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Microcontroller Based Multichannel Data Acquisition System using LabVIEW

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Abstract*: *Microcontroller based Multichannel Data acquisition system (DAS) using LabVIEW is presented. This system is facilitated by using the built-in 10-bit ADCs and digital I/Os of the microcontroller. In a typical setup for analogue voltage measurement, under program control, this system keeps on monitoring the voltage on analogue inputs and makes the digital equivalent and transfer to PC through USB port. It also allows to read digital inputs and to write digital outputs under program control by PC. The controlling program on PC was developed by LabVIEW which is used to read this input at pre-decided time intervals. The controlling program reads these values and process accordingly. Microcontroller programs are also developed and tested successfully. The DAS was successfully used to monitor analog voltage during the laboratory experiments. It is also used for reading data from a temperature sensor. The results reveal that the DAS is suitable and easy method for real time data acquisition. It is expected that this developed system may contribute in the field of automation.

Index Terms*: *Data Acquisition system (DAS), LabVIEW, Microcontroller, PC.

I. INTRODUCTION

The rapid development in the field of embedded technology demands a data acquisition system (DAS), which is fast in processing speed, small in size, low in cost and monitors the data in real time basis. Microcontroller as a processor has become popular because of its speed, energy efficiency, low cost and low weight [1]–[3]. It offers a broad use in DAS. A variety of DAS has been reported [4]–[8], where DAS is extensively employed in a number of automatic test and measuring equipments [4]–[6]. They are used to collect the required data from any peripheral input devices, such as meters, sensors and etc. via controlling program [9]. The measured data could be stored in the PC in a file for further processing if needed. The measured data can be shown numerically or graphically as a curve on the screen.

A typical DAS has a primary control and data processor, memory and a clock for time stamping the acquired data. A number of sensor attachments depending on the applications are also necessary. As most of the internal processors are digital in nature, hence the analog signals are often converted to digital format before being used for processing. For analysis, display and recording, the processor is further connected with computer or laptops. The complexity of a DAS system tends to increase with the increase in the number of physical properties to be measured, resolution of ADC and accuracy and speed of the measurement required.

In this work, the design and development of a Virtual USB based DAS system using PIC18F2550 and ATmega8 has been presented. PIC18F2550 is suitable for using as a virtual USB interfacing [10], whereas AVR microcontroller Atmega8 is employed for data acquisition. The ATmega8 has 16K bytes of Flash Program, 512 bytes EEPROM and 1K byte SRAM, three Timer/Counters, Internal and External Interrupts and many more additional resources [11]. Atmega8 supports 6 input analogue channels for ADC with 10-bit resolution. The data acquisition system presented makes use of six analogue inputs (AI) which are used for sensing the analog voltage and eight digital inputs /outputs (DI/DO) which are used for collecting or providing digital control signals. The USB based interface with computer is most favorable because of its high data transmission rate and ease of connectivity with computer. LabVIEW is employed to develop the application software which offers more flexibility during the process of data acquisition [12]. Hence, the designed USB based multi-channel DAS system using LabVIEW can give a high computational performance at an economical price.

II. METHODOLOGY

A. Hardware Design

The block diagram of the proposed DAS is shown in the Figure 1. The details of the hardware, the firmware and the software parts for the real time monitoring DAS are described. Figure 2 shows the circuit diagram of the designed DAS, where PIC18F2550 acts as a virtual USB interfacing. The data acquisition Module has been developed using ATmega8 which is a mid-range 28 Pin, high-Performance, and Enhanced Flash Microcontrollers with 10-Bit ADC. The circuit is powered from the PC through USB cable. The ATmega8 has 6 channels built-in ADC with 10-bit resolution. The analog signals required to monitor is applied

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to the ADC input. As the ADC is of 10-bit resolution so it will read the signal in 1024 steps. The reference voltage applied to the ADC is 5 V, hence it has an accuracy of 4.88mV.

The microcontroller based data acquisition unit has six analogue inputs to keep on sampling analogue voltage and eight digital inputs/outputs to read and write digital data. Port selection is made by Control Program. The acquired data is sent to PC through USB interface in Virtual mode (USB to Serial UART). The microcontroller based data acquisition system is constructed on a developed PCB board (Design by Proteus Software) fitted with minimum required system; IC bases, crystal etc. and ISP port for in system programming. The circuit was carefully constructed using necessary decoupling and taking care of stray pickups.

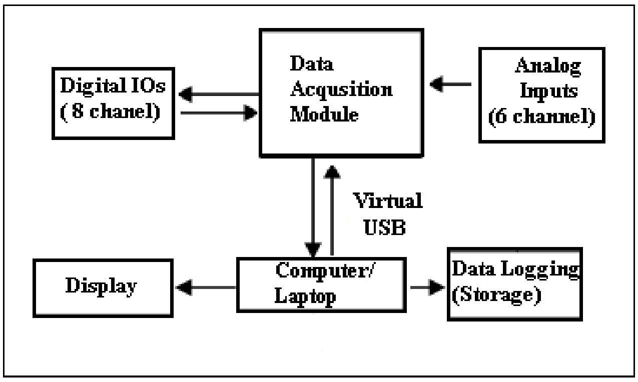

Figure 1: Block diagram of the designed Data Acquisition System

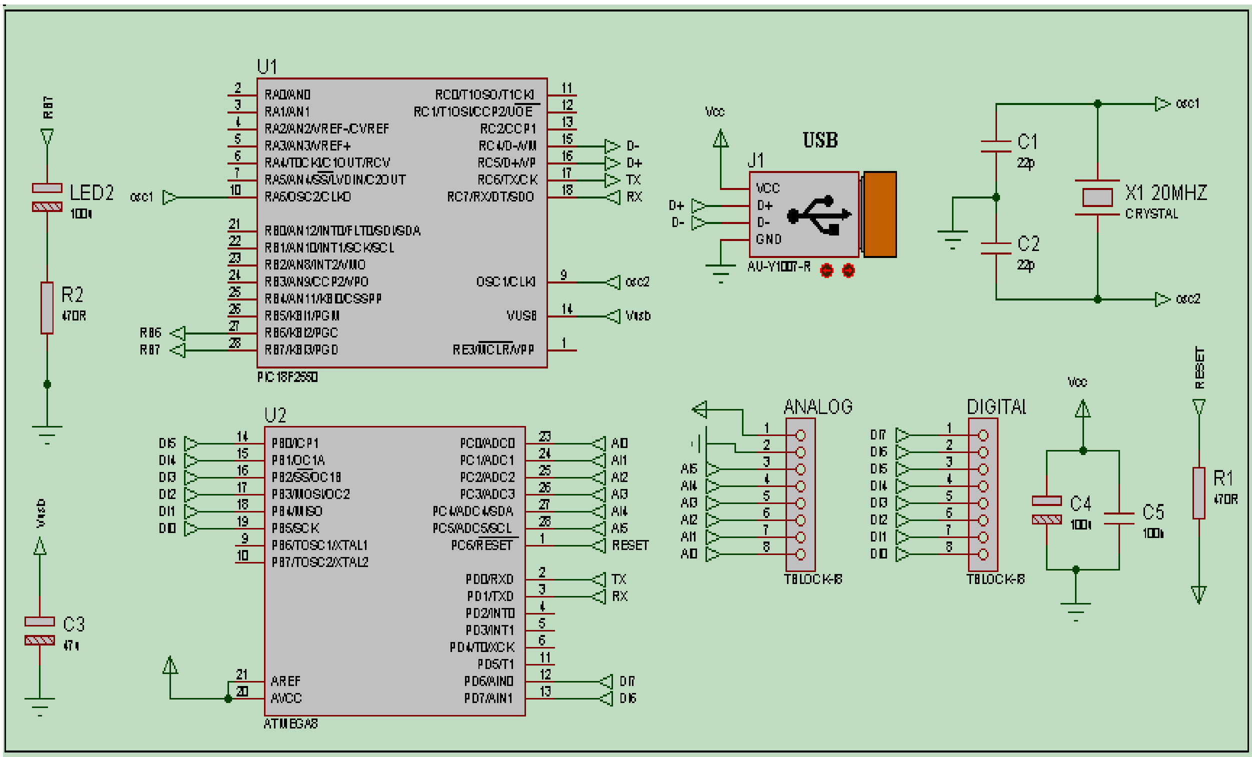

Figure 2: Circuit diagram of the designed USB Data Acquisition Module

This microcontroller hex code is then downloaded in to the microcontroller using a programmer, we used a USB based ISP programmer for AVR from Extreme Electronics. The programmer is easy to use however have few tricky things to be implemented in order to make it work. After downloading the program into the microcontroller, it starts running, at times, logical flaws remain and the program needs revision and necessary corrections. It took several repetitions to make it run the way it was expected to. Once the hex code is downloaded to the microcontroller, it functions independently and when connected to the computer, allows for the data transfer via USB port using appropriate controlling program.

B. Firmware Design

The data is transmitted to the PC using a USB to serial UART interfacing IC (PIC18F2550). The interface to the PC is thus USB and on the PC side, the IC PIC18F2550 emulates a virtual serial port. The firmware for PIC18F2550 and interfacing driver is also developed by modifying the original codes from Microchip which is compatible in Windows XP, Windows Vista and Windows 7 at 32-bit platform. On the DAS side the data is transferred to the serial UART.

Therefore, on the DAS side the communication is through the UART of the microcontroller. This facilitates the advantage of USB portability and eliminates the need to write complex code for USB communication as the communication code is to be written only for UART. To implement data acquisition and control a program is written in Basic by BASCOM-AVR from MCS Electronics for Microcontroller ATmega8. The program is debugged and assembled. The BASCOM-AVR on assembling the program generates a hex file containing the microcontroller code. The flow chart of the developed program is shown in figure 3. The UART baud rate has been set at 9600 to maximize the data transfer rate. The communication through UART is asynchronous. The PC application program initiates the data acquisition system. The PC requests the DAS for data by sending command characters through the UART. On receiving the command characters by the DAS, it does the work accordingly. In this DAS system, we have developed the code for 4 channel analog input as well as 8 Digital IO.

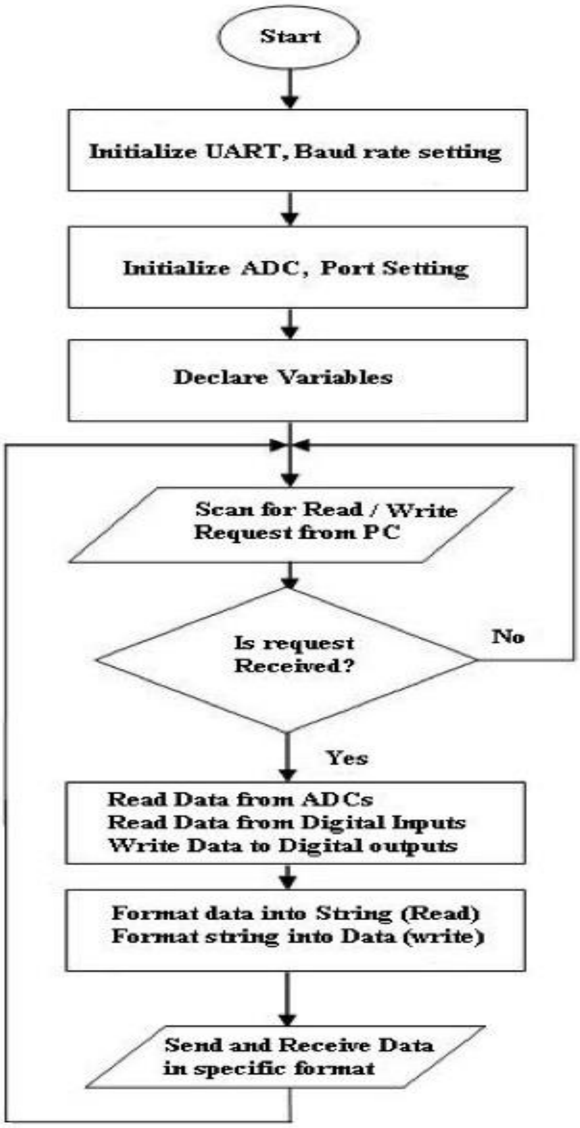

Figure 3: The flow chart of the microcontroller program of developed DAS

C.Application Program Design

A PC application program is developed in LabVIEW for proper acquisition of the data, real-time graphical display and storing the acquired data into a file. The Application program accesses the USB device as a Virtual COM port device of the PC [13]. The application program is developed to acquire data for a user settable time duration. As the program is started, it sends the command characters the DAS. The DAS then sends the data string to the PC or write to DAS digital port according to the instruction. For the received data string, the application program then performs an error checking by error checking methodology which has been developed. First the string is checked for its length. If the length is found correct and no error is found, the data string is declared valid and processed to extract the analog and digital data. The analog and digital data is displayed and also stored in a file on hard drive of PC. Figure 4 shows the developed DAS application software for user interface. It has the functions of port selection, analog input, digital output and digital input. Depending on the data acquisition modes, these functions can be used.

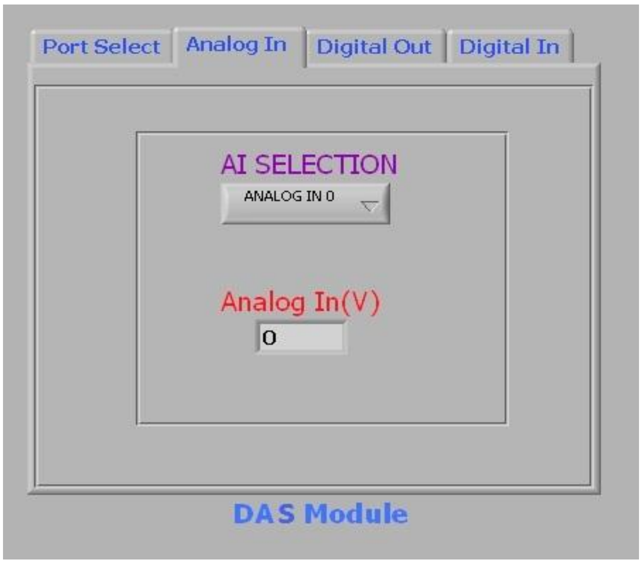

Figure 4. DAS application software for user interface.

D.Experimental setup

Figure 5 (a) and (b) show the experimental setup and its schematic diagram, respectively. In this setup, DAS is interfaced to PC via a USB cable. A potentiometer (POT) is connected to the analog input channel 1 (AI1) of DAS for the measurement of variable analog input voltage (0- 5 V) set by the POT. A digital multimeter is used to measure the set voltage by POT. For checking the control from the PC, a LED with a resistance is connected to digital output pin 0 (DO0). Furthermore, a common temperature sensor (LM35) is employed to analog input channel 0 (AI0) to build a PC based thermometer. The thermometer is examined at room temperature as well as increased temperature, respectively. For increasing the temperature, LM35 is heated by a hot soldering iron.

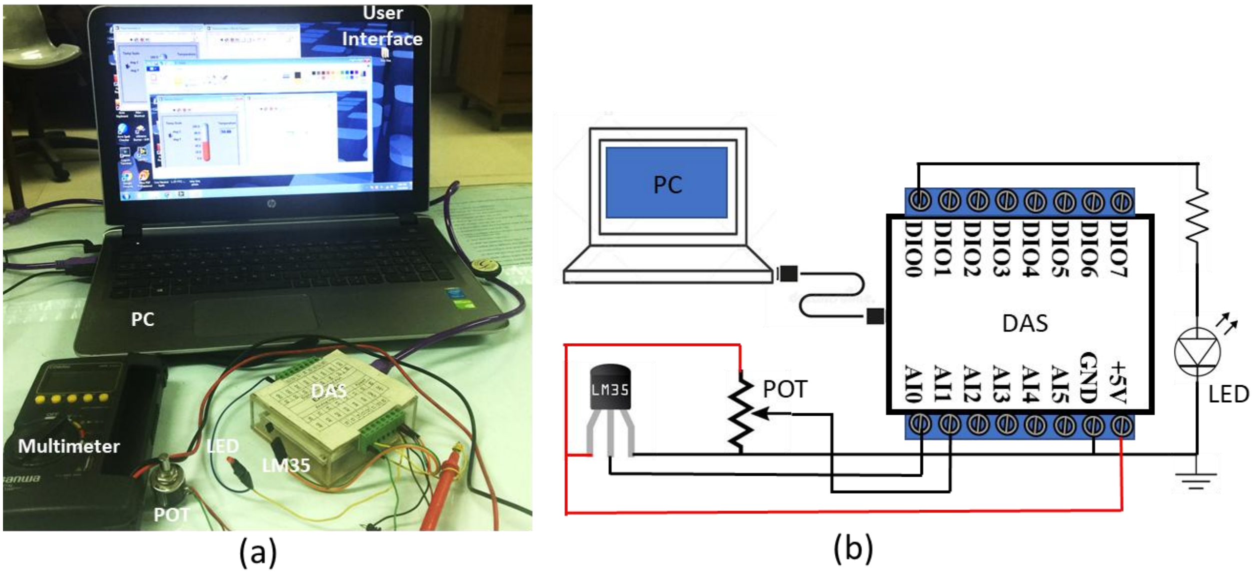

Figure 5. (a) Experimental setup and (b) its schematic diagram

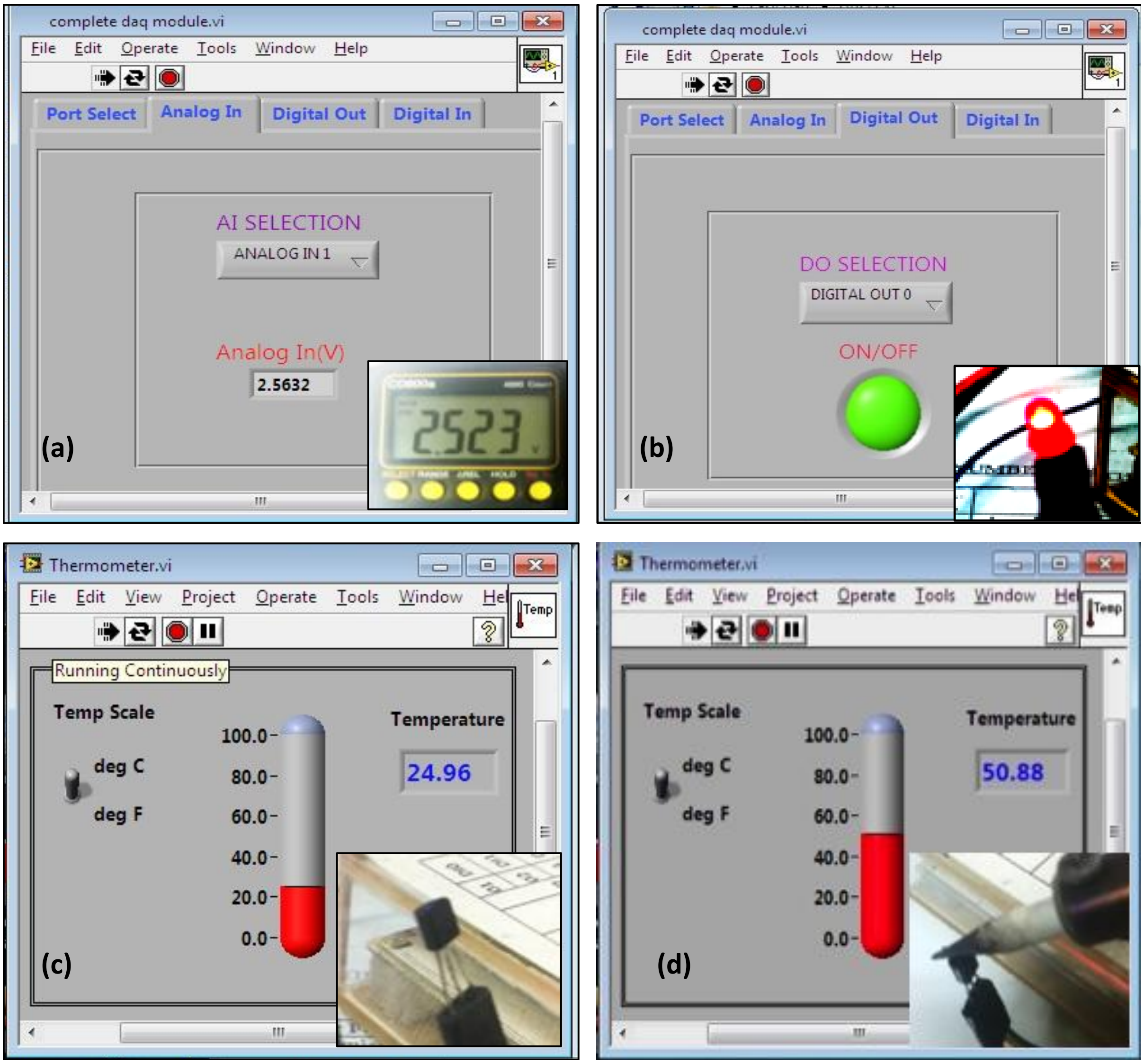

Figure 6. Various investigations by DAS (a) measurement of analog input voltage, (b) control of digital output, (c) measurement of temperature from sensor LM35 at room temperature, and (d) measurement of temperature after heated the sensor LM35 by a hot soldering iron.

III. RESULTS AND DISCUSSION

A laboratory level prototype of DAS was fabricated and tested under various conditions. Figure 6(a) shows the PC based measurement of analog voltage supplied from a potentiometer. A voltage of about 2.5 V was set by the potentiometer and applied to the DAS at channel AI0. DAS acquired the voltage and sent to the PC through USB. The application software showed the voltage of 2.5632 V in front panel, which was verified by a digital multimeter of 2.523 V (inset of figure 6(a)). This result reveal that the measured analog voltage is nearly same to the set value. It is supposed that the minimal difference of 0.040 V may be happened due to the tolerance of mathematical functions during conversion by ADC. Similarly, all other analog input channels were also examined and found satisfactory results. Furthermore, from the PC, a control signal can be sent to any electronic device via the digital outputs (DO) of DAS. Figure 6(b) presents a ON/OFF button in the application software of DAS. When the button was pressed to ON, a LED connected to DO0 became glow. This indicates PC based switching control of electronic device, which can play important role in the automation system.

Using the DAS, a PC based thermometer was developed to monitor the real time temperature from the sensor. Figure 6(c) shows the front panel of the thermometer, where the measured room temperature obtained from the sensor LM35 was about 25 ^{0}C. The thermometer has the facility to convert ^{0}C to ^{0}F as well as to display the temperature in numerically and graphically, which offers the system more versatile. Later, the sensor LM35 was heated by a hot soldering iron. Accordingly, the temperature increased to 50.88 ^{0}C as shown in figure 6(d). All these results confirm that the developed multichannel DAS is suitable for real time data acquisition and control to the analog system.

IV. CONCLUSION

In this paper, a general purpose low cost AVR microcontroller based data acquisition system (DAS) has been presented. Details of circuit design and construction of DAS are discussed. It has six analogue input channels, eight digital input, and eight output control signals from computer. The results of testing of the DAS are also demonstrated. The performance of the data acquisition system was found satisfactory during experiments. The developed DAS is flexible in design and it provides continuous measurements of several signals under program control. It is supposed that this DAS can contribute in the field of areas, where measurement, monitoring, and storing are important.

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REFERENCES

1. Z. Salem, I. A. Kamal, and A. A. Bashar "A Novel Design of an Industrial Data Acquisition System", Proc. of Int. Conf. on Inf. And Comm. Tech, ICTTA 2006: 2589.
2. R. Posada-Gomez, J. J. Enriquez-Rodriguez, Ding, G. Alor-Hernandez, and A. Martinez-Sibaja, "USB bulk transfers between a PC and PIC microcontroller for embedded applications", Proceedings of the Electronics, Robotics and Automotive Mechanics Conference (CERMA'08), 2008.
3. B. Nkom, and H. Musa, "Development of a Novel Microcontroller based data logger", 2nd International Conference on Adaptive Science & Technology, (ICAST 2009), 2009.
4. H. Shaikh Yusuf, A. R. Khan, and S. H. Behere, AVR Microcontroller Based Data Acquisition System for Laboratory Experiments, Advances in Applied Science Research, Vol 3 (1), pp. 208-215, 2012.
5. A. Bora, and K. C. Sarma, "Design of a USB based Multichannel, Low Cost Data Acquisition System using PIC Microcontroller", International Journal of Computer Applications, Vol 59(6), pp 5-8, (December 2012).
6. P. Asimakopoulos, G. Kaltsas and A. G. Nassiopoulou, 'A microcontroller- based interface circuit for data acquisition and control of a micromechanical thermal flow sensor' Journal of Physics: Conference Series, 10 (2005) 301.
7. N. Monoranjan Singh, and K. C. Sarma, "Low cost PC based real time data logging system using PCs parallel port for slowly varying signals", Journal of Assam Science Society, Vol 50 (1-2), pp 36-41 (Dec 2009).
8. N. Monoranjan Singh, K. C. Sarma, "Design of PIC 12F675 microcontroller based data acquisition system for slowly varying signals", J. of Instrum. Soc. of India, Vol 40 (1), pp 15-17 (March 2010).
9. A. Sagahyroon, T. Al-khudairi, "FPGA Based Acquisition of Sensor Data" Proc. of Int. Conf. on Ind. Tech., ICIT 2004 :1398.
10. PIC18F2550 Datasheet, available at *www.microchip.com*
11. ATmega8 Datasheet, available at *www.microchip.com*
12. Bruce Mihura, LabVIEW for Data Acquisition, 1st Edition, Prentice Hall, 2001.
13. Jan Louise Axelson, Serial Port Complete: Programming and Circuits for RS-232 and RS-485 Links and Networks with Disk, Lakeview Research, 1999.

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