like C and BASIC?
2. What kinds of sensor data can LabVIEW read and interpret?
3. With what kinds of equipment will LabVIEW be useful?

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4. Differentiate between the Front Panel and the Block Diagram. Similarly differentiate between controls and indicators. Give the corresponding terminology in conventional programming languages.
5. What does the acronym VI stand for? What is an instrument driver? How is an instrument driver structured in LabVIEW, that is what are the sub-VIs and their functions? Provide a brief answer.
6. Are there any speed limitations that are inherent to a measurement system that uses LabVIEW? Explain.
7. What are two important lessons that you learned from this lab that deal with the implementation of LabVIEW?

Plots

- Autocorrelation Write VI Front Panel
- Autocorrelation Write VI Block Diagram
- Autocorrelation Read VI Front Panel
- Autocorrelation Read VI Block Diagram