DEVELOPMENT OF SOFTWARE FOR ESTIMATION OF STRUCTURAL DYNAMIC CHARACTERISTICS OF MECHANICAL SYSTEMS IN REAL TIME

K. Prasanthi[1] , S K . Idrish[2]

[1] *M. Tech Student, Bapatla Engineering College, Bapatla, A.P, India*
[2] *Assistant Professor, Department of ECE, Bapatla Engineering College, Bapatla, A.P, India*

---***---

Abstract: *A control system is an interconnection of components forming a system configuration that will provide a desire system response. It comprises of control algorithm, plant & feedback. The plant may be a mechanical, electrical, pneumatic, etc. In this project deals with mechanical structure that is a beam as a plant for determining the structural dynamic characteristics of it by applying a known dynamic input (i.e. force) and resulting responses are measured .Signal processing methods are applied to the measured data to extract its parameters such as resonance frequencies ,damping…etc. A more sophisticated approach would use by applying wide band random excitation from single shaker (single input and multi output) simultaneous measurement of signal from an accelerometer and computer computation and storage of frequency response of functions(FRF's).The aforementioned work will be done through data acquisition toolbox from MATLAB .Data acquisition toolbox provides functions for connecting MATLAB to data acquisition hardware such as National Instruments (NI).Generally, aerospace vehicles vibrate at certain acceleration level at certain point. In order to clear the system for flight one has to demonstrate or test the system for specified accelerometer level for certain duration with in the laboratory. This particular work will also cover the development of control algorithm to get the desired acceleration at desired location. This project work also covers the designing of software for closed loop control system on real time in order to get the desired output on the structure*.

Keywords: Lab VIEW, Data Acquisition, Microcontroller, Ethernet

1. Introduction

Several technologies have already been introduced for industrial automation (e.g., standard and proprietary field and control level buses). In the last few years, some newly introduced connectivity solutions such as Ethernet, Wireless LAN, etc are used in industrial application. They are large number of additional automation solutions available in already existing methods. With the help of software we are able to program as per our needs. Data process can be changed or modified with software programs. Lab view „G" program allows users to create a graphical program which process the data obtained from the sensor (e.g., temperature sensor, pressure sensor, etc). This paper takes a case study of industrial automation for temperature monitoring application. This paper also gives an overview of modem day data acquisition system, data storage and control techniques.

2 Data Acquisition, Data Storage and Control System

2.1 Data Acquisition

Lab VIEW software is simple and easy to use, when you need to implement measurement and control, adding a data acquisition card you can achieve the following functions, including collect the data of the controlled object, dynamic display and real-time control. Multifunction DAQ data acquisition card has a simple structure, and it can capture signals. AQ Assistant is a configuration measurement tasks, channels and calibration end graphical interface. Users can use it to produce NI- DAQ mx task procedures. When you collect the signal in the DAQ hardware, you can complete measurement tasks by configuring the DAQ Assistant Express VI measurement are very quick and easy to implement, which development cost is low [1].

2.2 Data Storage

Acquired data is to be processed and stored for maintenance purpose in future. There are two methods used for data storage. Recorders or data loggers are used nowadays. Recorders and data loggers are used in measurements variables data such as temperature, pressure, pH, humidity; and also used for engineering and scientific applications such as high-speed testing (e.g., stress/strain), statistical analyses, and other laboratory or off-line uses where a graphic or digital record of selected variables is desired. Personal computers have the ability to provide necessary curves on CRT displays that could be analyzed [3]. In our system acquired information is collected in Lab VIEW and stored in Microsoft Excel.

2.3 Control System

A control system is a device, or set of devices, that manages, commands, directs or regulates the behaviour of other device(s) or system(s). There are two common classes of control systems, with many variations and combinations: logic or sequential controls, and feedback or linear controls. There is also fuzzy logic, which attempts to combine some of the design simplicity of logic with the utility of linear control. Some devices or systems are inherently not controllable.

Acquired data is sampled, processed and to then controlled as per the design. In control system the computer compares the signal coming from the sensor or DAQ device with the reference value which is called as set point here. According to the set point the controller makes a decision and sends a control signal to hardware equipment.

3. Hardware Implementation

This part explains more about the hardware design and construction involves in this system. There are temperature sensor, signal conditioning, ARM microcontroller, and ethernet driver. It has a separate power supply.

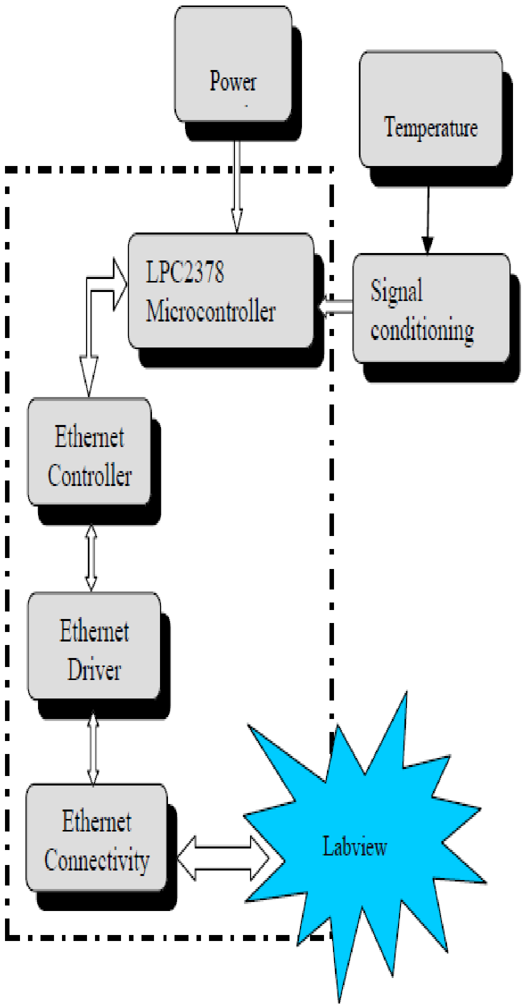

Figure 1: Hardware implementation

3.1 Temperature Sensor

LM35DZ is the temperature sensor from National Semiconductor. This sensor output voltage is linearly proportional to the Celsius. Temperature ranges between -55°C to and150°C and the accuracis about +2.0°Cand output scale 10mV/C.

3.2 Signal Conditioning

LPC 2378 microcontroller has inbuilt ADC. Microcontroller is programmed to read the data from LM35. The first thing in my program is to write a routine, that enables the ADC to read and write data, and then monitor the INTR pin of the ADC and bring an analog input into the register A. This task had to be accomplished by sending a high to low transition pulse on the WR pin through one of the port pins of the microcontroller. This converts the analog input into 8bit digital form.

3.3 Microcontroller to LM35 Interface

The LPC2148 are based on a 16/32 bit ARM7TDMI-S™ CPU with real-time emulation and embedded trace support, together with 128/512 kilobytes (kB) of embedded high speed flash memory At first, the microcontroller is interfaced with temperature sensor, LM35. This LM35 produce an analog signal corrsponding to the temperature value. Then the analog signal is converted into digital by means of ADC and then the digital value is read by microcontroller.

3.4 Microcontroller to LM35 Interface

In recent years, the ethernet network protocol has been widely adopted as the choice method of data communication for personal computers and other digital devices. Its popularity is primarily due to the immense use of the Internet, an information exchange infrastructure that communicates data via the ethernet network, by the general public. Furthermore, ethernet communication is readily available on most of the currently deployed PCs. As a data communication protocol, the ethernet is efficient. In all ethernet networks, devices can easily communicate at speeds of about 10 megabits-per-second, with some of the most recent ethernet networks communicating even at data speeds of 1 gigabit-per-second. Microcontroller and computer are interfaced by using Ethernet port. LPC2378 microcontroller circuit board consists of Ethernet port which is connected to Ethernet port available in computer [5].

Table 1: Margin specifications

Margin	*A4 Paper*	*US Letter Paper*
Left	18.5 mm	14.5 mm (0.58 in)
Right	18mm	13 mm (0.51 in)

4. Lab VIEW Developing Module

Lab VIEW (Laboratory Virtual Instrument Engineering Workbench) uses dataflow programming, where the flow of data through the nodes on the block diagram determines the execution order of the VIs and functions [9]. The block diagram contains this graphical source code, also known as G code or block diagram code.

Front panel objects appear as terminals on the block diagram [8].

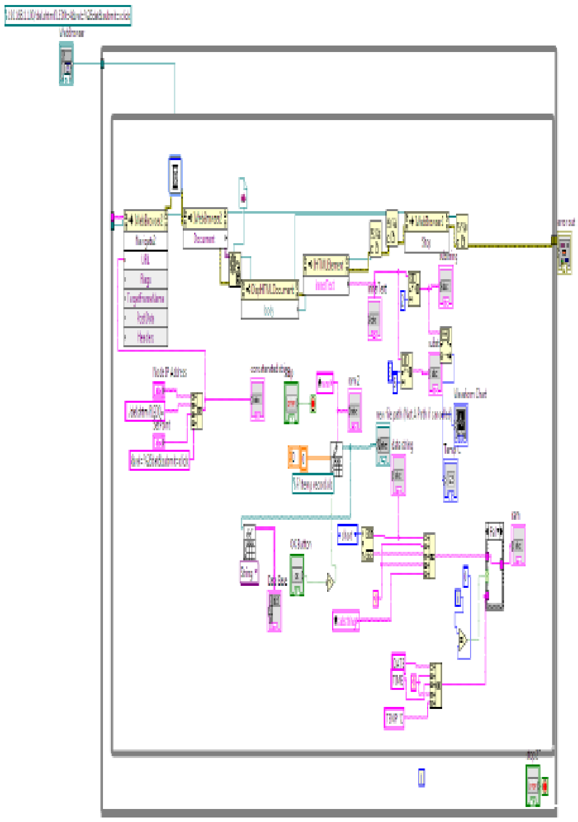

Figure 2: Lab VIEW block diagram design

5. Results and Discussion

5.1 Output Design of Microcontroller

The temperature sensor is the transducer that reads temperature of the particular environment, which we want to measure and converts the temperature into corresponding electrical signal. This analog signal is amplified by signal conditioning circuit and then the analog value is converted into digital by means of analog to digital converter in order to read microcontroller.

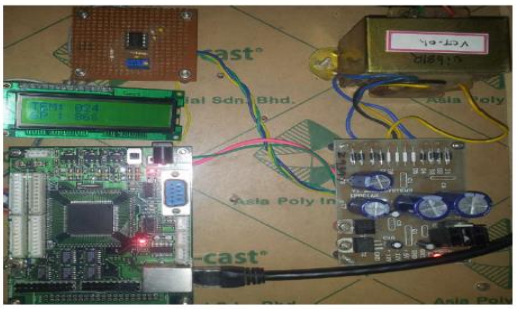

Fig: 3 Output Design of Microcontroller

Microcontroller is programmed to read this digital value corresponding to temperature and it is stored in the embedded microcontroller. Data can be displayed in LCD by programming the microcontroller. Through the ethernet port it can communicate with the Lab VIEW module in the computer. In Lab VIEW the temperature point is set and the set point is read by microcontroller and is displayed in LCD. This output is shown in the figure 3.

5.2 Impulse Input And Response

In signal processing, the impulse response, or impulse response function (IRF), of a dynamic system is its output when presented with a brief input signal, called an impulse. More generally, an impulse response is the reaction of any dynamic system in response to some external change. In both cases, the impulse response describes the reaction of the system as a function of time (or possibly as a function of some other independent variable that parameterizes the dynamic behaviour of the system).

In all these cases, the dynamic system and its impulse response may be actual physical objects, or may be mathematical systems of equations describing such objects.

Since the impulse function contains all frequencies, the impulse response defines the response of a linear time-invariant system for all frequencies.

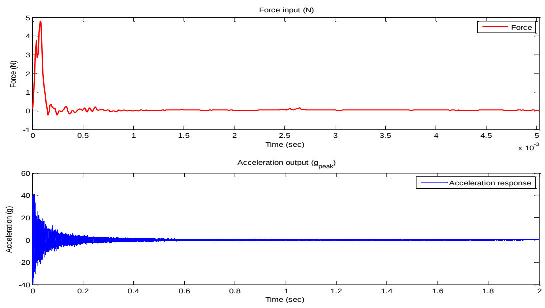

Figure:4 Impulse Input And Response

5.3 FRF And Phase

The following article will attempt to explain the basic theory of the frequency response function. This basic theory will then be used to calculate the frequency response function between two points on a structure using an accelerometer to measure the response and a force gauge hammer to measure the excitation.

Fundamentally a frequency response function is a mathematical representation of the relationship between the input and the output of a system.

So for example the frequency response functions between two points on a structure. It would be possible to attach an accelerometer at a particular point and excite the structure at another point with a force gauge instrumented hammer. Then by measuring the excitation force and the response acceleration the resulting frequency response function would describe as a function of frequency the relationship between those two points on the structure.

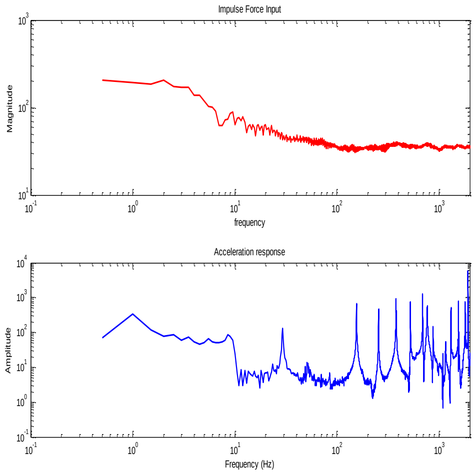

Figure : **5** FRF And Phase

5.4 System transfer function in frequency domain

Transfer functions are commonly used in the analysis of systems such as single-input single-output filters, typically within the fields of signal processing, communication theory, and control theory. The term is often used exclusively to refer to linear time-invariant (LTI) systems, as covered in this article. Most real systems have non-linear input/output characteristics, but many systems, when operated within nominal parameters (not "over-driven") have behaviour that is close enough to linear that LTI system theory is an acceptable representation of the input/output behaviour.

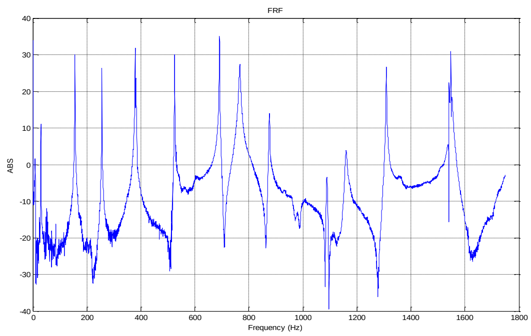

Figure: 6 System transfer function in frequency domain

6. Conclusion

Industrial automation through Ethernet is a good solution, which is faster and accurate. Ethernet communication supports data rates at the speed range from 100Mbps to several Gbps. It is highly reliable for high speed automation application. A web page designed with HTML coding, provides the data access in LAN. Each PC are connected with LAN network connection, is identified by the unique address called IP address. The communication within this network is established with the help of IP addresses. The software model for device control automation is developed in the web page. The user can observe the temperature reading taken from the workplace and control the temperature from his PC by accessing the web page through web browser.

My future work is focused on industrial automation through internet. So that, it is possible to access that web page through internet and can able monitor and control the temperature with a PC or Laptop

References

[1] Nie Chun-yan1, Xu Shan-shan2, and Ji Shu-jiao1, "Data Acquisition and Realization of Communication Transmission Based on Lab VIEW", 2012 International Conference on Computer Science and Electronics Engineering, DOI 10.1109/ICCSEE.2012.191.

[2] Shyam.R.Nair, Venkatesh Thalaimalayan, "Design of a Lab VIEW Based Real Time Simulator for ABS Tester", International Journal of Scientific and Research Publications, Volume 2, Issue 5, May 2012.

[3] Subhransu Padhee , Yaduvir Singh, "Data Logging and Supervisory Control of Process Using Lab VIEW", Proceeding of the 2011 IEEE Students', Technology Symposium 14-16 January, 2011, IIT Kharagpur.

[4] Gangling Guo, Zhejiang Li, Fan Yang, "Design of High Speed Pulse Data Acquisition System Based on FPGA and USB", 2011 International Conference on Multimedia Technology (ICMT).

[5] Nader N. Barsoum, Pin Rui Chin, "Ethernet Control AC Motor via PLC Using LabVIEW", Intelligent Control and Automation, 2011, 2, 330-339, Published Online November 2011 (http://www.SciRP.org/journal/ica).

Piotr Bilski and Wieslaw Winiecki, "Virtual Spectrum Analyzer Based on Data Acquisition Card", IEEE transactions on instrumentation and measurement, vol. 51, no. 1, february 2002.

[6] A. Ferrero, L. Cristaldi and V, Piuri, "Programmable Instruments, Virtual Instruments, and Distributed Measurement Systems: What Is Really Useful, Innovative.