

Embedded Web Technology and Industrial Communication

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Abstract – Traditional data acquisition systems which work on wired network are not capable of transferring remote data to monitor place which will be far away from the location where data acquisition system is working. Since these systems are with heavy costs and impractical approach, embedded devices with network communication facility are introduced. Embedded Ethernet is one of the devices from such category. The concept of embedded Ethernet makes it more powerful and easy to control and monitor remote data.

The system designed presents the real time monitoring system using wireless technology. Data transfer over wireless network is by using TCP/IP protocol. This system is based on conversion of SPI data to Ethernet data which could be transfer over the wireless network to the server and also over the internet. The system mainly includes SPI communication module, microcontroller module, and Ethernet interface module. The interface converter is suitable for large-scale technical installations, since it allows you to integrate up to 254 devices into the network via virtual COM port. The RS232 Ethernet Interface Converter provides you with both an RS232 and an Ethernet interface for data communication. The RS232 interface allows you to link up several systems, machines, or devices that support this connection type. The system is more reliable and secured than the wired data acquisition systems.

Keywords – TCP/IP, SPI Interface, Embedded Ethernet.

I. INTRODUCTION

In traditional industrial control system or data acquisition system, the structure that one host connects multiple serial devices through multiport serial cards is adopted. The task of host is to communicate with each serial device, process data and interact between the operator and computer. This kind of structure is feasible in case of fewer devices and at lower transmission data rate. Same system fails when more number of devices are to be connected and they are geographically far from the host, and also it will increase wiring length and loss of information. Hence it was mandatory to fix the problem with proper solution. As the embedded system itself has the performance of network and human-computer interaction, it is possible that the embedded system

replaces the previous control method based on microcontroller. A PIC based embedded Ethernet interface system is designed. In the system, the introduced PIC microcontroller can communicate with serial data acquisition equipments at the terminal through SPI interface and can transmit data to remote host computer through Ethernet interface. Compared with the system a host is connected to many serial devices, the task of host is only to complete a single Ethernet communication and its load is lower.

Web access functionality is embedded in a device to enable low cost widely accessible and enhanced user interface functions for the device. A web server in the device provides access to the user interface functions for the device through a device web page. A web server can be embedded into any appliance and connected to the Internet so the appliance can be monitored and controlled from remote places through the browser in a desktop.

II. LITERATURE SURVEY

A novel approach to control devices with embedded web servers was proposed by M. Can Filibeli, Oznur Ozkasap, M. Reha Civanlar 2005[1]. Device network is formed such that components can make use of one another's services and functions. Here devices include the home appliances used regularly. Basic idea states that each device will have separate IP address to interact with web servers. This can easily create confusion for the users.

Sir Mahboob Imran Shaik introduced The Design & Implementation of ARM Based Data Acquisition System [2] in 2011. He made the capabilities of input and output expandable to maximum. Being application in real time environment to control and data acquisition, system is unable to accomplish tasks like control, supervision when connected o LAN.

In this paper, the system introduced is compatible with LAN, MAN, WAN and over internet too. The Ethernet module can be named as interfacing card is converting the input data to IP packets. The input data is collected serially through PIC and is converted to Ethernet data. The output of this card can be given to LAN, MAN, WAN and over

internet. IP address configuration is necessary only for The Ethernet module and not all devices at the input. Hence, the system is more user-friendly and secure as well. It can also help to prevent the accidents at the factory location.

III. SYSTEM ARCHITECTURE

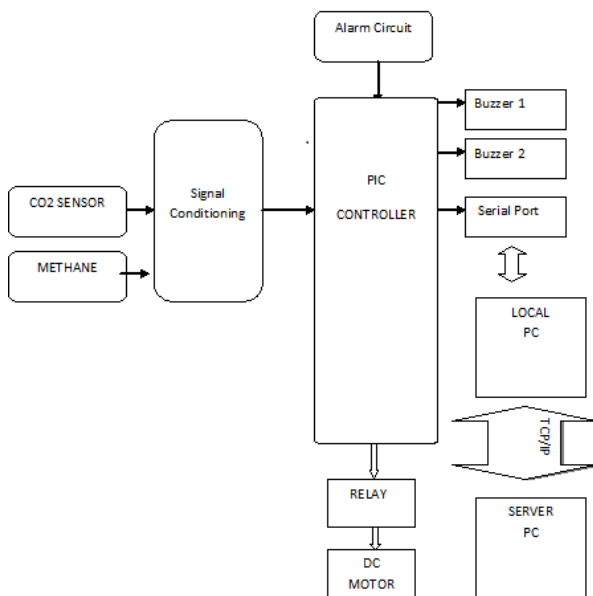


Fig.1. Module diagram of proposed system

IV. SYSTEM ARCHITECTURE

Here all the devices are connected to the PIC and the ADC converters are used to convert analog data into digital data. Serial communication is done in between controller and Ethernet controller .It is connected to LAN cable through RJ 45 registered jack and the whole device is connected to remote PC through internet. The system mainly establishes two tasks, one is to receive remote data from SPI interface and other is to transmit to Ethernet. Both the tasks are performed in in OS μC / OS- Π respectively.



Fig.2 Designed circuit board

The aim of designing system is to make traditional monitoring system with the capabilities of remote monitoring or data transmission by introducing Ethernet interface in it. The system is mainly composed of SPI communication module, processor module and Ethernet interface module.

The **SPI MODULE** transmits the data to Ethernet. The data which have been collected at SPI port are stored into buffer and restructured according to TCP/IP protocol and then are added IP and UDP message head on the condition that the PC with SPI interface is set to SPI slave mode and the SPI interface is enabled. At last, the converted data are sent to the host through the corresponding UDP port.

The **ETHERNET MODULE**: The local IP address and subnet must be set in order to receive data from the Ethernet interface. Then the proper UDP port is opened to monitor whether there are data in UDP port. The data received in form of UDP packets is analysed according to the standards (i.e. TCP/IP protocols). It is then saved into SPI buffer and sent to the SPI serial device through SPI interface driver. Industrial Ethernet not only gives manufacturing devices a much faster way to communicate, but also gives the users better connectivity and transparency, enabling users to connect to the devices they want without requiring separate gateways.

The Emergence of Industrial Ethernet – “*Ethernet everywhere!*”

- Industrial automation and process control applications
- Electric power utilities – substation automation applications
- Future growth and emerging dominance of Ethernet for industrial applications.

V. TRANSMISSION CONTROL PROTOCOL

The Transmission Control Protocol (TCP) is one of the core protocols of the Internet Protocol Suite. TCP is one of the two original components of the suite, complementing the Internet Protocol (IP), and therefore the entire suite is commonly referred to as TCP/IP. TCP provides reliable, ordered delivery of a stream of bytes from a program on one computer to another program on another computer. TCP is the protocol that major Internet applications such as the World Wide Web, email, remote administration and file transfer rely on. Other applications, which do not require reliable data stream service, may use the User Datagram Protocol (UDP), which provides a datagram service that emphasizes reduced latency over reliability.

TCP provides a communication service at an intermediate level between an application program and the Internet Protocol (IP). That is, when an application program desires to send a large chunk of data across the Internet using IP, instead of breaking the data into IP-sized pieces and issuing a series of IP requests, the software can issue a single request to TCP and let TCP handle the IP details.

IP works by exchanging pieces of information called packets. A packet is a sequence of octets and consists of a header followed by a body. The header describes the packet's destination and, optionally, the routers to use for forwarding until it arrives at its destination. The body contains the data IP is transmitting.

Due to network congestion, traffic load balancing, or other unpredictable network behaviour, IP packets can be lost, duplicated, or delivered out of order. TCP detects these problems, requests retransmission of lost data, rearranges out-of-order data, and even helps minimize network congestion to reduce the occurrence of the other problems. Once the TCP receiver has reassembled the sequence of octets originally transmitted, it passes them to the application program. Thus, TCP abstracts the application's communication from the underlying networking details

VI. SYSTEM TESTING

The circuit board consist of PIC, Ethernet interface module and RJ45 registered jack. The devices which are to be controlled are connected to the circuit board. In this way we are controlling the DC motor and monitoring the gas sensor.

With help of this system we can know the status of industry machineries and can control the machines via its own browser from remote location. To get the status of the DC motor through web type the IP address of the server board.

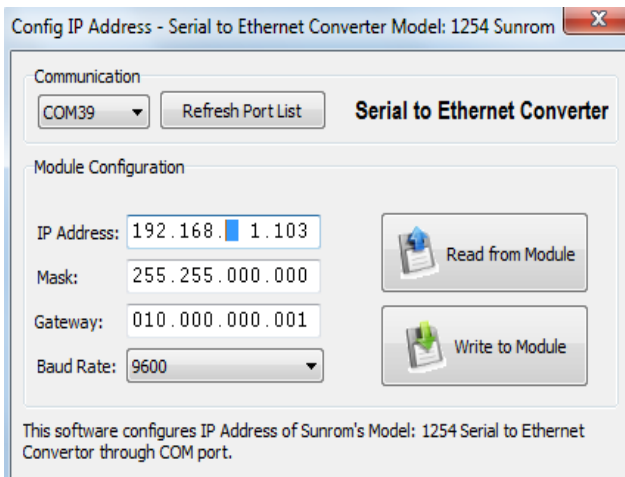


Fig.3. Write/Read IP Address from/to Ethernet module

Hence, results show that the client can access the whole industry from any remote place via its own local browser. In industry this system acts as data acquisition and control system and as web server, so the system is compact with less complexity.

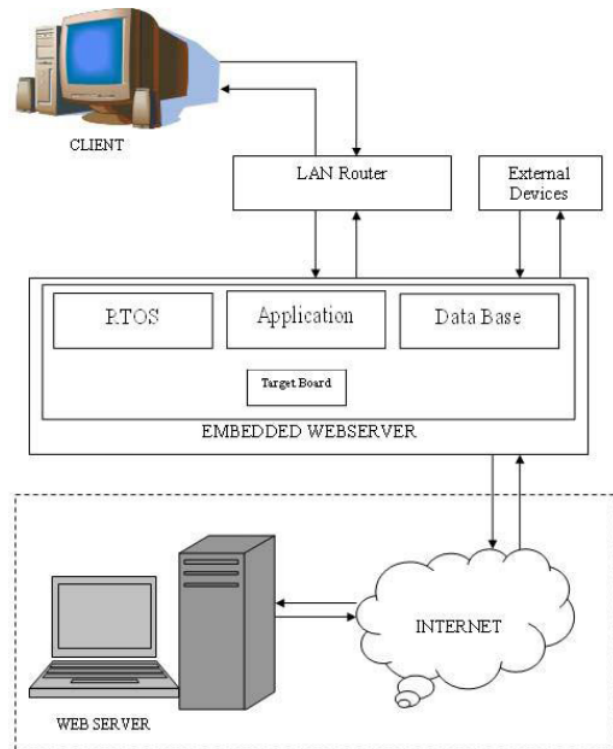


Fig.4. System using Embedded Ethernet

VII. ADVANTAGES

- Data can be monitored from anywhere
- No manual interruption is needed.
- System is reliable and totally automated.
- Needs less power supply can be battery operated.
- High Security.
- Timely alert can avoid accidents

VIII. RESULTS

Viewing the status of DC motor and monitoring it from remote place could be possible because of Embedded Ethernet used. Similarly monitoring sensor modules and other devices is possible.

A. IP Address configuration

The Ethernet module acts as a server board. To type an IP address of server we use the software PuTTY: A Free TELNET/SSH Client. PuTTY is a free implementation of Telnet and SSH for Windows and UNIX platforms, along with an xterm terminal emulator. It is written and maintained primarily by Simon Tatham.

Embedded Web Technology provides for the development of an embedded, real-time system that appears to the users of the system as a node on the World Wide Web. This capability provides for great savings by eliminating the need to develop and distribute user interface software that is platform specific and somewhat cumbersome to configuration manage.

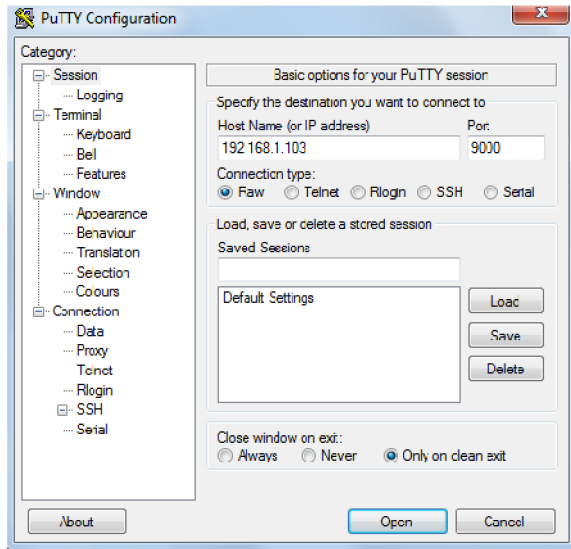


Fig.5. Configuration of an IP address

Here, the Ethernet module which acts as a server board shows the status of process at the industry location.

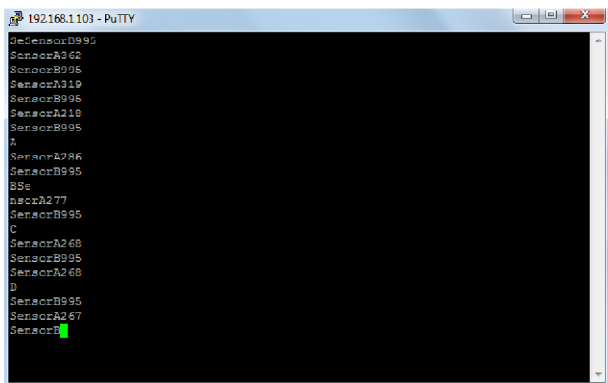


Fig.6. Status window at remote place.

IX. CONCLUSION

This design is more reliable and easy to access data from the places geographically far from the factory location due to embedded Ethernet used in the structure. The main contributions of this architecture are its lightweight design, automatic configuration and utilization of widely available network protocols of TCP/IP. With the help of this system fast data exchange between controllers and sensors is typically performed.

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