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Low Cost Remote Data Acquisition and Logging System Using Lab view

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Abstract

In any industry, process variables have to be transmitted in a suitable form, displayed in a remote location and have to be stored in a place to be analyzed later. An in-model data acquisition system has been developed that can accept inputs from various sensors and transfer the data wirelessly to the local control room and then the local computer will upload the data to the internet so that any remote computer can access the data as well as control it. In existing system, the use of long lengths of cable carrying low-level sensor signals that are extremely susceptible to induced noise. In addition, present methods of retrieving data require that multiple cables be routed across the balance, creating alternate load paths. Moreover, there is no facility for a remote user to monitor and control the process which makes the process inefficient in terms of cost, maintenance and security. In proposed system, the transfer of data from field to control room will be done wirelessly. So, there is no problem of cables. Moreover, Remote user has the facility to monitor and control the process through Internet/ Intranet. Thus, the system is more efficient in terms of cost, installation time, data security and simplicity.

Keywords: Data acquisition system, Embedded system, wireless communication, TCP/IP protocol, Xbee.

Introduction
Generally, the industries are spread in a very widespread area. Due to this, the processes are situated in faraway places from the local control room. So, a major

challenge is how to communicate the local control room and the process in the most efficient manner. The requirement is data should be secure, no data loss should be there, very less maintenance cost, and installation time should be less and most important is the cost effectiveness. At present, long cables are laid between the sensors which are situated in the field and the control room. This is a very inefficient method. The cost is not only high if the fibre cable would be lay between working station in the several tens of square kilometres, but also need to put into a lot of human and material resources with line maintenance and guard against theft. In the proposed scheme the remote wireless monitoring and control system is established. The method could solve problems with highly efficient and rapid, also could reduce the loss of country with effective, so it has the important significance and social and economic benefits for the dependability and the controllability of remote communication. By developing the desktop application, it is easier to monitoring all the activities of the industry. This includes the accessing the sensed data from the different types of sensors like motion sensors, gas sensor, chemical sensor and managing the databases of the same. Administrator manages all the data, and if any condition occurs, then he can control the entire thing remotely. The communication between the local control room and the field device takes place wirelessly[1].

A microcontroller is used to acquire data from the sensors which is there in the field or can be called as field device. The acquired data is subjected to analog to digital conversion in the microcontroller. Then the digital data will be transmitted serially to the local control room using the wireless module i.e. Xbee Pro. Now the process variables are the there with the local control room. The data can be logged in the computer for records and future analysis. Now, if the operator wants to change some set points or wants to perform any control action, he can send the data through the same Xbee as it is a transceiver module i.e. it can act both as a transmitter and a receiver module. The working software on the local control desk is National Instruments software Lab View. Now, the software will upload the data acquired to the internet. And through the internet, the remote user has the facility to access the data as well as control the process[2].

System Architecture

The overall system structure is shown in Fig.1. The first block presents the field device. The field device is placed in the field near the process. The field device function is to acquire the data from the sensors and send it wirelessly to the control room. The next block is of the local computer or the local control room inside the industry. It receives the data from the field device and display on the monitor. It performs the control action and uploads the data on the internet. The next is the remote computer which can access all the data through the internet as well as perform control action.

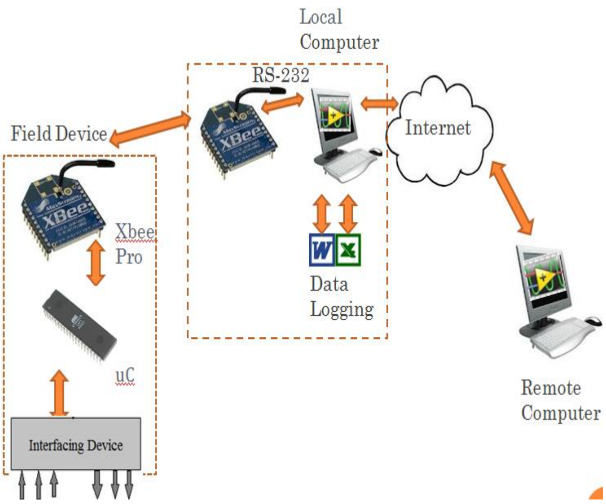

Figure 1: Overall System Structure

A. Field device

The field device consists of an interfacing circuit, a microcontroller and a Xbee module. The interfacing circuit is the interface between the sensor output and the ADC channel of the microcontroller. The analog to digital converter (ADC) in the microcontroller can accept only voltage signals between (0-5) volts. So, it is important to employ this circuit because different sensors have different type of outputs. Some sensors have a voltage output with a very small range and some have greater range. So, voltage divider circuit needs to be employed so that the output of the sensor is converted in the range (0-5) volts. Even some sensors have current output, so for that I-V converters need to be employed. After this the digital signal will be transmitted to the control room serially using USART through the Xbee.

B. Local Control Room / Local Computer

The local control room is situated inside the industry. It consists of a Xbee module and a computer installed with Lab VIEW Software. The computer receives the data wirelessly through Xbee. Now, using the TCP/IP protocol it will upload all the data to the internet. It will have the data server VI running in the PC. The data will be logged in Microsoft Word/ Excel using Lab VIEW. The data can be viewed in the monitor and appropriate control action can be taken according to the requirement.

C. Remote user

The remote user is situated outside the industry anywhere around the globe. In the remote user's computer the data server VI will be running. The remote user will be provided with the IP address and the port number of the local computer. Unless the remote user has the correct IP address and port number, the data cannot be accessed. In this way data security is provided for the remote user.

Hardware Used

A. AVR Microcontroller

The microcontroller is one of the most important device in the system. It is also called as AXON Controller having 100 pins in it .The unique feature of this controller like: 86 Programmable I/O Lines , 256K Bytes of In-System Self-Programmable Flash, Extensive On-chip Debug Support, Four 16-bit Timer/Counter with Separate Prescaler, Compare- and Capture Mode, Real Time Counter with Separate Oscillator, 16-channel, Twelve PWM Channels with Programmable Resolution from 2 to 16 Bits, 10-bit ADC, Four Programmable Serial USART has made it very special and more applicable than other controllers[4].

B. XBee-PRO OEM RF Modules

The XBee-PRO OEM RF Modules were engineered to meet IEEE 802.15.4 standards and support the unique needs of low-cost, low-power wireless sensor networks. The modules require minimal power and provide reliable delivery of data between devices. The modules operate within the ISM 2.4 GHz frequency band and are pin-for-pin compatible with each other. The Xbee can be used in two ways : either using USART or directly using the I/O pins of Xbee. This system uses USART method which is Universal Synchronus /Asynchronus receiver and transmitter. The data flow of USART is shown in Fig. 2.

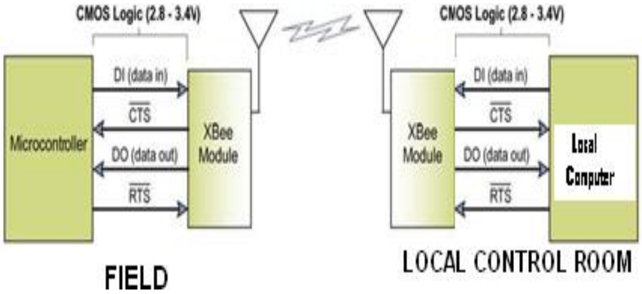

Figure 2: USART Data Flow

Software Used

C. Labview 10.0

Lab view (Laboratory Virtual Instrumentation Engineering Workbench) is a system design platform and development environment for a visual programming language from National Instruments. Lab VIEW is commonly used for data acquisition, instrument control, and industrial automation on a variety of platforms including Microsoft Windows. Lab VIEW ties the creation of user interfaces (called front panels) into the development cycle. Lab VIEW programs/subroutines are called virtual instruments (VIs). Each VI has three components: a block diagram, a front panel and a connector panel. The last is used to represent the VI in the block diagrams of other, calling VIs. Controls and indicators on the front panel allow an operator to input data into or extract data from a running virtual instrument. In our application, Lab VIEW has to be installed in the local computer as well as the remote computer.

D. Embedded C

Embedded C is a set of language extensions for the C Programming language by the C Standards committee to address commonality issues that exist between C extensions for different embedded systems. Historically, embedded C programming requires nonstandard extensions to the C language in order to support exotic features such as fixed-point arithmetic, multiple distinct memory banks, and basic I/O operations. Here, we are using AVR-Studio to write the embedded C code[3].

Communication Protocol

The Internet protocol suite is the set of communications protocols used for the Internet and other similar networks. It is commonly known as TCP/IP, because of its most important protocols: Transmission Control Protocol (TCP) and Internet Protocol (IP), which were the first networking protocols defined in this standard. The Remote user must know the IP Address and the port number of the local computer to access the data and control the process. The data flow of TCP/IP is shown in Fig. 3.

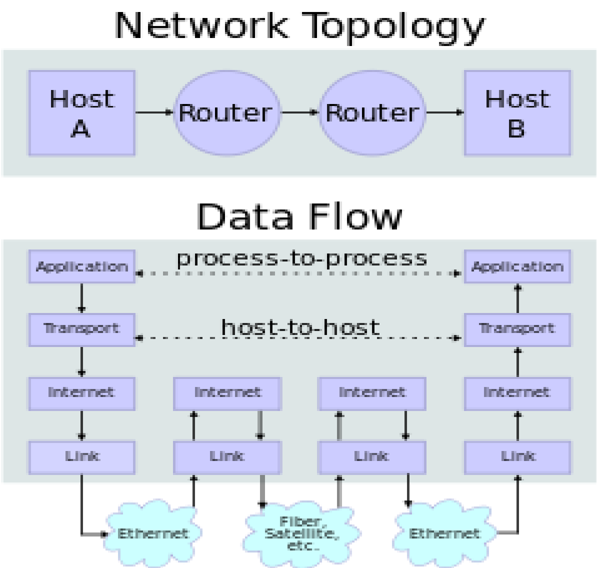

Figure 3: Data flow of TCP/IP

System Implementation

A. Algorithm

The algorithm mainly consists of two parts: one is the channel selection of ADC i.e. the particular pin number to be accessed in the microcontroller for the corresponding process variable. The next algorithm is of the control action to be taken in LabVIEW as per requirement.

1) Channel Selection:

At first, the operator in the control room will select the process variable which he wants to monitor. All the process variables are saved as alphabets starting from 'A'. Then, according to selection the particular alphabet will be sent from the local computer to the Microcontroller using USART. For example: B. Then, the Microcontroller will manipulate its ASCII code to generate a number. The difference between the ASCII code of the sent alphabet and 65(Starting ASCII value of capital alphabets) is found out.

For example: 66 (ASCII of B)- 65(Starting ASCII value of capital alphabets) = 1

This number is used to access the row of pre-defined 2-D array which contains the corresponding ADC channel number to be accessed. Then, the ADC conversion of the appropriate channel is done. The converted digital data is sent to the local computer in form of 4 byte packet using USART. Then, the operator can monitor the desired process variable.

2) Control Action:

When the acquisition starts, a dialog box appears in LabVIEW to enquire whether the user wants to just acquire the data or take control action also. If the user enters the option to just acquire the data, the normal operation of channel selection goes on and the required data is monitored. On the other hand, if the user wants to perform the control action also, then the user is asked to enter the set point of the process variable which needs to be controlled. Then, the current value of the process variable is compared with the set point. If there is no difference, normal operation goes on but if there is a difference, the difference is found out. Then, a $ symbol is sent to the microcontroller along with two digits, for example: $10. The symbol $ means that control action needs to be taken. The first digit denotes the output channel number which needs to be controlled. The second digit denotes the state of the controller whether it needs to be switched ON or OFF. If it is 1, the controller output should be low and if its 0 the output should be vice versa.

B. System diagram

1) VISA Palette

The VISA palette is used to set up serial communication between the microcontroller and the local computer. The main functions used from this palette are VISA configures serial port, VISA Read and VISA Write. VISA configure serial port is used to set the value of parameters like Baud Rate, Packet

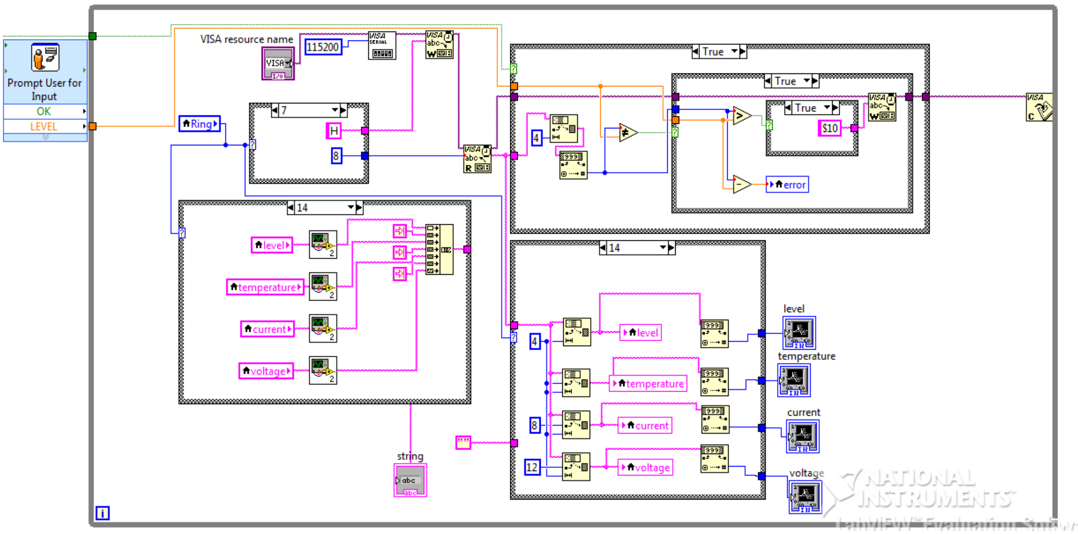

Figure 4: Channel selection and Control Action Block Diagram

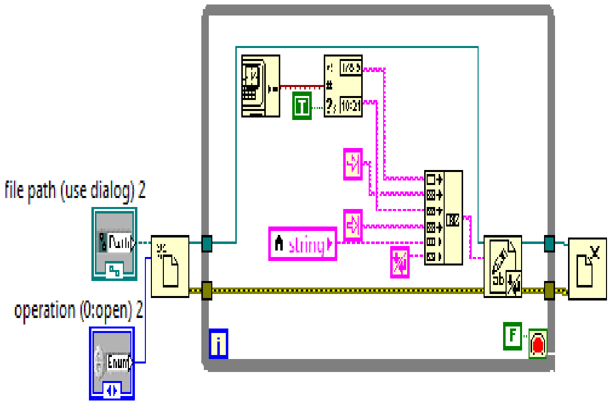

Figure 5: Data logging Block Diagram

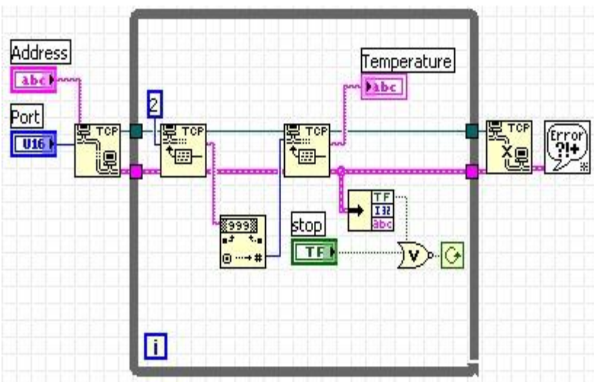

Figure 6: Data Server TCP/IP

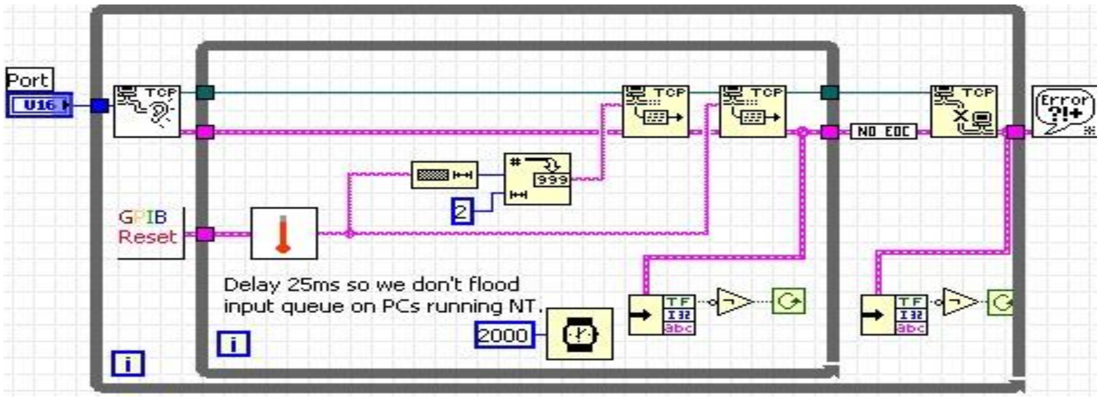

Figure 7: Data Client TCP/IP

Size, Start and Stop Bits, Parity bits. VISA Read is used to read the data sent by the microcontroller whereas VISA Write is used to transmit the data to the microcontroller. The block diagram of VISA can be referred in Fig. 4.

2) Data Logging

The data logging Block Diagram can be seen in Fig.5. The data acquired along with the time stamp in stored in an excel or word file in a tabular form. It is done so that in future if any problem comes the previous data can be seen. The file name has to be specified where the user wants to save the data.

3) TCP/ IP

After the data has been reached to the local computer, it has to be uploaded to the Internet so that the Remote User can access the data and perform the control action. In the Local computer, Data Server.vi needs to be executed and in the Remote computer, the Client.VI needs to be executed. In this two things are required by the Remote computer. They are Port number and IP address of the local computer. When these two information are there with the Remote computer, then only it can access the data of the local computer. In this way, the data is secured even when it is there in the internet. The Block diagram for Data Server can be referred to in Fig.6 and the block diagram of Data Client can be referred to in Fig.7.

Simulation

Fig.8 shows the various process variables response with time and amplitude. The level and temperature of a tank are taken. And the other two variables are kept constant i.e. they are given 5 volts supply. So, it can be seen that how the process parameters of the tank are varying and the channels which are provided with constant supply are constant. There is no error and disturbance in the response.

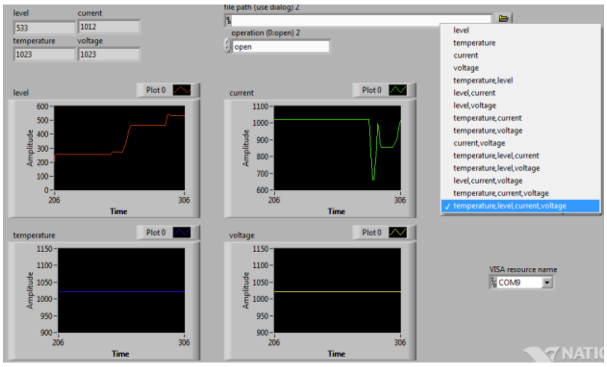

Figure 8: Response of different Parameters

Conclusion

This system is able to acquire data accurately and with a sampling frequency of around 8 KHz. The data is transmitted from the field device to the local computer wirelessly through Xbee. The operator is able to take control action according to its choice. The local system can do data logging with time-stamp. The local computer room is able to upload the data to the Internet through the TCP/IP Protocol. The Remote User can successfully access the data from the local computer through Internet. The Remote user is able to control the process successfully. This system can be implemented with 32 bit microcontrollers like ARM so that the sampling frequency can be increased.

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