

Temperature monitoring and control system using NI ELVIS and LabVIEW

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Abstract- A temperature monitoring and control system based on National Instruments Educational Laboratory Virtual Instrumentation Suite (NI ELVIS) kit. Application program on LabVIEW is designed and implemented. An application is made which can be installed on any personal computer which is connected to the experimental setup. Application uses NI based NI-ELVIS kit connected with sensors for data acquisition. Logging of the data and printing of the report can be supported on the setup machine with little extension of the application program. Online data from the sensors can viewed in graphical form showing changes with respect to time.

Keywords- LabVIEW, NI ELVIS, Temperature Monitoring and Control system.

I. INTRODUCTION

PC based data acquisition, monitoring and control systems are gaining importance these days. Due to the flexibility offered by various platforms in practice. LabVIEW has been used successfully served the purpose for many years in test and measurement applications due to the ease of graphical programming and its wide area of functionality for interfacing directly to instruments, sensors and actuators.

Trend is emerging for monitoring and controlling processes using virtual instrumentation. LabVIEW is one such software platform where virtual instrumentation can be realized^[1].

Here application implementation of temperature monitoring and control systems using LabVIEW is discussed in this paper. This system connects temperature sensors to a computer through NI ELVIS kit. Digital outputs of card control the temperature of system by controlling cooling/heating element.

II. NI ELVIS KIT

The National Instruments Educational Laboratory Virtual Instrumentation Suite (NI ELVIS) integrates the commonly used instruments – including oscilloscope, digital multimeter, function generator, bode analyzer, and more – into a compact form factor ideal for the lab or classroom. NI PCI-6251 M Series DAQ device is back bone of this kit, it is inserted to PCI slot of a computer which is a data acquisition card with capabilities of Analog Input Outputs and Digital Input Outputs.

The NI LabVIEW graphical system design software is used to develop customized application for virtual instrumentation using NI ELVIS^[2]. The virtual instrument available from a single platform, NI ELVIS, eliminates the need to purchase multiple instruments for one application.

The NI ELVIS LabVIEW soft front panel (SFP) instruments combined with the functionality of the DAQ device and the NI ELVIS workstation provide the functionality of the SFP instruments like: Arbitrary Waveform Generator (ARB), Bode Analyzer, Digital Bus Reader, Digital Bus Writer, Digital Multimeter (DMM), Dynamic Signal Analyzer (DSA), Function Generator (FGEN), Impedance Analyzer, Oscilloscope (Scope), Two-Wire Current Voltage Analyzer,

Three-Wire Current Voltage Analyzer and Variable Power Supplies.

III. DATA ACQUISITION

Data acquisition, is obtaining data from an instrument or device to the computer or device with GUI capabilities. DAQ boards perform a variety of tasks, including analog measurements, digital measurements, and timing I/O. The benefit of using National Instruments boards is the availability of NI-DAQ drivers for the boards. Most board manufacturers do provide their own drivers for their equipment. The Data Acquisition sub palette is a part of the Functions palette. The Data Acquisition palette is made up of six sub palettes: the Analog Input VIs, Analog Output VIs, Digital I/O VIs, Counter VIs, Calibration and Configuration VIs, and Signal Conditioning VIs. The Intermediate VIs allows configuring the hardware and associated settings.

For data acquisition from sensors, signal conditioning of sensors is mandatory. The signal conditioning circuit does the conditioning of signals from sensor such as amplifying, removing noise, isolating for protection purpose and so on. This signal conditioning protects the processing unit from being damaged by the external signals from sensor as well as improves data accuracy. The basic conditioning such as isolation is provided on the DAQ device card and other conditioning such as amplifying is to be carried out externally. The filtering processes can be done in software to de-noise the signal data. Other manipulation with the data can be applied in software to get the representation of sensor data in units as per the requirement.

A. Hardware Setup

NI ELVIS kit is used for data acquisition^[3]. This kit consists of a PCI DAQ Device card which is inserted in the PC which is connected to the LAN. PCI card is connected to the external pinout board. Four temperature sensors are connected to the analog input channels of the PCI DAQ Device card. The digital outputs are connected to the relay card which further can be connected to cooler or heater.

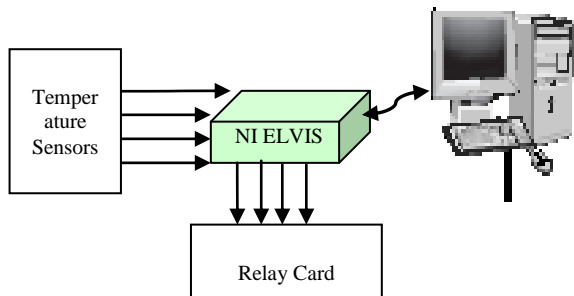


Figure 1. Hardware Setup

The temperature sensor used are LM35 a Precision Centigrade Temperature Sensors Calibrated directly in °Celsius (Centigrade) with linearity of + 10.0 mV/°C scale factor and 0.5°C accuracy, supports -55° to +150°C range, operating from 4 to 30 volts and Low impedance output, 0.1 ohm for 1 mA load^[4].

The relay card is connected with the digital IO lines. As per the algorithm when relay is energized the connected respective controlling device may be heating or cooling device is turned on. The relay used is to operate on 12V DC so the driver circuit is built on the relay card. Also the isolation is required from DIO which is fulfilled through the use of driver circuit.

IV. SOFTWARE SETUP

Programming with LabVIEW is very user friendly and easier as various tools are available in a single programming platform wide area of applications can be designed using it. Advantages of the built-in networking tools of LabVIEW such as NI DataSocket™ can be easily used to extend and integrate these embedded systems with other systems.

The application for monitoring as well as controlling the temperature is designed on LabVIEW software but the application here are the installer files. So it does not require LabVIEW to be installed on the machines. Installation of the acquisition software can be made on the machine where hardware setup is connected. So far as the drivers are concerned for NI ELVIS, it is not required to install separately. The installer will install the drivers with the application software.

A. Algorithmic flow of application

The figure shows the algorithm to monitor and control the temperature of system. First of all the hardware setup is required along with the application software installed in a computer. As discussed the PCI card is required to be installed in computer and connected to the NI ELVIS kit along with the sensor and relay cards. Once all setup is done the application is run. As per the algorithm the flow will start from checking the hardware connections especially the NI ELVIS kit, if it is not connected the application will not start acquisition.

After successful detection of the kit, the threshold values is asked to set for in the software, which is voluntary as even if the user exempts from this setting process default threshold i.e. minimum 25°C and maximum 100°C is set for all sensors. Once the configuration process is skipped the application will

not allow setting it again until application is halted and restarted.

Once the configuration process is over the acquisition starts and application will monitor the sensor readings. As per the

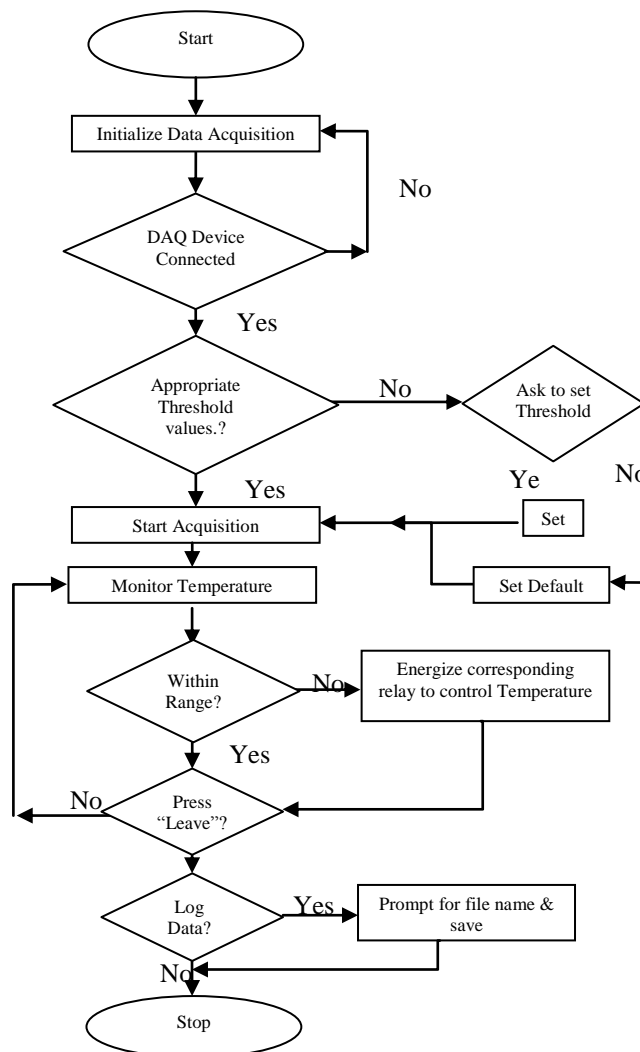


Figure 2. Software Flow at Remote end and setup end algorithm if sensor reading is higher than upper threshold value

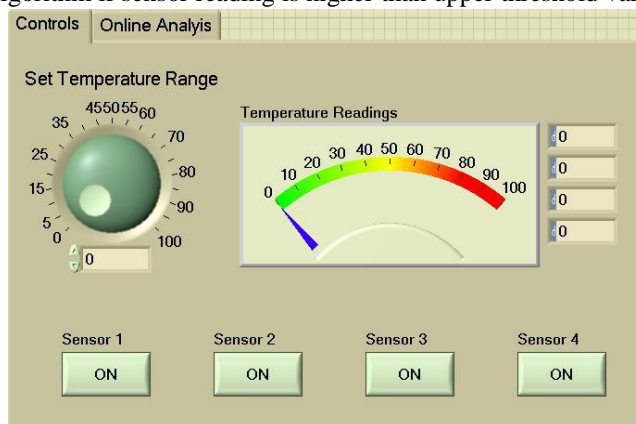


Figure 3. GUI – Control Tab

than the cooling device connected is turned on and if the sensor reading is less than lower threshold value than the heating device is turned on.

At end or in midst of the acquisition if LEAVE button is pressed than the application will stop and ask for data logging. If user selects the data logging than file name is asked for to the user. The data recorded will be logged in an excel file format with time stamp.

B. Graphical User Interface

GUI is a very important part of the application so far as the monitoring and controlling is concerned. The data acquired from the sensor is to be represented in correct form to analyze

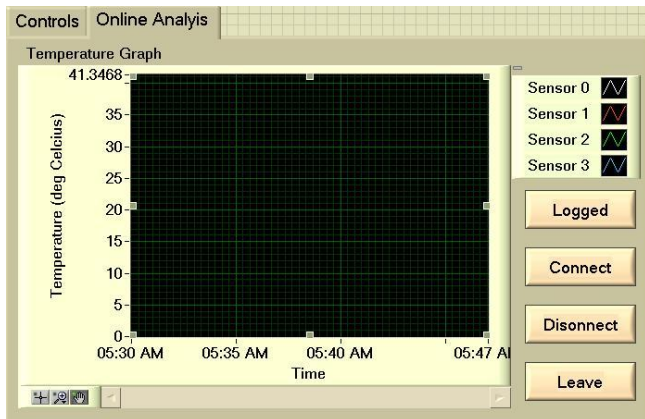


Figure 4. GUI – Online Analysis

The screenshots of GUIs are as shown here in figure 2. The first GUI shows the Control Tab where the knob is used to set the temperature threshold range for individual sensor. Pressing

respective sensor button will display and enable the threshold setting for individual range setting. The dial titled Temperature Readings will indicate the sensor readings on the dial as well as the adjacent numeric indicator will show the instantaneous amplitude in numeric form.

The GUI figure-4 shows Online Analysis Tab where the graph where the changes in the sensor readings are shown in live form. All of the four sensor waveforms are shown on the same graph with timestamp. The buttons beside the graph are for enabling data logging, connecting-disconnecting with the acquisition device and to stop application by pressing Leave.

V. FURTHER ENHANCEMENTS

Further this application can be used to acquire data from other sensor types such as pressure sensors, hall sensors, photo sensor, and many more. With little modification in the application code the respective sensor quantity can be displayed and analyzed on graphical form.

Also, the remote monitoring feature over LAN can be added to application for making it more advanced such as to be accessible from any LAN connected terminal provided the application software is installed.

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