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DEVELOPMENT OF A MICROCONTROLLER BASED DATA ACQUISITION SYSTEM TO CAPTURE ANALOG SIGNALS

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Abstract- *A data acquisition system receives analog signals from the real world physical conditions and converts them into digital numeric values to be manipulated by an interfacing device. The purpose of this paper is to present the development of a microcontroller based data acquisition system that measures the physical parameters with good precision. The proposed design is capable of measuring analog signals simultaneously from several channels. It is more compact and user-friendly than other existing data acquisition systems. The potential benefit of this development is the low fabrication cost for a stand-alone system. As a part of demonstration, temperature is measured with the developed data acquisition system using different types of sensors and transducers. However, it is also possible to measure other physical parameters such as pressure, humidity, force etc.*

Keywords: Data acquisition system, Analog signals, Microcontroller, Sensors.

1. INTRODUCTION

Data acquisition begins with the physical property to be measured. Examples of this include temperature, light intensity, gas pressure, fluid flow, and force **[1,2]**. Regardless of the type of physical property to be measured, the physical state that is to be measured must first be transformed into a unified form that can be sampled by a data acquisition system. The task of performing such transformations falls on devices called ***sensors***. A sensor, which is a type of transducer, is a device that converts a physical property into a corresponding electrical signal or, in many cases, into a corresponding electrical characteristic that can easily be converted to an electrical signal. It is usually complicated to have constant measuring, recording & storing results of these parameters using the traditional measuring apparatus like meter **[3]**. Hence a system is designed to have a constant monitoring & storing data in the computer easily. Using data acquisition system anybody can easily measure temperature of a medium e.g reservoir, fluid in pipe line, machine inside temperature etc and storing data that may be needed to analyze the system in future. It is more user friendly than other temperature measuring device such as digital thermometer. In case of digital thermometer its need to change position of thermocouple probe to measure temperature at various point of a medium whereas in data acquisition system there have several channel which can capable to read data at various point of a medium at the same instant. Therefore it removes complexity of work. In data acquisition system there is a retting of pulse in saving data. So this system helps to do work if needs much data for calculation, plot graph, simulation etc. digital systems are used widely because complex circuits are low cost, accurate, and relatively simple to implement. Data acquisition system is used in many different industries today in order to achieve greater productivity and monitoring the physical condition of equipment, process related to production in our modern industrial societies. Industries that presently employ such automatic systems include steel making, food processing, paper production, oil refining, chemical manufacturing, textile production, cement manufacturing, testing, calibration process and others.

In this project, a microcontroller based data acquisition system device is fabricated to capture the analog signals for any physical parameter. As a part of demonstration, temperature is sensed by the sensors and signal is conditioned in suitable format. The signal is then converted into digital signal and finally transferred to the personal computer so as to achieve monitoring and the data can stored for analyzing in future **[4]**. The system proposed in this dissertation is based on sensor technology & microcontroller 16F877A. A sensitive real time monitoring can be achieved by this system hence performance characteristics and physical condition of the system can analyze. The output of microcontroller is given to IC (MAX232) then to personal computer. This receiver interface with personal computer which will display real time results and these can also be stored &

retrieved for future references and can also be used for the comparison purposes in the form of graphs, charts and tables by processing it using personal computers. In addition, there is rapid growth in the use of microcomputers to perform difficult digital control and measurement functions.

2. DESIGN AND FABRICATION

Design is defined in which gives a proper outline about any system or process. Here also show a design of DAQ which explain by topics and diagram as given bellow:

2.1 Components Description

The components which used in Data Acquisition system are voltage regulator, resistor, capacitor, crystal, microcontroller, Max -232, Breadboard, Diode, adaptor, USB to serial port(RS-232), Temperature sensor (LM-35), connecting wire. The voltage regulator 7805 virtually immune to damage from output overloads and it can sustain maximum 35-40V and typically 1-1.5A **[5]**. Resistor is used to develop the voltage where Capacitor is like a battery that store electrical energy. Crystal is used to give oscillation **[5]**. For converting analog signal into digital signal microcontroller is used. There is integrated circuit that is used to converts signals from RS-232 serial port to signals suitable for use in TTL compatible digital logic circuits. Breadboard refers to solder less that is reusable and make it easy to use for creating temporary prototypes and experimenting with circuit design and a Diode is a two-terminal electronic component with asymmetric transfer characteristic **[5]**, with low resistance to current flow in one direction, and high resistance in the other. It is used to safe the microcontroller.

AC adapter are used with electrical device that required powered but do not contain internal components to drive the required voltage and power from main powers. There is an interfacing device called IC **MAX232** that is used for sending/receiving data to microcontroller from RS 232 serial port to a personal computer (PC) **[6]**. For connection in circuit connecting wire is used. LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature **[7]**. The characteristics of the sensor (LM 35) is given in the **table 1**. Output sensors are voltage form (0-5 Voltage loops) and they require conditioned circuits. These current loops are standard in the process control industry.

Table1: Sensors Characteristics [8]

Characteristics	Temperature
Range	-55°C to +150°C
Accuracy	± 4°C at room temperature ±8°C at over a range of 0°C to 100°C
Output	0 to 5 Voltage loop
Voltage Supply	12 Volt
Scale Factor	0.01V/°C

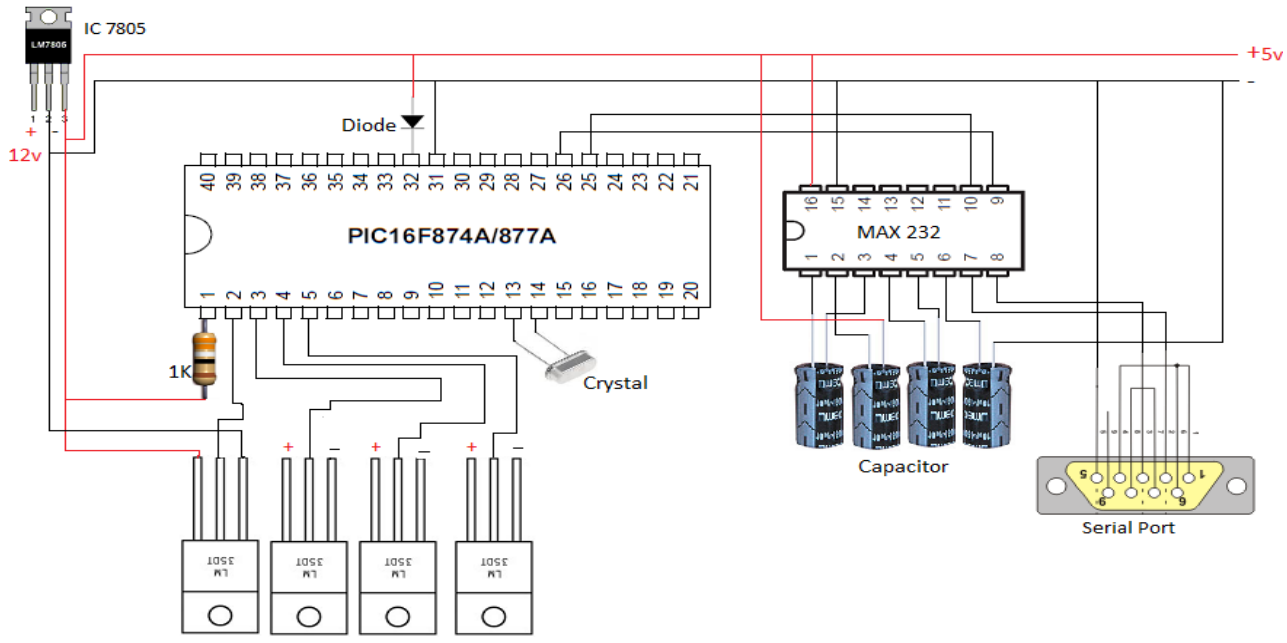

Fig. 1: Circuit Diagram

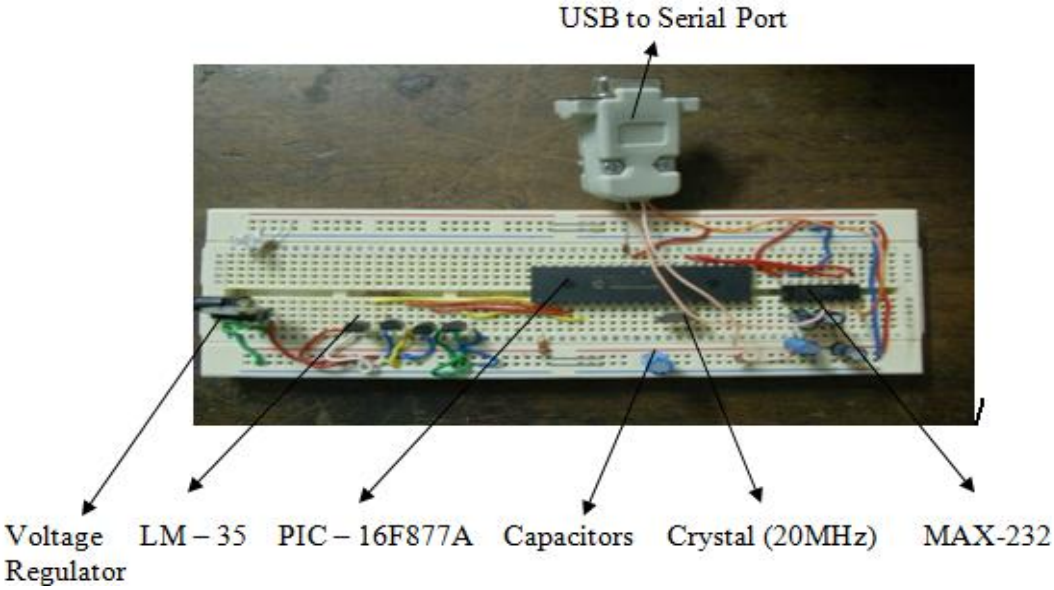

Fig. 2: Snap and Lay out of diagram

2.2 Construction

In **figure 1**, at first output of the voltage regulator (7805) is connected to the supply voltage pin that is 32 number pin with the help of Diode to protect the microcontroller. Then a resistance of 1k is connected to MCLR port to reset the running program for beginning as a new program if needed. There are four temperature sensor (LM-35) whose output pin (middle pin) are connected to the four analog pin 2, 3, 4, 5 respectively as shown in circuit diagram, positive pin are connected to the output positive terminal of the voltage regulator and rest of the pin(negative pin) are connected to ground. A 20 MHz crystal is connected to the 13 and 14 pin whose 13 pin indicate the input and 14 pin indicate the output in order to give oscillation. The output pin 25 and 26 of 16F877A are connected to the input pin 9 and 10 respectively of the MAX-232.There are four capacitor (10 micro farad) connected to the MAX - 232 which is shown in our diagram. Voltage is supplied at 16 pin and 15 pin is grounded of MAX – 232. The pin number of 7 and 8 are connected to the 2 and 3 of female port for serial connection respectively. The serial ports are grounded port 5. **Figure 2** represents the snap and lay out of the project work.

2.3 Working Principle

Voltage is supplied to the network diagram and an input is given to the sensors. The signals are received by the microcontroller as a voltage which is converted into digital form with the help of program installed in microcontroller as a result displayed the output in temperature (°C). Output is supplied to MAX – 232 and finally showing output in computer display with the help of serial connection to the computer and software 'TERMITE' saves the data in the computer as a notepad file in the computer.

3 MICROCONTROLLER PROGRAM DESCRIPTION

In this fabrication, **Mikro C** is used as a programming language. In this program sensors (LM-35) read input as a voltage where port A act as a input by which data is read Then the voltage is converted into temperature by ADC and delay time is 100ms. That means program will stop after 100ms. The formula is used to convert voltage into temperature is given below:

Value= 0.0196078431372549*temp_res*20;

The value shows as a text in the display. For example, sensors one=20.39215 °C. Similar process is applied for each and every sensors.

4 INTERFACING AND DATA IMPORT

4.1 Installation

DAQ hardware needs two different type of software. First one is driver software for serial port which links the hardware with the computer and the second one is "Termite" to receive desired data from the DAQ hardware and save the data into a desired file as a text document. The software is provided in a disk. At first install 'Serial Driver' then software is compatible for windows XP. If it is used in windows 7 change the compatibility to windows XP (Service Pack 2). After installing driver software connect the USB port of the serial cable to the computer and wait until the pc recognizes it. Then go to device manager option under the properties of 'My Computer' and find out the COM port in which device is connected as shown in Fig. 3. Then install the DAQ software termite.

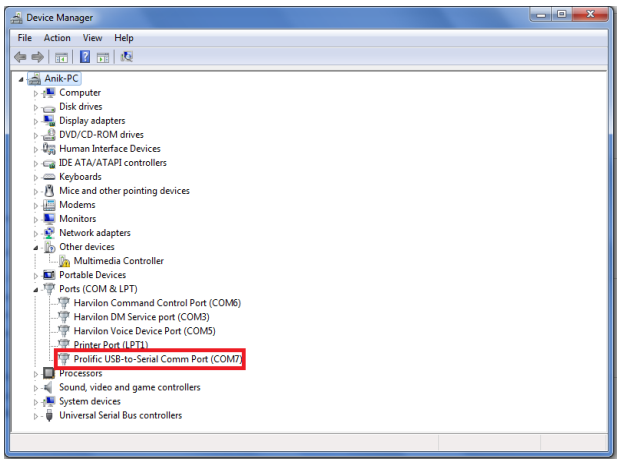

Fig. 3: Snap of the device manager

4.2 Use of Termite

The program then run after installation and following window will show as Fig. 4.

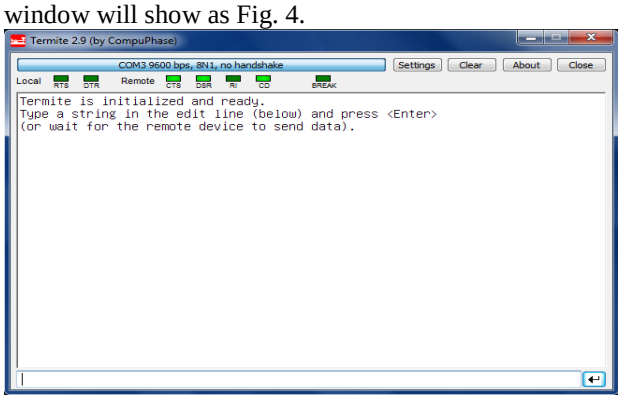

Fig. 4: Snap of TERMITE

For configure COM port click on settings tab. Then in the settings option of the Termite do the following changes according to the Fig. 5. The baud rate must be set to 9600.

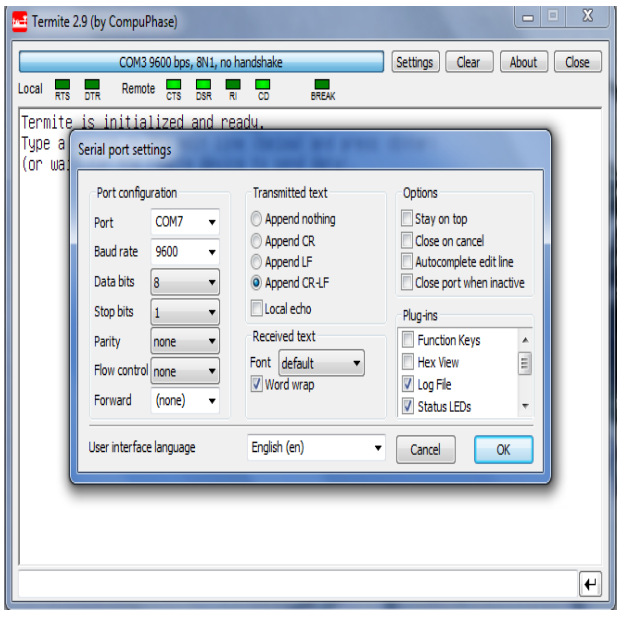

Fig. 5: Serial Port Settings

Save the data check on the Log File under the plug-ins option, select the desired file location and a suitable name for the file and then click ok. Power the DAQ hardware after connecting it through serial cable with the PC.

5 RESULT DISCUUSSION

5.1 Calculation

It will need to use a voltmeter to sense V_{out}. The output voltage is converted to temperature by a simple conversion factor and use a conversion factor that is the reciprocal, which is 100 ^{o}C/V..The sensor has a sensitivity of 10mV / ^{o}C. The general equation used to convert output voltage to temperature is:

$$\text{Temperature } (^{o}\text{C}) = V_{out} * (100\ ^{o}\text{C/V}) \ldots\ldots\ldots \textbf{(1)}$$

So if V_{out} is 1V, then Temperature = 100 ^{o}C. The output voltage varies linearly with temperature. The results of the experiment are saved in Notepad (Fig. 6).

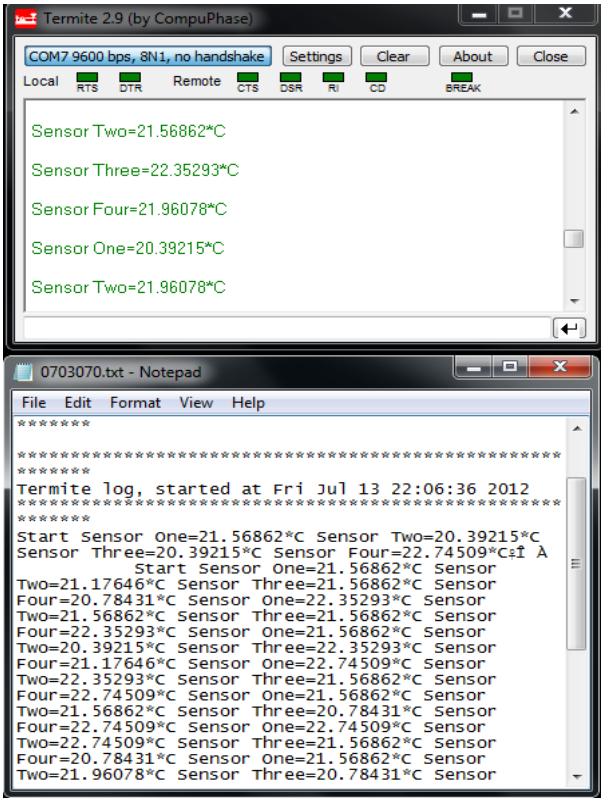

Fig. 6: Data saved in Notepad

From result it is shown that four sensors give result simultaneously and the data automatically save in notepad. There is a clear menu by which anyone can reset all the value from termite. It also shows the time of which the data was saved. Therefore in it can able to take data of any moment from the day. Thus it brings a good impact to measure the temperature of any medium such as pipeline, duct, reservoir etc. So it can easily say that it can give a good output in our industrial arena.

The main advantage is that if we fabricate a real DAQ system we don't need to import it at higher cost. It is

Compact in Construction, less cost and easy to fabricate, highly reliable. It can able to give accurate reading on behalf of any physical phenomena. For highly used in large industrial purpose use of PLC can ensure a flexible system. It can capable to take signal at various physical conditions such as pressure, temperature, force, humidity in air etc at a time. It is possible to re-program as per as requirement. This device can able to record the measuring data and monitoring facility is available due to PC connection.

6 CONCLUSIONS

This data acquisition system, while functional, could be improved. In this project we use only five channels to measure the temperature. But in future more channels will add in design of data acquisition system therefore it can capable to measure temperature of many point in a medium. In this project we use RTD sensor (LM-35) but in future we will use thermocouple as temperature measurement sensor whose main advantage is to read temperature much more wide range. Therefore it will use in vast industrial technology. We will also have a nice thinking to add a new parameter in this device which can measure pressure therefore it become a device which can able to read temperature and pressure at any point at a time as like a unique device in a efficient manner.

Data acquisition system is together useful measurement data for characterization, monitoring, or control .The data acquisition system proved to be a successful, yet challenging final project. Choosing a different microcontroller platform on which to base the project made hardware design much simpler .The specific parameters will dictate the resolution, accuracy, channel count, and speed requirements for a data acquisition system. There is a wide assortment of data acquisition components and solutions on the market, ranging from PC plug-in cards to data loggers to VXI mainframe systems. The temperature, pressure sensors measure the respective elements with reasonable accuracy.

7. RFERENCES

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