

INDUSTRIAL TEMPERATURE MONITORING AND CONTROL SYSTEM THROUGH ETHERNET LAN

S.Rajesh Kumar¹, S.Rameshkumar²

¹ M.E Communication System,
PGP College of Engineering and Technology, India
rajesh26july@gmail.com

² M.E Communication System,
PGP College of Engineering and Technology, India
ssrrameshkumar@gmail.com

Abstract: This paper presents a PC based temperature monitoring and control system using virtual instrumentation, LabVIEW. Data acquisition is an important role in industry in order to ensure the quality of service. Temperature sensor measures the temperature and produce corresponding analog signal which is further processed by the microcontroller. The simulator acquires data from the microcontroller through Ethernet port. The data will be displayed on the LCD in microcontroller and PC monitor. Automation and control can be done with the help of control circuitry.

Keywords: LabVIEW, 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 (eg, 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

LabVIEW 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-DAQmx 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 LabVIEW 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 behavior 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.

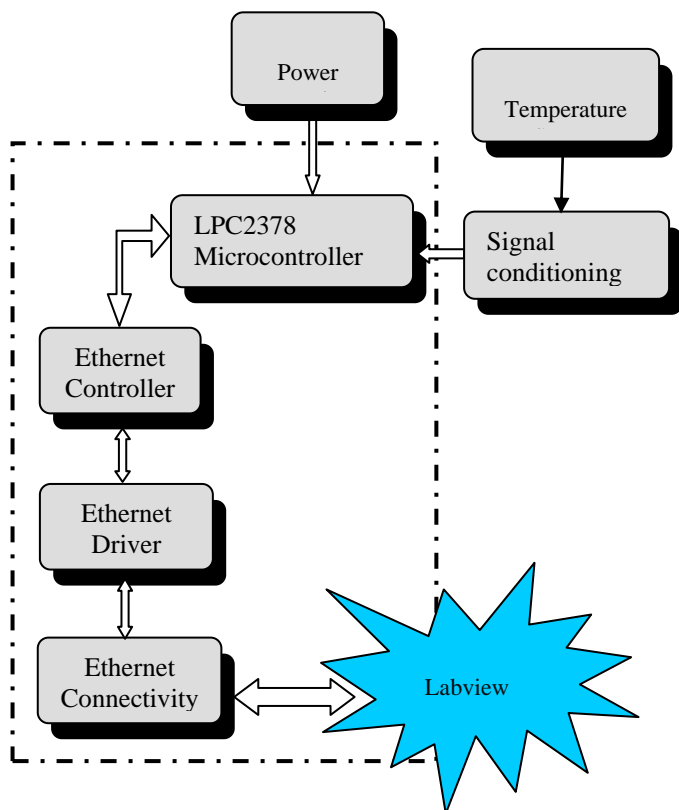


Figure 1: Hardware implementation

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 and 150°C and the accuracy is about $\pm 2.0^{\circ}\text{C}$ and output scale $10\text{mV}/^{\circ}\text{C}$.

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 corresponding 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. LabVIEW Developing Module

LabVIEW (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].

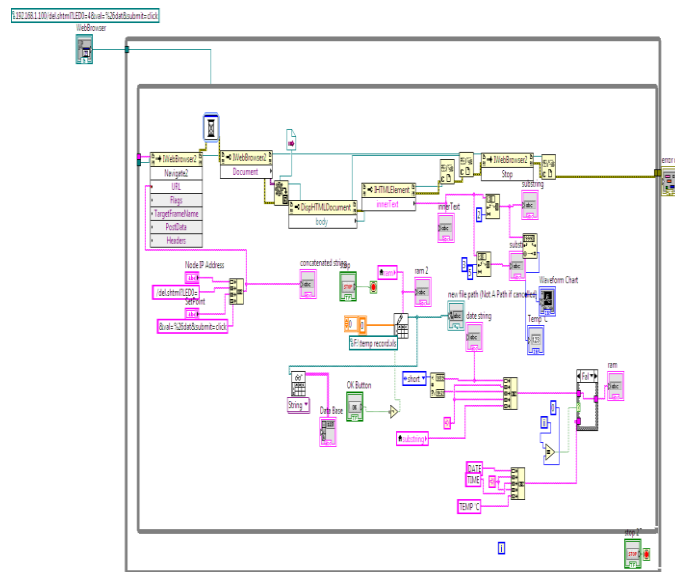


Figure 2: LabVIEW block diagram design

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.

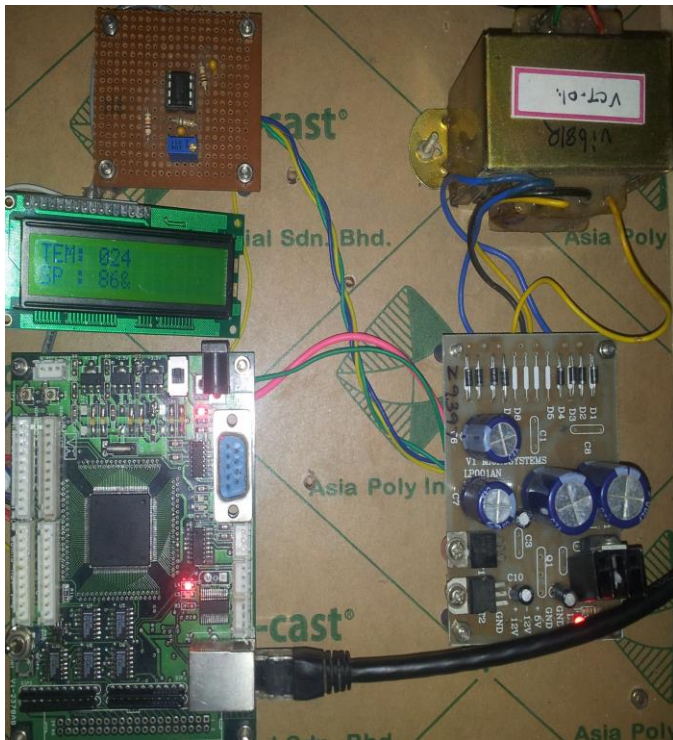


Figure 3: LabVIEW block diagram design

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 LabVIEW module in the computer. In LabVIEW 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 Output Design in LabVIEW

The command is entered in the LABVIEW. Here PC with LABVIEW is used as the interface software for the design of the graphical user interface for providing microcontroller interface. NI VISA5.2 device driver must be installed in order to interface the microcontroller with the help of ethernet port. LabVIEW communicate with the microcontroller by using its IP address. Microcontroller is designed with Ethernet controller and Ethernet driver. Lab view module initializes the communication by accessing the IP address of the embedded web server.

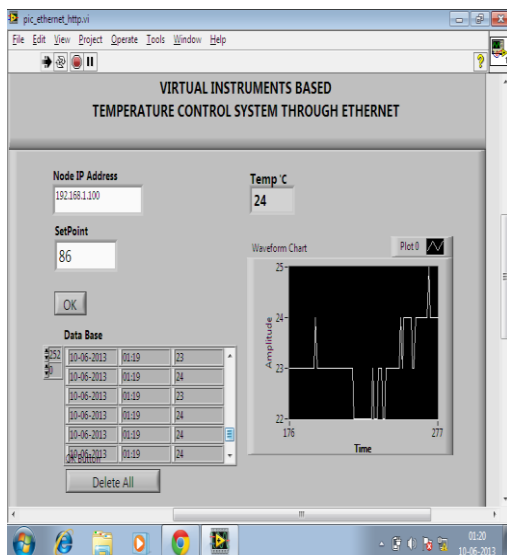


Figure 4: Output design in LabVIEW

The value obtained from the temperature sensor is displayed in both LCD and LabVIEW module. 24°C is the value obtained by the sensor and the temperature is to be maintained under 86°C as requested by the user in set point. In microcontroller, the feedback signal is converted to the analog value and it plots the temperature values in LabVIEW software [6]. When set point is done, microcontroller reads the value and displays in LCD. Figure 4 shows the output module of LabVIEW.

5.3 Table

Table 1: Data Storage in Excel

Date	Time	Temp °C
10-06-2013	01:19	23
10-06-2013	01:19	24
10-06-2013	01:19	23
10-06-2013	01:19	24
10-06-2013	01:19	24
10-06-2013	01:19	24
10-06-2013	01:19	24
10-06-2013	01:19	24
10-06-2013	01:19	24
10-06-2013	01:19	23
10-06-2013	01:19	23
10-06-2013	01:20	24
10-06-2013	01:20	24
10-06-2013	01:20	24

Table 1 shows the database created by labview module. It stores the measured value in excel format, for maintenance purpose in future.

5.4 Web Page Result

This system aims at implementing embedded web server for data acquisition and control system. Here the embedded microcontroller is programmed to act as the web server. The web page is designed and uploaded in the embedded microcontroller. Web server application is ported into an ARM processor using embedded 'C' language. Web pages are written by Hyper Text Markup Language (HTML).

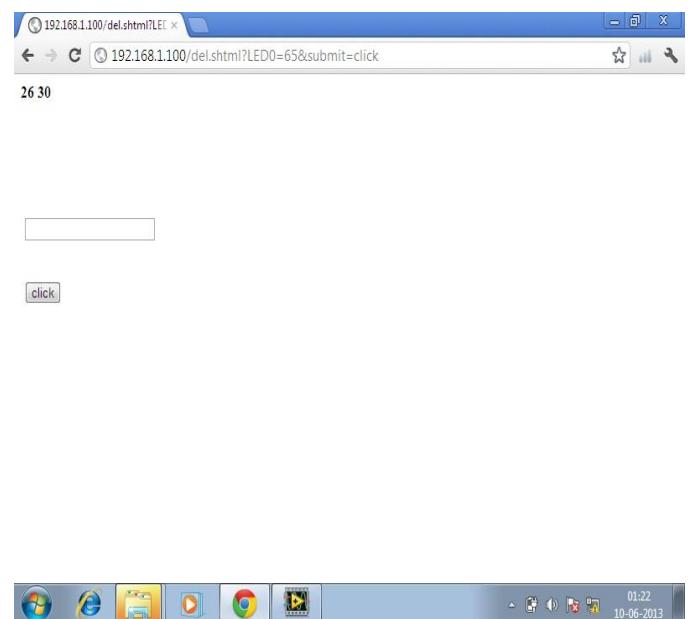


Figure 5: Web page design

Figure 5 shows the communication between microcontroller and computer through web browser. A web browser is opened and by typing the IP address of the embedded web server, we can access the data. It is also designed to set a set point to limit the temperature below a particular value. The value 26 is the measured value by the sensor and 30 is the default set point. We can change the set point any time, so that it sends the value to embedded web server and displays it in LCD.

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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.

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Author Profile



Rajesh Kumar received the B.E. degree in Electronics and Communication Engineering from M.Kumarasamy College of Engineering in 2008 and pursuing M.E. degree in Communication System from P.G.P College of Engineering and Technology in 2013, respectively. His areas of interest are LabVIEW and antennas.