

Introducing LabVIEW in Undergraduate Measurements and Instrumentation Course

Jiaxin Zhao

Indiana University–Purdue University Fort Wayne

Introduction

Computer data acquisition is more and more widely used in today's undergraduate laboratory courses. Among the commercially available computer data acquisition systems, the hardware and LabVIEW software by National Instruments are widely used in both industry and educational institutions. Following this trend, some educators successfully implemented LabVIEW in their laboratory courses.

The practice for introducing and using LabVIEW in undergraduate laboratory courses generally falls into two categories. The first one is to introduce LabVIEW in detailed fashion, with extensive lecture time devoted to LabVIEW, such as the practices by Globig, Lee, and Knights and McDonald, respectively. This approach is very useful for an introductory laboratory course with sufficient credit hours for the lectures. The LabVIEW Student Edition is used as the textbook and all or most of the laboratory experiments have LabVIEW components in them for the students to practice. As a result, the students are able to generate their own LabVIEW programs. The other approach is to use LabVIEW in individual laboratory experiments, in an introductory laboratory course as well as in more advanced laboratory courses, such as the practices by Arthur and Sexton, and Orabi, respectively. The LabVIEW program is supplied by the instructor and the students are not required to write their own LabVIEW programs for the particular experiment. However, because the students do need to use the LabVIEW programs to acquire data, the experiment strengthens the students' understanding of the LabVIEW software.

In the department of Engineering at Indiana University-Purdue University Fort Wayne, the general purpose computer data acquisition hardware and LabVIEW software by National Instruments are used extensively in the mechanical engineering laboratory courses. The Measurements and Instrumentation course is designed as a pre-requisite for those laboratory courses and thus is an ideal place to introduce computer data acquisition hardware and software to the students. However, due to the limited time available in this two credit hours course, it is very difficult to cover the LabVIEW software in a detailed fashion. As a result, an approach that falls in between the two categories discussed above is used. The basic features of LabVIEW software were introduced in one lecture and then several laboratory experiments using LabVIEW were used to strengthen the students' understanding of LabVIEW.

The Introduction to LabVIEW Environment

The basic features of LabVIEW environment are first covered in a lecture together with the computer data acquisition hardware. The students were presented with the procedures of LabVIEW data flow programming and the comparison with traditional programming languages. The front panel and block diagram for a LabVIEW program, which is called a Virtual Instrument (VI) was discussed. The editing features of functions palette and controls palette were introduced, as well as a brief discussion of the hierarchy of the organization of various panels on those palettes.

In the first lab session of the course, the students were instructed to perform a tutorial from the *Getting Started With LabVIEW* Manual. Students gained first-hand experience with the front panel, block diagram, various icons and the programming in LabVIEW. Then, the students followed a tutorial written by the author to connect and configure a physical channel for a T thermocouple. The final information of the configured channel is shown in Figure 1. Configuring the thermocouple channel and subsequent connecting a T thermocouple provides the students with hands-on experience with the computer data acquisition hardware.

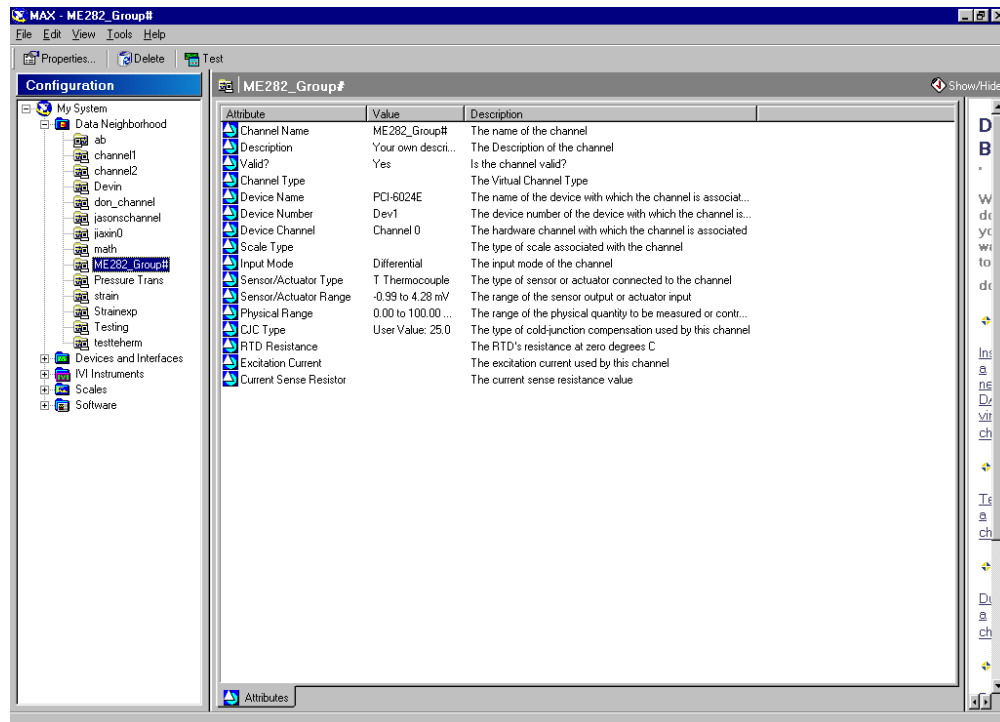


Figure 1: Configuration of A Physical Channel for A T Thermocouple

Using LabVIEW Example Programs

After the students gets the experience with LabVIEW and the computer data acquisition, the students should use them as much as possible. However, the students are still not competent in writing

a LabVIEW program on their own, a goal which is difficult to achieve with current limited lectures devoted to LabVIEW. So, a natural approach is trying to use the provided example programs embedded in LabVIEW as much as possible. As a matter of fact, LabVIEW is a very powerful program that comes with an extensive library of VIs for various tasks. For most applications in various laboratory courses, the students do not need to write their own LabVIEW programs. All they need to do is to know where to find the example VI from LabVIEW for that particular application, and know how to run the VI. In the following lab sessions, the computer data acquisition hardware and LabVIEW were used whenever a sensor used in the lab generates a voltage signal to strengthen the students' experience with LabVIEW.

In Lab 2, an LVDT sensor was used to measure linear dimensions. The output from the LVDT signal conditioner is simple DC voltage and LabVIEW provides VIs that read voltages. The students were asked to search for a continuous voltage measurement VI from LabVIEW library using the keyword "voltage" and use it to take LVDT readings. The front panel and block diagram for this VI is shown in Figures 2 and 3.

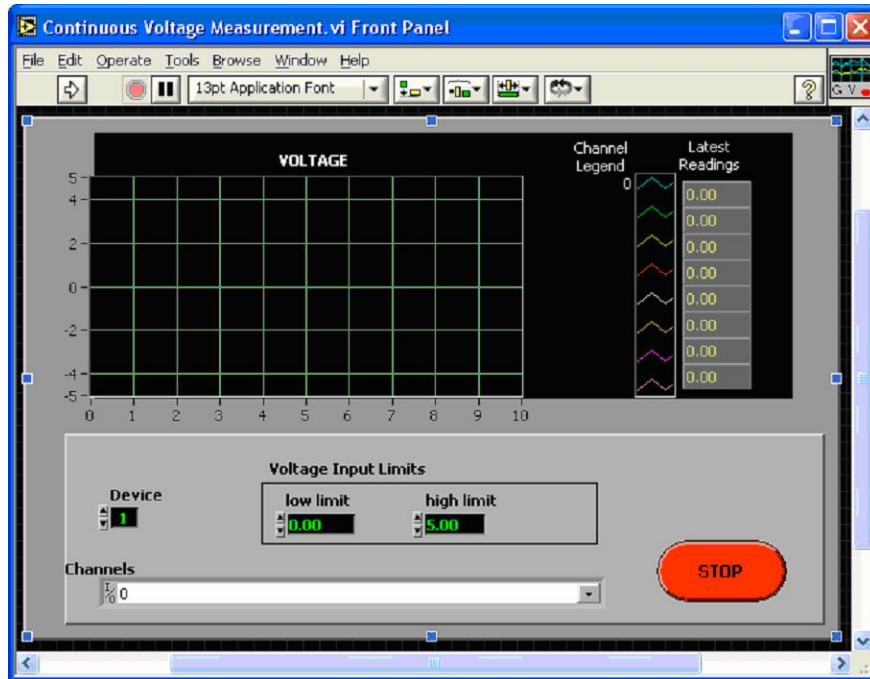


Figure 2: Front Panel of Continuous Voltage Measurement VI Provided by LabVIEW

Furthermore, in Lab 6, students used T thermocouple to measure temperatures. The students were asked to search for a continuous temperature measurement VI from LabVIEW library using the keyword "thermocouple" and configure it for the T thermocouple. Modifications to the VI were also performed by the students to display the original thermocouple voltage data. In this way, they could record down the voltage data and later on practice converting the voltages to temperatures using the ITS curve-fit equation. By doing this, the students got to experience the data manipulation done in the background of the LabVIEW VI. The front panel and block diagram for this VI is shown in Figures 4 and 5.

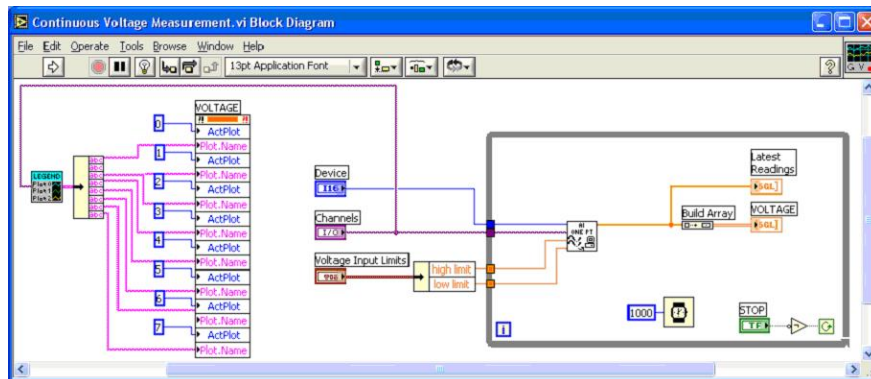


Figure 3: Block Diagram of Continuous Voltage Measurement VI Provided by LabVIEW

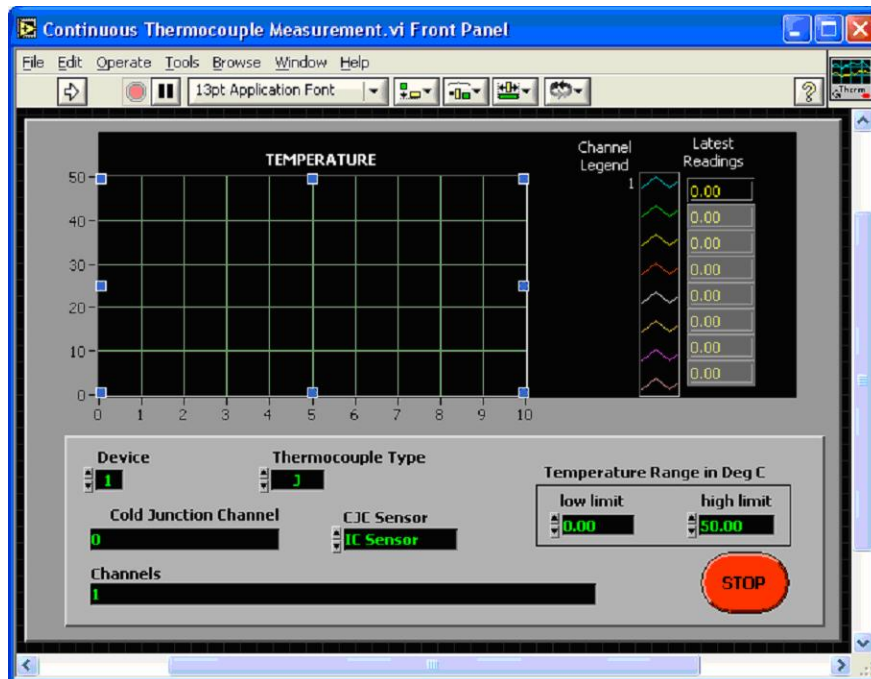


Figure 4: Front Panel of Continuous Temperature Measurement VI Provided by LabVIEW

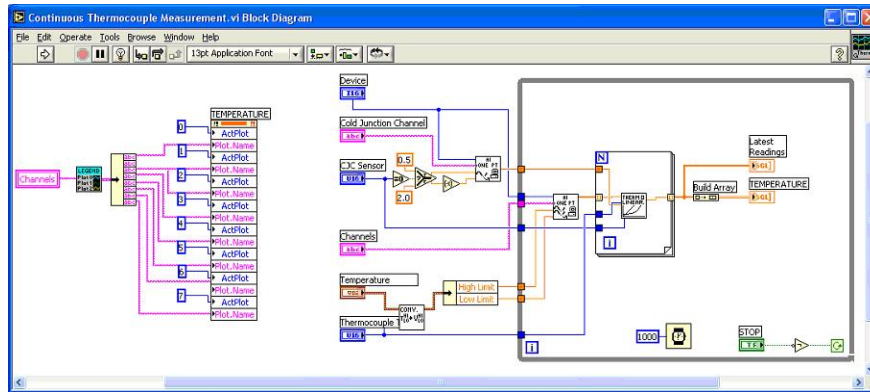


Figure 5: Block Diagram of Continuous Temperature Measurement VI Provided by LabVIEW

Understanding Simple LabVIEW VI

With the previous developed experience with LabVIEW, the students were now expected to be able to fully understand what is going on in simple LabVIEW VI. In Lab 9, laser displacement sensor was used to measure the vibrational displacement of a cantilever beam. The students were provided with a simple LabVIEW VI written by the author that acquires the voltage output from the sensor and performs a frequency analysis to show the vibration frequency. The front panel and block diagram for this VI is shown in Figures 6 and 7.

In addition to use the program to acquire the experimental data, the students were also asked to fully understand the various icons used in this VI and discuss them in their lab reports. Because they were not required to write their own LabVIEW program, because of the limited lectures devoted to LabVIEW, the success of discussing the data flow of this LabVIEW program was used as an indication of the students' understanding of the LabVIEW software that they gained from this course.

Conclusions

In this paper, the approach used by the author to introduce students to LabVIEW in an undergraduate measurements and instrumentation course is presented. The LabVIEW software and computer data acquisition were used by the students throughout the semester and as often as possible. Although the students were not required to write their own LabVIEW program, they gained experience of using LabVIEW with minimal lecture coverage of it. From the instructor's experience with the same group of students who took this measurements and instrumentation course, they seem to be more comfortable using the LabVIEW programs in later laboratory courses, such as the laboratory of mechanics and materials.

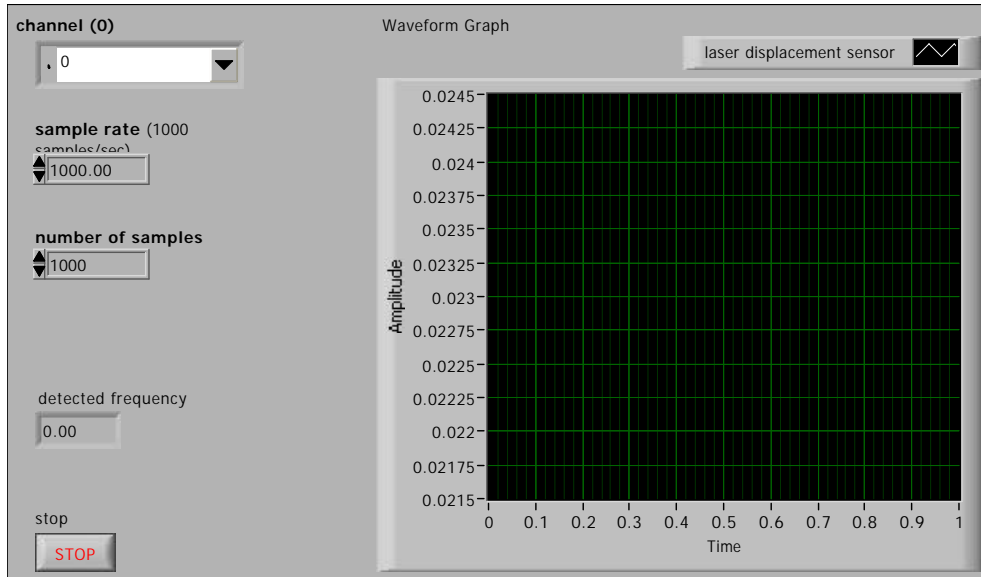


Figure 6: Front Panel of Vibration Analysis Using Laser Displacement Sensor VI

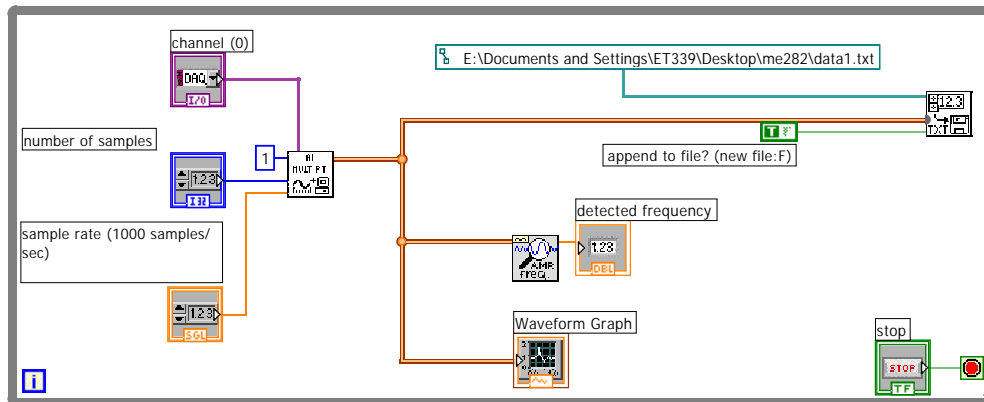


Figure 7: Block Diagram of Vibration Analysis Using Laser Displacement Sensor VI

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