LabView programming II

Equipment needed: PC with LabView 8.0 and DAQmx 8.0 installed. NI USB 6009 DAQ box, Oscilloscope and connecting probes, function generator, desktop universal testing machine and control accessories, lecture note for handy reference

預習報告：**Please read the lecture handout and submit answers to the following questions before starting with the Lab.** It will be even better if you can get acquainted with the LabView environment before you come in for this laboratory session.

1. **What is a Front panel and what is the Block diagram?**

2. **What is the difference between a For-loop and a While-loop?**

3. **What is an VI and what is a SubVI?**

4. **What is a tunnel in the loop structure?**

5. **What is dataflow programming?**

6. **What is a Case structure and what is a Sequence structure?**

7. **What is an array and what are array functions?**

8. **What is a DAQ device? What functions are normally included in a DAQ device?**

9. **How to configure a DAQ device for data acquisition and control in Labview?**

10. **Explore possible functions and techniques for the VIs needed in the lab first before you come**

Notes:

1. Please create the following subdirectory in the hard disk: C:\temp\B92522xxx&B92522xxx, where B92522xxx&B92522xxx are the id numbers of the members in your group. Save your work in this directory for marking.
2. After you finish each experiment, please ask the Teaching Assistant to verify it.
3. In each experiment, follow the step by step guideline to complete your VIs and save them into your directory for later use and grading purpose.
4. There are many different ways to achieve the same results for the following experiments. LabView will log the revision history, computer ID and other details, so do not try to copy the other person's work to submit as your own!

Caution: The machine uses 220V AC. Take every precaution to prevent an electric shock!

Experiment 1 –A virtual oscilloscope

Aim: To write an Oscilloscope VI and use it to display the output from a hardware function generator.

Procedures

1. Select **File»New** to open a new front panel.
2. Put a waveform chart display and a stop button on the front panel. Label the axes and title.
3. Check that the DAQ device (USB 6009) has been hooked up to the computer.
4. Attach wires to the AI0 + and AI0- terminals. Check that the terminals are on the Analog side.
5. Call the DAQ assistant in the block diagram. Configure the DAQ device to measure analogue input voltage. Refer to lecture note for detailed procedures (A flash movie on DAQ assistant configuration can be accessed from the Window Desktop, use fast forward to get to the portion you want.) Details about the settings are:

    (a) Use the ai0 channel for input
    (b) Use differential input.
    (c) Use a measuring range of -20 to +20 volts.
    (d) Use continuous acquisition.
    (e) Take 1000 samples at 1 kHz.

6. Wire up your DAQ assistant to the waveform display. You will also need a loop structure. Use the stop button to control the operation of the loop.
7. Hook up the hardware function generator, set it to output a low frequency (say 0.05 Hz) and small amplitude (say 1V) with zero offset signal. Use the hardware oscilloscope to check the output first.
8. Run your Oscilloscope VI.
9. Hook up the function generator output to the AI0 +/- terminals of the DAQ device. Check whether your VI is working correctly.
10. Play around with the frequency knob on the function generator. Does your virtual oscilloscope follows your changes closely.
11. If everything works OK, try to modify the sampling rate in your DAQ assistant configuration (say to 100 samples at 100Hz). What is displayed if your input signals are 0.1Hz, 1Hz, 10 Hz, 50Hz, 100Hz, 200Hz, 1000Hz. Play around with the no. of samples, sampling rate and signal frequency. Fill in the following table in your lab report. Discuss the possible reason for your observations in your report.
12. Demonstrate your results to the teaching assistant and save your work as "scope.vi".

Sampling rate	No. of sample	Signal frequency (Hz)	Observation (displayed waveform) and explanation

End of Experiment 1

Experiment 2 –A virtual function generator

Aim: To write a Function Generator VI. Convert the output into analogue voltage and display it on a hardware oscilloscope.

1. Select **File»New** to open a new front panel.
2. Write a VI that can give (1) sine wave (2) triangular wave (3) square wave. (4) ramp (i.e. a increasing straight line, starting from 0 to 5.
3. Your front panel must allow the user to choose which type of waveform he/she wants.
4. You should also allow your user to change the amplitude and frequency of the waveform.
5. Check that the DAQ device (USB 6009) has been hooked up to the computer.
6. Attach wires to the AO0   and GND terminals. Check that the terminals are on the Analog side.
7. Call the DAQ assistant in the block diagram. Configure the DAQ device to give analogue voltage output voltage. Refer to lecture note for detailed procedures (A flash movie on DAQ assistant configuration can be accessed from the Window Desktop, use fast forward to get to the portion you want.) Details about the settings are:

   (a) Use the AO0 channel for output
   (b) Use a measuring range of 0 to +5 volts. (you cannot get negative voltage with USB 6009)
   (c) Use 1 sample (on demand)

Note that USB 6009 can only generate analog output at a maximum rate of 150 samples per second. You can only feed your waveform data to it one at a time. It cannot accept a whole array of waveform data at once. To do this, you can do your waveform calculation in 2. and put it into an array first, then feed it one by one to DAQ assistant. You can also make one calculation and send it to DAQ assistant and put this into a repetitive loop. You may think of other way to achieve this.

8. Wire up your waveform data to the DAQ assistant.
9. Hook up the oscilloscope probe to the wires connected to AO0 and GND.
10. Run your function generator VI.
11. Can you see the waveform you desired on the oscilloscope?
12. Can you change the switch among sine, square, triangular and ramp?
13. Can you modify the amplitude and frequency of your waveform.
14. Demonstrate your results to the teaching assistant and save your work as "FunGen.vi".
15. In your report, please include the following:

    i. Record the logic and algorithm you used to get the desired waveform.
    ii. Discuss the relation between the frequency obtained, no. of data in one cycle of your waveform and the limitation in digital to analog output rate.
    iii. What is the maximum frequency you obtain with your VI? What is the theoretical maximum frequency that should be achievable?
    iv. Do you think you can improve it further, why and how?

End of Experiment 2

Experiment 3 – Mechanical testing machine control

Aim: To write a Mechanical Properties Testing VI to interface with a desktop universal testing machine.

Caution:
1. **The machine uses 220V AC. Check that there is no loose wire and bare metal that can come into contact with the main supply of the controller. Do not try to meddle around with the controller, especially the protective cover of the main connection.**
2. **Check that there is no obstacle that may obstruct the motion of the cross-head of the testing machine.**

Procedures

1. Movement of the cross-head of the desktop universal testing machine can be control by a voltage (-10V to +10V, -ve and +ve voltage give different direction of motion)
2. Direction of motion can also be controlled by a switch on the control box.
3. Read the instruction on the use of the knobs and buttons on the control box. In particular, you must know where the emergency stop button is and how to use it.
4. Program a simple VI that allow you to output a constant voltage from USB 6009. The front panel should contain a numerical control (slider or dial or numeric input) and a stop button. The block diagram should contain the numerical control, DAQ assistant and a stop button.
5. Test your VI with the hardware oscilloscope to make sure it is doing what you want!
6. Connect the AO0 and GND terminals to the position control terminals on the controller box. The position control terminals and wiring diagrams for the machine control will be available on your bench.
7. Use your VI to output a small voltage (< 0.5V) and observe the motion of the cross-head. Stop the machine if you get near to the end of travel. Be sure not to let the screw stud come all the way out of the gearbox!
8. Use the direction control switch to change the motion direction of the cross-head.
9. When you get acquainted with the control of the testing machine, you can try to use your function generator VI "FunGen.vi" to control the motion of the testing machine. Be sure not to let the screw stud come all the way out of the gearbox!
10. In your report, record the detailed control logic of the whole set-up and discuss how to write a VI that can carry out a tensile test, log the displacement and load data and display the data on the screen. (You will need this VI later for a real tensile test!)

End of Experiment 3