Fast Distributed Parameters Process Control for the Motivation of local flow in industries

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Abstract—In this paper, we focus on the interaction of different controlling modules, communication systems between controlling HMI and modules and also real time computing for the sake of building efficient embedded and networked control systems. Day by day, the use of distributed applications is increasing. This thing is increasing the importance of getting detailed knowledge how to design the system to reach independently. With the help of this project, we are increasing the quality of service. This research work will prove as a helpful material for private companies who are mainly working on automation. The main problem in the analysis and design of DCS control system is the lack of hardware platforms working in real times. For this, we are presenting a simple prototype which can be modified on the basis of requirements. In this prototype, we are controlling level, pressure and temperature modules through the help of a master microcontroller. Master controller sends this data to HMI on computer through the help of RS-232.

Keywords— *PIC, LABVIEW, HMI, LED, DCS, IDs, RS-232, MATLAB, Bridge IC, Buffer IC, Register network.*

I. INTRODUCTION

This project has diverse applications in control industry like field of pharmaceutical, oil and Gas, food and personal care products, automobile assembler, fertilizers, cement and in glass, chemical industry etc. Because there are several processes which require continuously and accurate monitoring and controlling of temperature, pressure, level, humidity etc. These processes can be manufacturing, designing, refining, fabrication and power generation etc [1]. In this paper, an infrastructure is designed and for these hardware requirements are fulfilled by using microcontrollers features like A/D converters, interrupts, display interface and communication protocols for interfacing [1]. Microcontrollers convert analog data in digital form and send this data to LCD. LCD displays the data for convenience of operation. For better performance, we have to keep two basic points in mind. First one is computing of feedback systems which refer to the real time computing techniques and second one is feedback of computing systems which refers to the controlling of computing systems [2]. For applications in which operator needs to interact with physical hardware, there is need of a mechanism by which operator can control and monitor the physical hardware without direct interaction. This need can be fulfilled by HMI. In industries, lots of software are available to design HMI. For process analysis, we use software like LabVIEW and MATLAB[3]. HMI used in this project is designed on LabVIEW through which we can monitor and control the industrial environment's parameters.

II. DESCRIPTION

A. DCS

DCS was introduced in 1975 by Honeywell (TDC2000) and Yokogawa (CENTUM). Other vendors are: ABB (Bailey etc), Foxboro, Emerson (Fischer, Rosemount etc). We can define a distributed control system as a system which consists of several ID's working for a specific task. ID's can be microcomputers, workstations, robots etc. ID's are used to support processes, coordinate activities and exchange of information through the help of a communication network.

We can say a DCS system usually a process, dynamic system or a manufacturing system in which for the purpose of communication and monitoring control elements are distributed and interconnected through the help of a network.

In DCS system control elements are distributed throughout the system instead of centrally located. Each subsystem is controlled by one or more controllers. For communication and networking the whole system is connected by networks. DCS is a wide term used in many industries to control and monitor distributed components and for the purpose of interconnection, it uses communication protocols. We can achieve better fault tolerant performance by a distributed system than a centralized system because architecture and intelligence are distributed which makes it easier to avoid from single point failures [4]. The architecture of Distributed control system is shown in Fig.1.

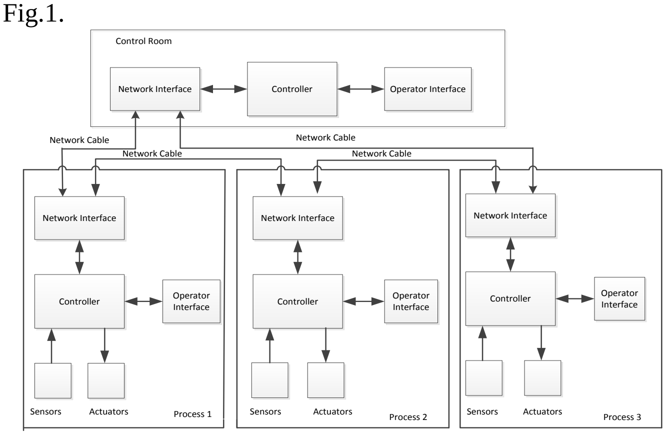

Fig.1 Distributed Control System Architecture

B. Sensors

In modern age, sensor networks are gaining so much importance. These are playing a central role in research community. There are a large number of temperature sensors which can be used for measurement of temperatures. For this purpose most commonly used are LM35 and LM34.In our paper, we are using LM35DZ for temperature sensing [11]. LM35 gives out put voltage which is directly proportional to current and this current produce Celsius temperature [11]. LM34 (or LM35) produces 10 mV for variation in each degree of temperature and the A/D has 10-bit resolution with a maximum of 1024 steps. One of the major advantages of using this sensor is that we have not to extract a large amount of output voltage as we do in case of linear kelvin temperature sensor.

There are a variety of level sensors being available in the market. The method used by us is the one in which there is no need of ADC. We have used the Electric Conduction method for that purpose using the electrical conduction property of water. The electric conduction method is very simple one what we have to do is to put a live wire in the tank of 12 or 14 volt when the water or the liquid touch the wire the liquid will became liquid of that voltage level which we have to detect . For the purpose of detection we use transistors with the base of transistor attach with the wire which are attached to a marked scale at different level the bottom of the scale contain the live 12 volt wire as the water rise the wires for detection receive voltage so base will conduct and so level can be determined.

C. Microcontroller

Microcontroller is one of the most important component which is used in industry for controlling purposes. Microcontrollers have high performances and their operating speed is DC-20MHZ clock input. These Microcontrollers have feature of sleeping mode for sake of preserving power. This is a programmable IC. It has built in EPROM, EEPROM, timers, comparators, UART etc. It has low power and high speed.

D. Logic Level Conversion

The data coming from pic microcontrollers is in TTL compatible logic level. We cannot operate our circuits by using this logic. Also RS-232 is not compatible for TTL logic. We have to convert this in some other form. So we use line driver or voltage converter [5]. For this purpose in our project we are using buffer IC because these are used to match the signal level of two different things. It also boosts up the signal so that it can travel through large distances.

E. Serial Communication

In electronic industry, serial communication is extensively used. Various types of communication devices are used with PIC. The most commonly used are RS-485, RS-232, V.24, and V.10. Normally PCs have two communication ports name COM1 and COM2.COM1 have 9 pin connector now a days the standard usually used for that is DB-9. Fig.1 shows the pin configuration of DB9 connector.

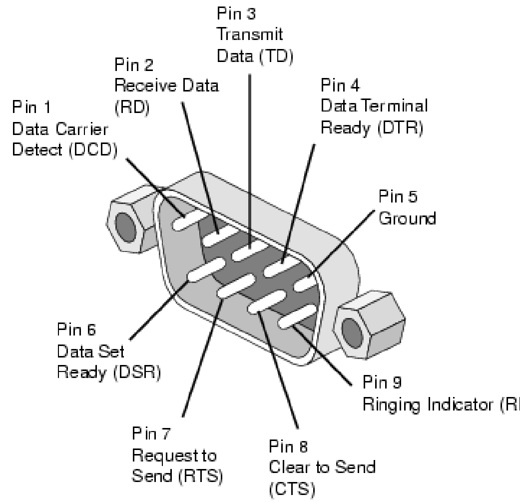

Fig.2 DB9 Connector male type

For connecting our hardware, we also used serial to USB converters. There are three types of transmission methods in RS-232. These are simplex serial communication, half duplex and full duplex. Here, we are using full duplex method in this method we used 3 pins out of 9 pins.

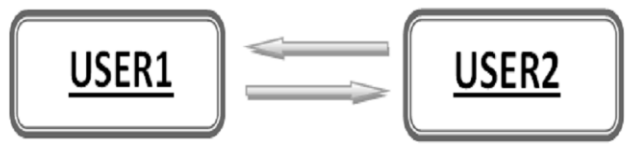

Fig.3 Full duplex serial Communication

F. LabVIEW

Large systems like airplanes, power plants and traffic control systems are controlled by human interaction. They interact with automation control systems by using UIs, GUIs, and HMI. LabVIEW is a true time tool by which we can perform multiple tasks in real times at same time but MATLAB is single tasking. First of all we tried to make HMI on MATLAB but we have to face many problems of polling (decision making) and scanning (information processing). To avoid these problems, we decided to design HMI on LabVIEW. HMI can also be used for automation of control systems. Modules are controlled continuously. This can be done in LabVIEW by using simple blocks.

III. FLOW CHART OF PROTOTYPE

Sensors sense temperature, pressure and level. Then, provide this analog data to slave controllers PIC16F877A. ADC of slave controllers converts this analog data in digital form. Then this digital data is shown on LCD and also send to master controller PIC 18F452. All information is provided to the HMI through RS-232. HMI monitor this data and send controlling information to actuators through the help of relay board. The main idea of overall description is given in following block diagram:

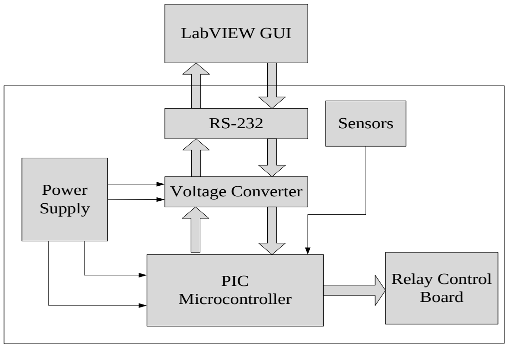

Fig.4 Flow Chart of Prototype

IV. FLOW CHART OF SLAVE MODULES

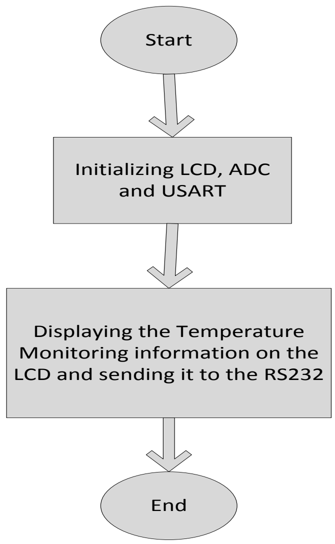

Fig.5 Flow Chart of temperature module

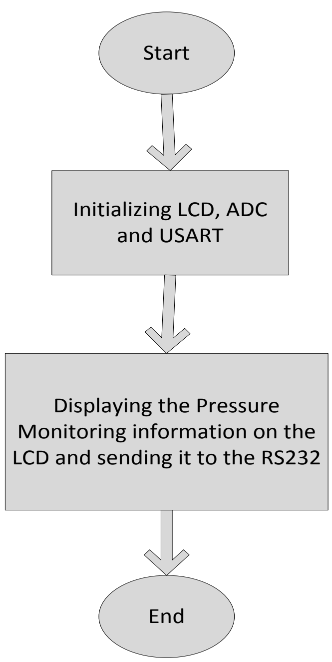

Fig.6 Flow Chart of Pressure module

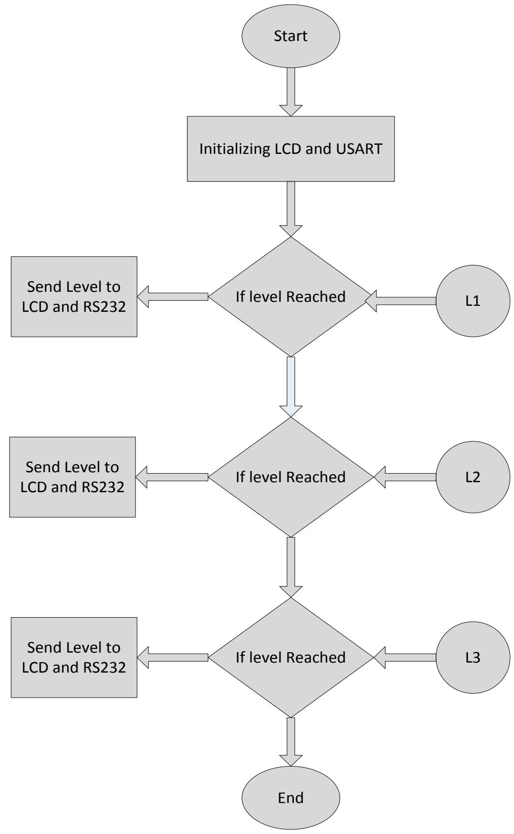

Fig.7 Flow Chart of Level module

V. HARDWARE DESCRIPTION

In our paper, LM35DZ is used for temperature sensing purpose. It can be installed in any industrial environment. But in project it is put in water tank for sake of measuring temperature. Tank is mounted on electric heater. Here, electric heater works as an actuator. By conduction method, we can find the level of water in tank. We are using solenoid valve as an actuator to remove extra water from tank. We are finding pressure manually. PIC16F877A is also mounted in each module on board. This controller has built in A/D converter. Also crystal oscillators bridge ICs and register network A103J are mounted on boards of every module. Bridge IC is used here to match signal level. With the help of RS-232, we transmit data to master controller and HMI.

Fig.8 Hardware Board for Temperature module

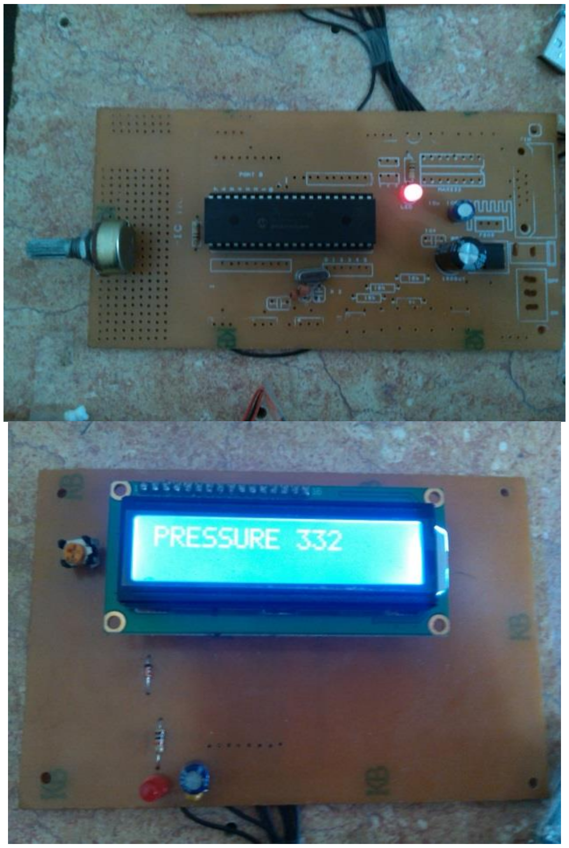

Fig.9 Hardware Board for Pressure module

Fig.10 Hardware Board for Level module

VI. MASTER PIC FLOW CHART

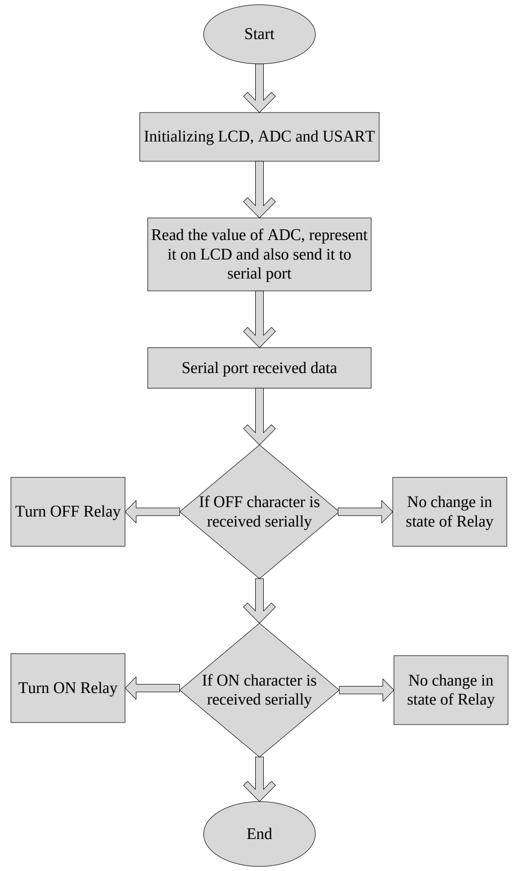

Fig.11 Flow chart of PIC working

VII. LABVIEW HMI

In master HMI, level, pressure and temperature are monitored at the same time. Here, in hardware no pressure sensor is used and we set it manually by using variable resistance as shown in Fig.9. Limits are set for temperature. Consider there are three zones. When the temperature is less than 25 ^oC ,it means temperature is low and yellow LED becomes ON. When the temperature is in safe zone, green LED becomes ON. The safe limit of temperature is between 25 and 50 ^oC. If the temperature is greater than 50 ^oC then red LED becomes ON and it sends command to the controller to turn of the electric heater.

Three points are set to find the level of water in tank. These points are 1, 2 and 3. When the level is low, yellow LED becomes ON. When the level is in safe condition between low and high green LED becomes ON. If the level is more than normal then red LED becomes ON and it sends command to the controller to open valve.

When the pressure is less than 200, yellow LED becomes ON. When the pressure is between 200 and 450, green LED becomes ON. If the pressure is more than high than 450 red LED becomes ON.

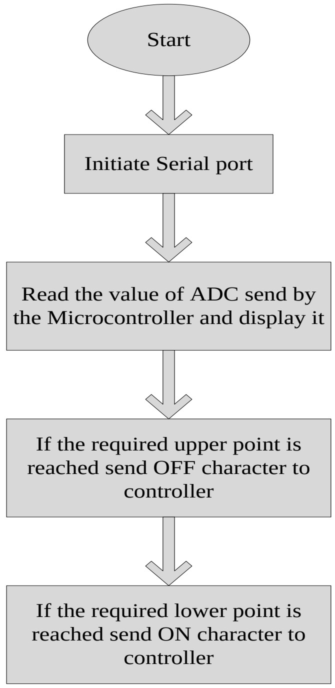

Fig.12 Flow chart of LabVIEW HMI

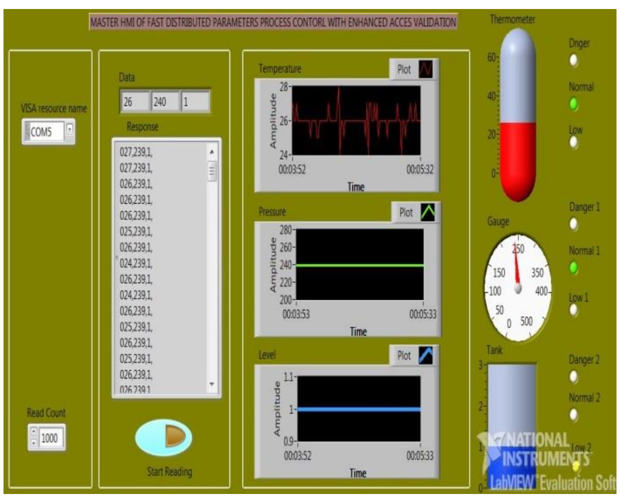

Fig.13 HMI for temperature, level and pressure monitoring and controlling

CONCULISION

In this paper, our main concern was development of industrial parameters that how automation of these parameters can be made possible by using less hardware and HMI on LabVIEW. First of all, we tried to make HMI on MATLAB but we have to face many problems of polling (decision making) and scanning (information processing) because MATLAB cannot perform multiple tasks in real times. To avoid these problems, we decided to make HMI on LabVIEW. The designed HMI is user friendly and it provides all information of processes. Through this HMI, a user can start and stop the operation and also monitors it in real times. The internet process control, network control and internet data logging is also incorporated with this system. Only known person can get access it through internet because it has strong security system. In future, we shall try to design the HMI of closed loop level controller.

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