VIRTUAL INSTRUMENTATION APPLIED TO MONITORING A SENSOR PLATFORM

Virtual Instrumentation based on Computer Supported Education

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Abstract: A virtual instrument is a system formed by a computer and an equipment of measurement or command which uses a program executed in the computer. The real equipment is accessible to the operator by the graphic interface of the employed software. The monitoring of sensors in the test platform uses a HMI (Human Machine Interface) developed in the software LabVIEW. The experimental tests with sensor platform allow the students perform experiments on-line for monitoring the observed signal in the output sensors.

1 INTRODUCTION

Virtual Engineering is a word used to mean the way of accomplishing projects, tests and simulations in engineering. This paradigm has two great components: virtual instrumentation and computer simulation. The first one refers to the use of the computer to amplify the instruments functional capacity, while the second one corresponds to the use of computer to simulate the behavior of processes, systems, devices, means and materials.

Now, one can tell about virtual instrumentation by sending real data in real time to a simulated model, which processes these data and sends them to the physical system via adequate interfaces, signals and effects. Thus, a virtual instrument is a system formed by a computer and an equipment of measurement or command which uses a program executed in the computer. The real equipment is accessible to the operator by the graphic interface of the employed software (Adam, Rosow and Karselis, 1996).

Actually, the keys on the virtual instrument screen do not always correspond to the real control of the instrument connected with the computer, in other words, the computer amplifies the functions of the instrument connected with the computer, by adding new characteristics in the measures provided by the instrument (Bhaskar, Pecol and Beug, 1986).

2 MATERIALS AND METHODS

The software used to produce the virtual instrumentation was the LabVIEW, which, based upon the data flux, utilizes the program wherein the data flux determines the execution. This software is very functional because the user’s interface or frontal panel is very much like the conceptual interface that a real instrument would show to the user. So, it not only facilitates the students’ comprehension, as the inclusion of them in work to develop interfaces. Furthermore, the LabVIEW possesses other advantages such as: being thoroughly integrated to communicate with hardware, counting upon resources to connect its applications to the Internet via LabVIEW Web Server and applicative such as ActiveX and TCP/IP networks (Ertugrul, N., 2002).

The LabVIEW programs are called virtual instruments (VIs - Virtual Instruments). The VIs have three main components: the frontal panel, the block diagram and the panel of icons and connectors, wherein the frontal panel is the interface with the user, the icons diagram contains the code that controls the frontal panel objects and the panel of icons and connectors that modularize the diagram, so as to allow the use of the VI in another VI.

The LabVIEW comes with a set of VIs that allows data configuration and acquisition, as well as

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the sending of data to DAQ (Data Acquisition) devices. The main task of a DAQ system is to measure and to generate real physical signals, it means that the data acquisition system finality is to gather information from the real world in order to generate data that can be manipulated in a computer or micro-processed system. So, the platform of experiments is composed of several sensors and actuators to convert the physical signal into an electric signal, such as voltage or electric current, which can be monitored and controlled via the data acquisition board.

Besides all these advantages, to facilitate the study of experiments, increase the iteration of the student with the teacher and the learning, LabVIEW allows experiments to be accessed remotely. Thus, a site was created, and to have access to the experiments, LabVIEW must be configured as a server, and the student must have the software installed on the machine, thus performing the monitoring.

For the proposed work, we utilized the National Instruments data acquisition system, the NI-USB 6210 (National Instruments, 2007), which is connected with the computer via USB (Universal Serial Bus) inputs. The NI-USB 6210 possesses 16 analogical inputs, 4 digital inputs, 4 digital outputs, two 32-bits controllers/temporizers and a frequency generator.

3 EXPERIMENTS

The experiments are presented in this section describing the greatness of each one, as regards the sensor and the actuator being employed; to describe the experiment itself; to show the electronic circuit used; to expose the block diagram and the interface created in the LabVIEW.

3.1 Experiment 1: Strain Gauge

Use the Strain-Gauge to measure the deformation of an aluminum bar, caused by the placing of weights on its edge.

3.1.1 Strain-Gauge

The electric resistance extension-meter, also known as strain gauge, is a small frame made of thin metallic blades that can be glued to the surface of a component or structure to measure its deformations. The thin layer of sticking-plaster used serves to transmit the structure deformations to the strain gauge, also serving as isolation between the two. This instrument changes little structure dimension variations into equivalent variations of its electric resistance, so being considered like a transducer (Fraden, 1993).

Extension-meters are used in the experimental analyses of deformations in machines, bridges, locomotives, vessels and in the construction of transducers of strength, tension, pressure, flux, acceleration, among others.

The representation of the Strain-Gauge Platform of Experiments, in block diagram, is shown in Figure 1.

This platform contains an aluminum bar, horizontally fixed by a support. Two identical extension-meters are stick-plastered to the bar, with one on the upper part and the other on the lower one.

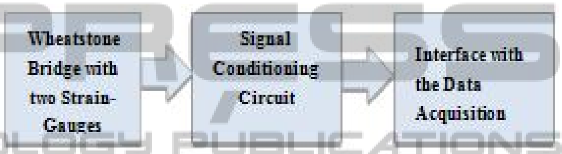


Figure 1: Blocks Diagram of Strain-Gauge Platform.

To measure the deformation caused by a force on the bar, the extension-meters are connected to a Wheatstone bridge, as shown in Figure 2. The bridge is completed with two pressure resistors with equal resistance. This configuration is called "½ bridge" because there are two active elements (extension-meters). Other configurations used are the "¼ bridge" and the "full bridge", with one and four active elements, respectively.

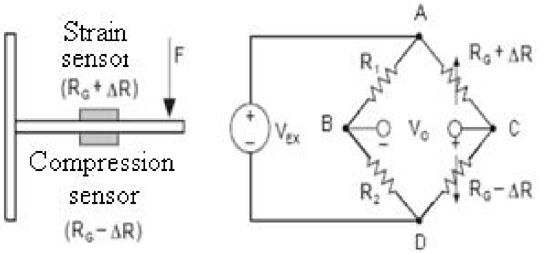


Figure 2: Electric diagram of Wheatstone bridge with two extension-meters.

The way how the extension-meters are positioned on the bar allow them to undergo opposite deformations. Therefore, the resistances will suffer the same alterations, further to minimizing the effects of temperature, as the temperature variations will be made sensitive by the resistive frames of the extension-meters. Thus, are presented the equations (1 - 4):

$$R1 = R2 = RG \quad (1)$$
$$R3 = RG + \Delta R \quad (2)$$
$$R4 = RG - \Delta R \quad (3)$$
$$\Delta R = K\varepsilon RG \quad (4)$$

Wherein K is a Constant that depends on the alloy used in the confection of the extension-meter and ε is the deformation. To accomplish the measurements, the bridge is excited with a continuous V_{EX} voltage and the V_o voltage must be void when the bridge is in balance, *i. e.*, when the bar is exempted from deformation. The deformation is then found throughout the following equation (5):

$$\frac{V_0}{Vex} = -\frac{K\varepsilon}{2} \quad (5)$$

The value of the V_o voltage is very small in relationship with the bridge excitation voltage. However, the applications with extension-meters require an amplification to increase the output level of voltage, and this, on its turn, will increase the reading resolution and will improve the signal-noise relation. After the measurement, the value is divided by the gain so as to obtain the real deformation value.

3.1.2 Platform and Interface

The experiment is accomplished by means of the platform of experiments shown in Figure 3. It is connected with the data acquisition platform throughout a flat cable. Furthermore, a program was developed in the LabVIEW and its interface is shown in Figure 4. This is how the deformation measurement is achieved.

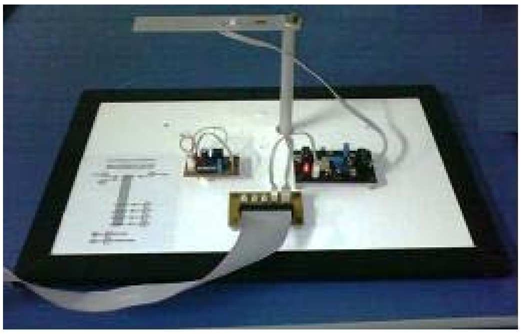
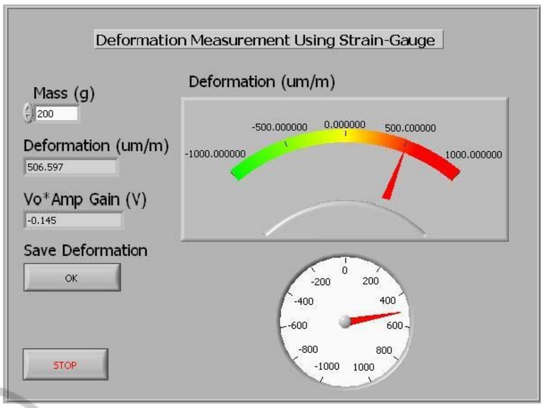


Figure 3: The Strain-Gauge Experiment Platform.

In the hole shown on the edge of the bar, some determined masses must be placed with a piece of wire. For the smaller masses, the wire must be very thin, so that its mass may not influence in the measurements. Then, if we put the desired masses on the bar, we click on “record deformation” and the deformation caused by mass on the bar will be given.



Deformation Measurement Using Strain-Gauge

Mass (g) 200

Deformation (um/m) 506.597

Vo*Amp Gain (V) -0.145

Figure 4: Interface in the LabVIEW to measure the deformation.

3.2 Experiment 2: Accelerometer

In this experiment, our objective is to characterize the ADXL 202 accelerometer throughout its mathematical model, and the use of the LabVIEW for acquisition of the experiment data.

3.2.1 Accelerometer

The platform of this experiment, shown in Figure 5, is composed of the ADXL 202 sensor accelerometer (Mohn-Yasin, Korman, and Nagel, 2003), a metallic basis where a 180° protractor is fixed. On the same metallic basis, a plate - where the accelerometer is also placed - is fixed in a way to let it in a 0° reference level; this plate also carries the signal conditioning circuit. The platform still contains an interface with the data acquisition platform, consisting of a plate with 34 pins, wherein the measurement points are found (point 11; axis X and point 12; axis Y). The interconnection with the platforms is made by a flat cable.

The representation of the accelerometer Platform of Experiments – in block diagrams – is shown in Figure 6.

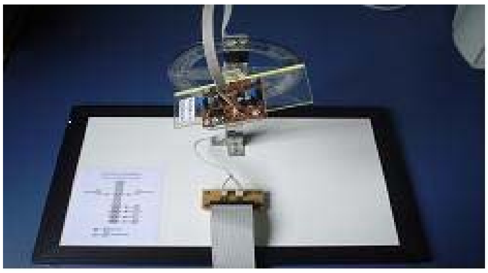


Figure 5: Photo of the Accelerometer Platform.

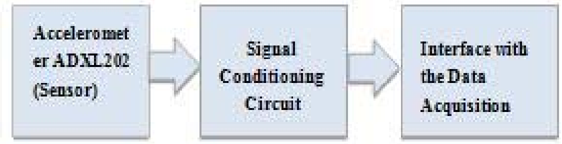
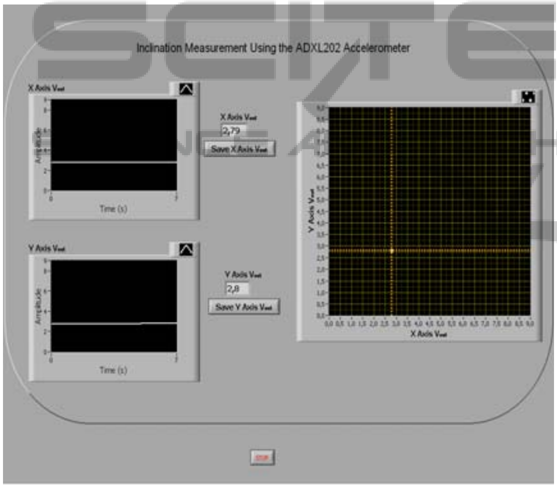


Figure 6: Blocks Diagram of Accelerometer Platform.

3.2.2 Interface

Using the experimental platform constructed in the LabVIEW, we managed to measure the voltage referring to a level of inclination. First of all, we must adjust the values of voltage referring to each sensor axis (accelerometer), so, as to show a point on the screen of the created interface (XY Graph), as can be seen in Figure 7.



X Axis Vout 2,79

Y Axis Vout 2,8

Figure 7: Interface created in the LabVIEW to measure inclination.

4 CONCLUSIONS

The experiments gave us expertise in various fields, such as analog and digital electronics. We could also see how important is the development of interfaces using LabVIEW, which is a simple software, and, eventually use it in others applications.

The discussed experiments attempted to transmit to the students the concepts involved in this paper using the computer as a main tool for performing and analyzing experiments.

Also, the flexibility of iteration between student and teacher provided by technology tools establishes a new dynamic of teaching. The students can better organize your questions on the subject under study and they have the initiative to find their answers.

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