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Low Cost Data Acquisition and Control System Based on Single Chip

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Abstract The advance technological, the processes monitoring are becoming more complex with increase in, efficient, analysis of process, number of parameters under data acquisition with single chip environment is increases . New generation data acquisition developments have been emerge with controlling and monitoring with microcontroller technology, which enables real-time data collection, analysis, logging and plotting of data. The requirements the demand of an improved, efficient and up- to-date data logger is increasing, with combination of a sensor, microcontroller, and a data storage device. Data loggers are provided with real time record and time of acquisition. In this paper, a data logger prototype is designed and tested for the specific application as pressure, temperature and vibration. The system works around the AT-MEGA-16 microcontroller. The system is designed and developed to measure temperature, vibration and pressure with accurate sensors and the result is stored in memory such as EEPROM for post process analysis. During the testing, it is verified that there is real time correct data acquire and stored in memory. Using a LCD display verified the current data storage. The focus of design is on portability and low power consumption in robust environment.

Keywords: *single chip, microcontroller, DAQ, display, multiple sensors*

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1. Introduction

The processes to collect analyze and store the data for later use is called logging. It is a process to record data during a run time test measurement. The human brain and its memory, is the best data logging mechanism. There is the need to collect; store information faster than a human, data logger can possibly collect the information with a accuracy [1,2]. Data logging also implies the control of sensor data, collection methods and analyzes technique. It is commonly need of scientific experiments and in monitoring systems. Data loggers automatically make a record of the instruments with different sensing parts , where user determines the type of information recorded. Their advantage of the single chip measurement setup is independent operation of a system. The fixed function loggers are more powerful, programmable devices capable of handling hundreds of input [2].

The advancement of technology, the processes are becoming more complex. But efficient analysis of process, number of parameters data acquisition and storage. In our practical work, single chip system-the single microcontroller has all the associated communication and processing is preferred in industry, such as automatic control, household appliances and chemical industry etc [3]. The development of society, people put forward higher requirements for single chip, for data acquisition and control system where microcontroller need to be more accurate, effective and reasonable [4].

A microcontroller is hart of data acquisition system and control system. The control system is ensuring working and gives related instructions after analyzing and processing received data [5,7].

Temperature, pressure and Vibration are physical parameter having ever-changing natural environment. It can be measured via a array of sensors. The temperature is sensing change in a physical characteristic and status of the material [8]. One must be careful when measuring temperature to ensure that the measuring instrument (thermometer, thermocouple, etc) is really in the temperature range that is being measured. Under some conditions heat from the measuring instrument can cause a change in temperature gradient of the material, so the measured temperature is different from the actual temperature of the system. In such a case the measured temperature will vary not only with the temperature of the system, but also with the heat transfer properties of the system [3].

The objective of this paper is use of data logging for temperature, pressure and Vibration measurement. In order to meet the above requirements, a low cost, versatile, portable data logger prototype is designed. A microcontroller based data logger has been developed for measuring temperature at input channels of ADC. The master slave concept is implemented in design for data

acquisition from temperature sensors, pressure sensor and vibration sensor. An integrated Liquid crystal display (LCD) is used for display the real time of data [13] .

2. Relevant Theory

Simple comprehension Definition of single chip

Single chip microcontroller, which integrates computer system and peripheral attached to a chip. The core part of computer and a chip constitute a complete system [5]. we usually talk about but the microcontroller (single chip) which gives intelligence to machines and can implement simple process control [9].

2.1. The Development History of Single Chip

The development of single chip includes three stages: Single-Chip Microcomputer (SCM), Microcontroller (CMU) and System-on-a-chip (SoC). Single chip developed from embedded programming independently, work with the acceptable environment which solved the modular application on chips, it became system on chip(SoC) naturally [9].

The single chip system base data acquisition panel is costly but effective mechanism, this practical approach create the need of designing the multiple sensors based data acquisition module. The basic aspect of the system acquisition process and analysis of the data using the PC.

Microcontroller has a major impact in industrial process control. A microcontroller has a CPU in addition to a fixed amount of RAM, ROM, I/O ports and timers all on a single chip. The on chip ROM, RAM and number of I/O port in microcontroller makes them applicable in many applications with cost and space reduction and portability [12].

3. Experimental Development

3.1. Hardware Structure

The block diagram of prototype is shown in Figure 1. Configured with the hardware agreement. The sensor1, sensor2, semsor3 is temperature, pressure and vibration sensor. The block consists of advance microcontroller unit AT-MEGA 16. The microcontroller has inbuilt 10 bit analog to digital convertor (ADC) that help the analog, physical data acquisition by digital controller [13].

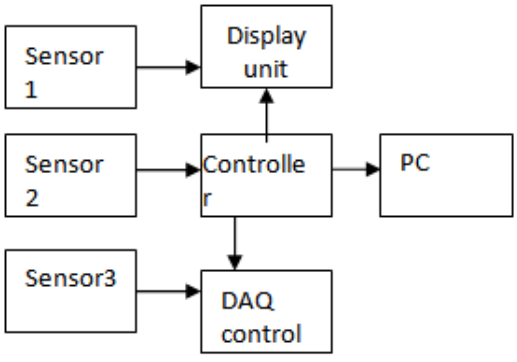

Figure 1. general block diagram of DAQ system

The supply voltage uses is 3.3v for the sensor voltage and the microcontroller is work on the 5v DC supplies. The keyboard and display are important methods to mechanized man-machine interaction. Reset circuit is implement reset, which brings convenience to debug system. Serial interface using MAX-232 chip enabling two way communication with peripheral conveniently. The RS232 Module gives the data at the universal terminal as Hyper Terminal with 9600 baud rate and other communicable environment and features. The hyper terminal with the different Baud rate will provide the flexibility to set the data acquisition rate with the synchronization with the hardware module [3,10,13]. The ADC module adopt 10-bit conversion chip enabling it to extend out.

3.2. Software of Data Acquisition System

Tasks of software controlled hardware based single chip data acquisition system mainly include scan, conversion, display and communication with PC and sensor network. Software of AT-MEGA16 is developed using embedded environment, using assembly language and C programming language, and emulator and C complier provided by manufacturers [12].

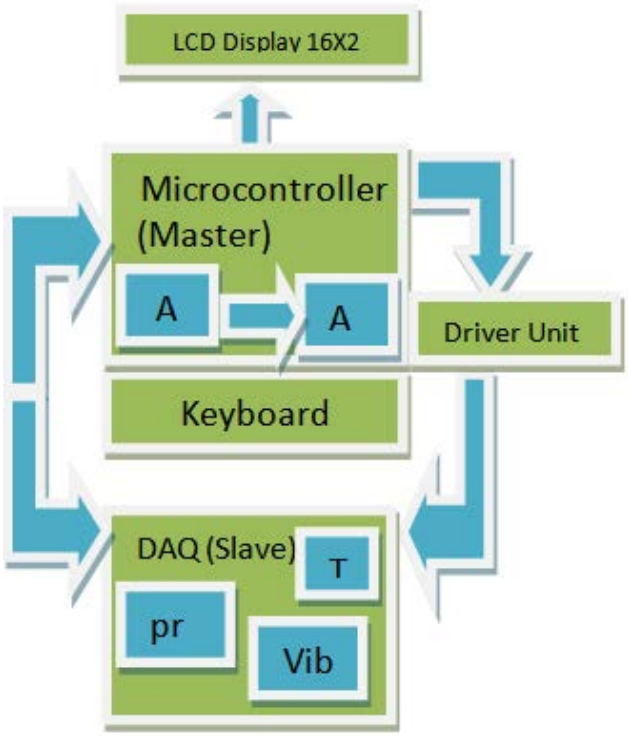

Figure 2. DAQ functional block diagram

3.3. Conversion Module

Conversion module featured by 10 bit inbuilt precision ADC in the slave module, containing a temperature, pressure and vibration sensor. The microcontroller with interior channels, eight external channels and four conversion modes adopts single channel mode with repeated conversion [11].

The general equation used to convert O/P Voltage to temp is * Temp (°c) = volt*(100°c/v)

* So if voltage is 1v then temp= 100°c * The output voltage varies linearly with temp

The general coding used to convert O/P Voltage to temp is

```
temperature = ad_voltage /2;
digi1 = temperature/1000;
digi1 = temperature % 1000;
digi2 = digi1/100;
deg1 = digi2 +0x30 ;
digi2 = digi1 % 100;
digi3 = digi2/10;
deg2 = digi3 +0x30;
digi3 = digi2 % 10;
deg3 = digi3 +0x30 ;
```

This code converts the analog voltage sense by the sensors. The sense voltage is converted into the ASCII format using MOD (%) operation step by step.

3.4. Serial Interface

Serial interfacing module has two pins, transmit (TX) pin and receiving pin(RX). The communication begins with initiation command greeted by the microcontroller; signal is transform between master and slave. It can send data or stop receiving with independent data availability monitoring [14].

Pressure acquisition mainly takes sample voltage generated by the pressure sensor. Sampling is carried out ever 10 ms and pressure data is sent in time.

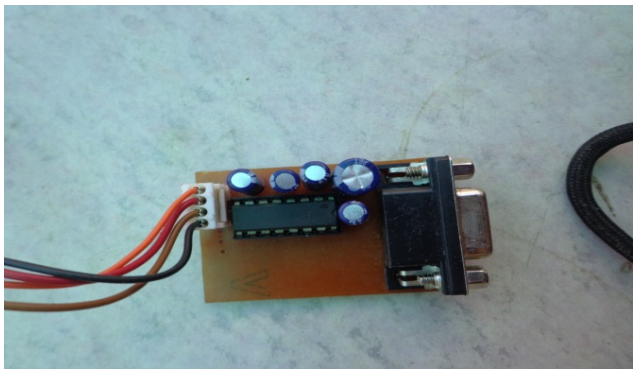

Figure 3. serial communication module

The acquired data is accepted in voltage form sensor and converted using the MOD (%) operation and ASCII format with the Dividend and Reminder logic (Mod) , convert the complete MOD result into the specific Hex code. The acquired data is converted into the string for transferring purpose through TX. The data converted into the string transmit serially using the serial communicator module using MAX232 on real time basis at the rate of 9600 Baud.

3.5. Advantages of DAQ System

The microcontroller based control system is NODE intelligence module. The reliability and repeatability of the whole system are strong, and applied in automatic control system industry. The performance is same as sensor NODE to NODE data acquisition system by taking microcontroller the data validation process is implemented at each string transmitted and received at the hyper terminal. The hardware polling feature is implemented using the master salve frature available in the programming structure available in the ATMEGA structure.

The master microcontroller perform the power on self test (POST) for the slave microcontroller then only the data acquired by the master. The master status is also confirmed by the slave and if master found busy in process, then it hold the data for some time.

Features of data acquisition system

1) Low power consumption 500mW when it works.
2) high data operation speed,
3) It has a real-time clock (RTC), which can keep it working when outage happens.
4) It has broad development environment

Basic Executive Structure of DAQ System

Each slave node module of microcontroller system has independent operational capability; control centre can finish the configuration of control system, testing and control. Its over-all structure can be expressed as:

Human-machine interface ↔ control centre ↔front-end processor of the system↔ node intelligence module ↔ controlled equipment. Of course[17].

4. Result

4.1. Hardware and Software of Microcontroller Control System

The hardware in sing chip control data acquisition system, which is equipped with on board and PC control, input and output port, conversion module, keyboard, display, etc. Its operating principle is interlinked to the said system of over-all structure with the algorithm given above [10,15,17]. The coding format used to burn the code is I probe provided by I-Labs module.

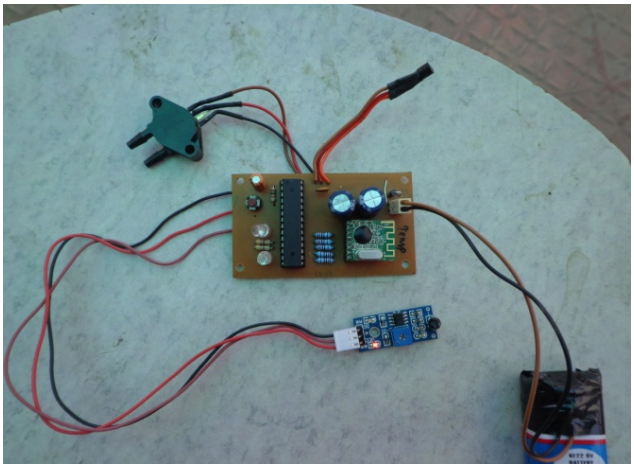

Figure 4. Sensor module with single ship microcontroller

4.2. Software Control System

C programming language program as software for the controls system takes workflow of single chip AT-MEGA16.

The microcontroller shown in Figure 2 and working prototype module is shown by Figure 5. The communication protocol and hardware principles, concluded that software communication module is controlled by register establishment, in USART controllers [12].

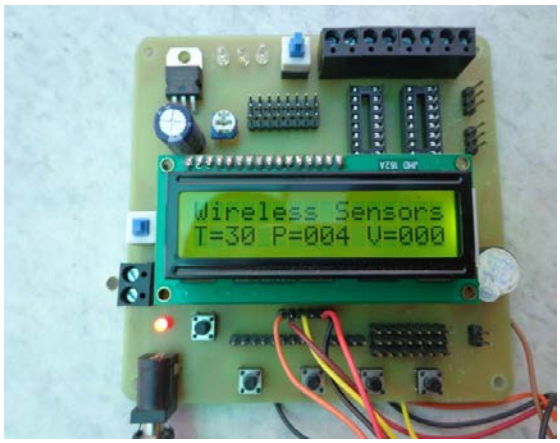

Figure 5. snapshot of prototype

The length of transmission character is 8 bit with Baud rate is 9600 Bauds, the circuit is free multi-machine protocol, which send, receive and interrupt enable. Serial communication adopts interrupt mechanism, RXD and TXD used in this prototype. If master program sends data, the interrupt signal can be set as assess to interrupt to send data. If there is RXD, a signal will be set up to inform slave program that data is coming. If we want to receive data, while the service program then we used interrupted, The program checking and processing data with the master controller-processor, which transfer correct data to main function of the system and calculate it. The responsive information will be sent to computer[17].

Table 1. Result at Room temperature condition

Time (in minutes)	Standard temp(°C)	System acquired temp (°C)	Pressure (mbar)	Vibration (ppm)
8:05 am	33.3	33.35	04	00
8:15 am	33.3	33.39	10	50
8:25 am	33.3	33.39	08	00
8:35 am	33.5	33.50	08	230
8:45 am	33.5	33.53	03	100
9:00 am	33.5	33.53	07	37
8:15 am	33.8	33.9	03	37
8:30 am	33.9	33.9	05	37
8:45 am	34.5	33.9	3	37

Table 2. Result at moderate temperature condition

Time (in minutes)	Standard temperature (°C)	Sys. Temp (°C)	Pressure (°C)	Vibration (°C)
10:05 am	35	34.8	05	00
10:20 am	35.5	35.3	10	35
10:40 am	35.5	35.5	15	25
11:00 am	35.5	35.5	20	23
11:20 am	35.8	35.9	25	25
11:40 am	35.8	35.9	30	22
12:00 pm	35.8	35.9	35	22
12:20 pm	35.8	35.9	35	22
12:40 pm	36	36.3	40	22
1:00 pm	36.4	36.28	45	22
1:15 pm	36.8	37.00	45	22
1:30 pm	37	37.4	45	25

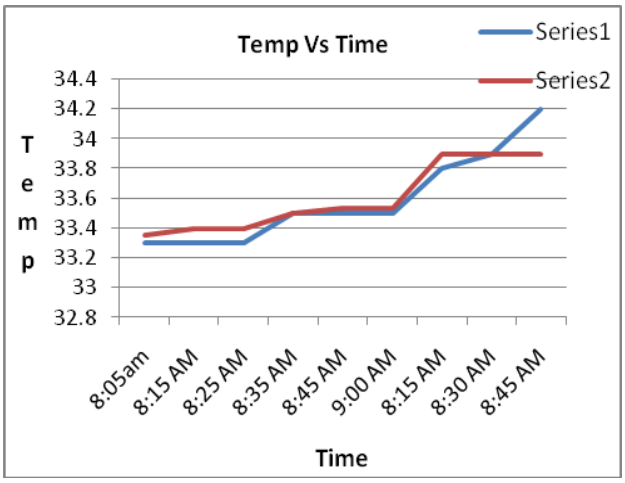

Figure 6. Graph of temp error between manual and system acquired

5. Conclusion

The above tables (Table 1 and Table 2) of readings obtained by comparing standard temperature with the temperature of channels, the accuracy of the channels is discussed as the temperature measurement is done using conventional methods have some measurement error as compared with the new system. Accuracy is the degrees of conformity of a measured analog and digital quantity to its actual (real time or true) value that is the quality of errorless to the truth or the true value.

The prototype application was designed and developed to prove a couple of concepts about the data acquisition in general and some notions about the possibility of adding remote controlling/monitoring. This has a teaching purpose: it is being used for a series of experiments between several laboratories, at the moment. From one point of view one can process the experimental data gathered from a real process, but one can also see the result of one remote command sent to industrial equipment in the real time.

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