UDC: 004.415

DESIGN AND IMPLEMENTATION OF PROGRAM FOR DATA ACQUISITION AND PROCESSING IN SENSOR NETWORKS WITH TEMPERATURE SENSORS

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The purpose of this work is the development of a program for acquisition and processing the data obtained from temperature sensors in sensor networks. Wireless sensor networks application for collecting, processing, and presenting information is one of the promising areas as well as for operating procedures monitoring. Temperature, humidity and pressure are the most commonly measured phenomena in current industrial production. LabVIEW environment was used to achieve this purpose. Created program reads out the temperature values from sensor of the DAQ signal accessory, transmits them to the computer, process these data, and every second shows temperature values on the front panel in three measurement scales: Celsius, Kelvin and Fahrenheit. Obtained results can be used as a base for sensor network node software development.

Key words:
Sensor networks, data acquisition, sensor, temperature, LabVIEW.

Introduction

Designing the distributed data acquisition systems in a variety of application areas is more relevant than ever. Wireless sensor network sapplication for collecting, processing, and presenting information is one of the promising areas as well as for operating procedures monitoring. Temperature, humidity and pressure are the most commonly measured phenomena in current industrial production. So, for example, within a middle nuclear power plant there are about 1500 sensor nodes for temperature measurement, and a large chemical company provides more than 20 thousand of such nodes.

The purpose of this work is development of a program for acquisition and processing of data obtained from temperature sensors in sensor networks.

Data Acquisition (DAQ) Hardware

Data transmission process follows several steps. Any measurement starts from a transducer or a sensor, which converts the physical phenomenon into a corresponding electrical signal. Then, the signal conditioning is performed. After converting physical phenomena into the signal measured with a signal conditioning hardware or without it, the signal should be transmitted to the computer. DAQ multiple components required are signal accessory, cable, data acquisition unit and computer. All this hardware enables the computer to operate as the computer-aided measurement system.

Chosen for this workDAQdevicehas three following interfaces to send and receive signals:

1. I/O connector is the 68 pin connector, which provides the signal input and output from the DAQ device;
2. input/output computer interface transmits data between the DAQ device and the computer via the USB port;
3. real time system integration bus (RTSI) is used to share and synchronize timing and control signals between multiple boards in a single computer. It has eight analog/digital inputs-outputs.

ThemostcommonlyusedDAQdevicesmanufactured by National Instruments are the E Series devices. Usually DAQ devices include four common components: analog input, analog output, digital input/output and counters. A representative E-series device includes sixteen analog inputs, two analog outputs, eight digital I/O lines and two counters.

The digital input/output circuit performs both input and output function. A representative DAQ device has eight digital I/O lines for receiving or generating signals.

Counters are hardware controlled registers that are designed specifically to increment or decrement a count register. This register can be read and it can also be preloaded with a given value.

The conditions with which the counter increments or decrements is dependent on the inputs to the counter. Counters measure or generate discrete TTL signals.

In thisworkchannel of analog input is used. Input signal pass through analog input scheme from connector input/output and then transfers on analog-to-digital converter (ADC). Analog input scheme consists of a multiplexer and an instrumental amplifier. Multiplexer is a commutator which connects only one of the several input channels to instrumental amplifier at a time.When data is transmitted from several input channels, multiplexer alternates all channels, connecting it one by one toamplifier. Softwarecontrols the order ofinput signals connection to amplifier. Instrumental amplifier gains or reduces incoming signal.

ADC converts an analog signal into discrete, which then transfers to a computer for analysisvia a computer I/O interface. Used in the work ADC has 12 bits resolution at rates up to 250 kS/s and can operate in two following ranges: bipolar range from -2.5 V to 2.5 V,and unipolar range from 0 to 5 V.

TheDAQ signal accessoryperforms the role of the sensor node (Fig. 1) in the described data acquisition system. To provide temperature measurement anIC temperature sensoris used .Accuracy of the temperature sensor is 1.5℃. Type of sensor output signal is analog.

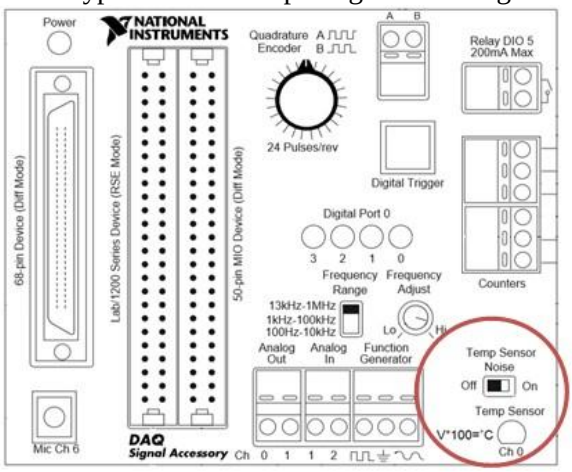

Fig.1. The DAQ signal accessory

The temperature sensorwires to the zero-orderanalog input channel. Temperature sensor provides an equivalent voltageat the channel output. Because the IC sensor voltage islinearly proportional to the sensor temperature, it is necessary to use the equation (1)to convert it to degrees Celsius:

$$V \cdot 100 = T, \tag{1}$$

where V isan equivalent voltage value, and Tisa temperature value in degrees Celsius.

Data Acquisition Software

Development environment LabVIEW (Laboratory Virtual Instrument Engineering Workbench) was chosen to design the software program for data collection from temperature sensor. The main advantages of LabVIEW are usability and clearness for user. LabVIEW is powerful and flexible software environment used for measurement and analyze findings. It is used in data acquisition and processing systems as well as for control of technical object and operating procedures. The program carries outa measurement of temperature once a second.

In Fig. 2 the front panel of developed program is shown. User is able to choose data acquisition device and number of physical channel on the front panel. Measurement information about temperature displays on the front panel in three scales: degree Celsius, Kelvin and Fahrenheit. Each second user can see both the current temperature value and the result of a previous temperature measurement, which are written in the table. Current date and time are shown on a corresponding indicator.

Fig.2. Frontpanel of the program

Program operation order can be represented by the algorithm shown in the Fig. 3.

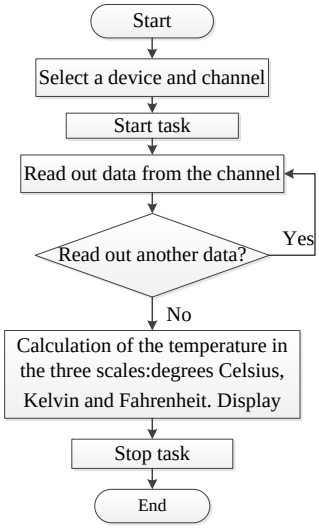

Fig.3. Programalgorithm

Basic virtual instruments (VI), used with the DAQ device for temperature measurements, are part of NI-DAQmx and are shown in Figure 4. «Create Virtual Channel» creates a virtual channel or a set of virtual channels. This subVIenable to determine the type channel, for example, analog input-output channels, digital input-output, counter for measuring temperature, voltage generation, etc. SubVI «Start Task» is responsible for transition task in working condition, and for start the measurement or generation. «Read» reads the data from virtual channels. «Stop Task» stops the task and returns it to the state before the launch.

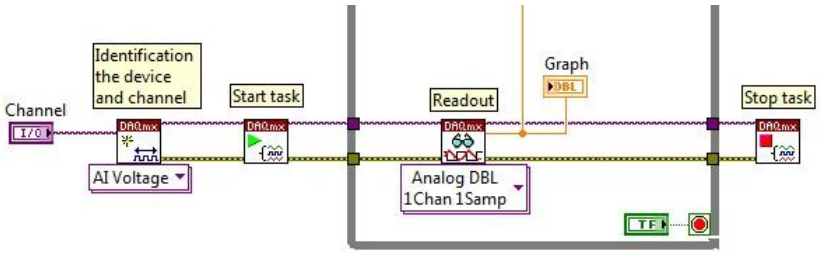

Fig.4. Temperature data reading from analog input channel with DAQ device

One of the basic program tasks is temperature calculation in different scales. Determination of temperature in degrees Celsiusis realized by formula (1). Formulas (2) and (3) should be used to take temperature in Kelvin and Fahrenheit.

$$T_1 = T + 273, \tag{2}$$

$$T_2 = 1.8 \cdot T + 32, \tag{3}$$

where T1 isantemperature valuein Kelvinand T2 is an temperature valuein Fahrenheit .

Figure 5 shows part of block diagram, which responsible for temperature calculation in three above-listed scales.

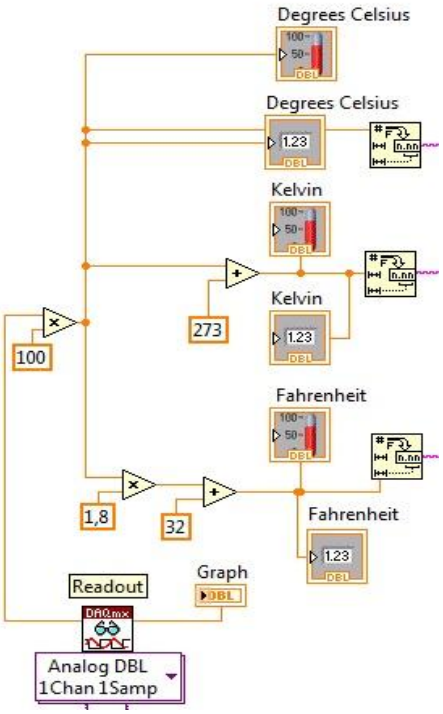

Fig.5. Temperature calculation in scales of Celsius, Kelvin and Fahrenheit

Virtual instruments «Get Date/Time In Seconds Function» and «Get Date/Time String Function» are used to acquire information about date and time (Fig. 6). It is significant to register time of measurement with a given accuracy because measurement is performed once a second. Initially date and time are shown at one indicator, but «Get Date/Time String Function» allows to divide them to two different fields.

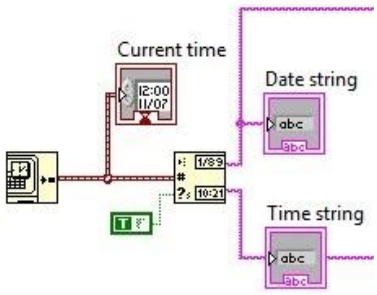

Fig.6. Recording current date and time

Conclusion

This paper presents the program developed for acquisition and processing the data, obtained from a temperature sensor. The program was designed in LabVIEW environment, which provides interaction between hardware and software with NI-DAQmxvirtual instruments support. Created program reads out the temperature valuesfrom sensor of the DAQ signal accessory, transmits themto the computer, process these data, and every second shows temperature values on the front panel in three measurement scales. Obtained results can be used as a base for sensor networknode software development. Further researches will be devoted to measurement data transmission to another computer by network protocols.

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