

## **SHELTERED DISTRIBUTED MULTI-SENSOR DATA ACQUISITION SYSTEM**

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### **ABSTRACT**

In this Modern era, the requirement for a flexible data acquisition system is increasing in all the fields of industry as well as scientific research. Collection of data, processing the data, secure transferring of the data, controlling the field parameters etc are the primary requirement of the system. This project aims to describe a secure - low cost - distributed data collection and control system based on Embedded Ethernet. The sensed and measured data at the remote location can be accessed through the network. The control PC can process the information and the control signal will be transmitted back to the field through the same wireless Ethernet. So here the microcontroller is enabled to communicate through a data communication network. This will provide greater flexibility to the embedded system and will enhance its usage in more applications. This project can be considered as a perfect blend of two major arenas- Embedded Systems and Data Communication Networking

**KEYWORDS:** Data Acquisition, Embedded Ethernet, Data Encryption, Sensor Modules

### **INTRODUCTION**

Embedded systems often perform monitoring and control functions such as gathering and reporting sensor readings or controlling motors and switches. Ethernet enable computers to communicate, to share resources and providing access to the Internet. For many years, embedded systems and Ethernet networks existed in separate worlds. But developments in technology now make it possible for embedded systems to communicate in local Ethernet networks as well as on the Internet. Network connectivity enables embedded systems to be more powerful and easier to monitor and control. An embedded system will be able to host a Web site, sending and receiving e-mail, uploading and downloading files, and exchanging data other computers connected via a network interface.

The above ideas laid to the birth of a new concept- 'Embedded Ethernet'. In simple words Embedded Ethernet is nothing but a microcontroller which is able to communicate with the network. It can be considered as a "single-chip implementation of the Ethernet networking standard. Embedding Ethernet in a device will give the capability to communicate via Ethernet without using a computer. We can setup a device with a web server and interact with much of its functionality through a webpage. Instead of needing to physically walk by a machine to check its status signaled by a blinking light or loud buzzard, the device itself can communicate its status directly to a remote PC.

In this concept we are bringing together two areas of computer technology—Networking and Embedded Systems. An embedded system that supports Ethernet requires Ethernet controller hardware to provide the Ethernet interface. A module containing an Ethernet controller include firmware support for communicating with the controller.

## LITERATURE REVIEW

Nagula V et al [3] presented a design of ARM processor-based embedded Ethernet interface. In the design, an existing SPI serial device can be converted into a network interface peripheral to obtain compatibility with the communication network. Shaikh YH et al [1] presented a Data acquisition and control system based on AVR microcontroller for laboratory experiments. In a typical setup, the measuring system, under program control continues the monitoring of the voltage or current analogue inputs and makes the digital equivalent available on the selected ports. Chavan V M et al [2] designed a research on real web access functionality which is embedded in a device to enable low cost widely accessible and enhanced user interface functions for the device. The project focused on developing real-time services for switched Ethernet networks, keeping the Ethernet and TCP/IP standards. Roy V.B et al [4] developed an embedded web server using ARM9 processor and a Real Time Operating System. The RTOS is used to monitor all the tasks of the web server. Filibeli M C et al [5] suggested that powerful microcontrollers can be used as an integral part of the home and office appliances. Integrating these web servers to these intelligent appliances will help in controlling them over the Internet and also in creating effective user interfaces in the form of web pages. Hoang H [6] recommended that Switched Ethernet can be extended to allow for periodic real-time traffic using earliest deadline first scheduling. He explained the advantage of supporting special communication patterns apparent in industrial and embedded systems. Ahmed I H and Kapila V [7] described a DC motor position control experimental setup that can be accessed via the Internet. The experiment consists of a server consisting of a low-cost microcontroller and a client computer. The client computer sends or receives data to or from the microcontroller using UDP packets. Clausen D [8] described the design of a microcontroller-based hardware device which has a standard RJ45 Ethernet port and an LCD display. The device will receive and decode UDP/IP datagrams. After this they will display the contents of those datagrams as text on the LCD display. Hendrey G R and Koopman P [9] suggested that Standard 10 Mbit/s Ethernet can be used for embedded real-time networking despite fundamental problems with schedulability, delay bounding and prioritization.

## METHODOLOGY

### Basic System

The distributed data acquisition system with web access functionality enable low cost widely accessible and enhanced user interface functions for the device. The system can be monitored and controlled from remote places through the browser in a desktop.

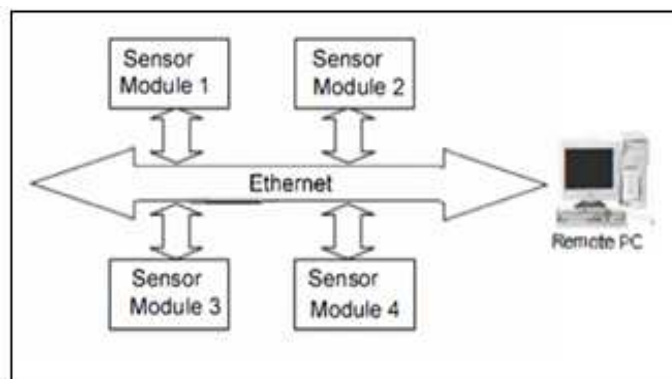


Figure 1: Basic System

Here the Internet can be used as a channel to monitor and control microcontroller driven processes. This methodology eradicates the need for the user to interact with the microcontroller from close proximity. In addition, an interactive GUI for process monitoring and control has been developed with the platform independent, Internet-based graphics tool – Java.

This project explains the implementation of a data acquisition and control terminal with Ethernet capability using PIC16F883 microcontroller. The system is having two client modules distributed in the observation area at a distance. Each Module consists of Microcontroller, Serial to Ethernet Converter and the Data Sensing and Control units. Each module is connected to the Ethernet through a router. The unit forms one sensor module of the data acquisition system. Similar modules will be distributed throughout the sensing area, which are connected to the LAN

We have three different sensors to detect the temperature, light and voltage. The sensor information will be collected by the PIC and it will be encrypted and fed to the converter. The converter will send this to the monitoring PC through the wireless network. Thus all the data acquired will be transferred to the monitoring server via Ethernet. IPv4 protocol stack has been successfully ported to the module by means of S2E converter. As TCP/IP stack is ported in the converter, each sensor module acts as a true Ethernet device. UDP datagrams are used to communicate with the server.

Ethernet controller is interfaced with an RJ-45 port with the router for connection to an Ethernet network. The S2E Module supports one 10/100 Mbit Ethernet port. The basic send and receive functionalities of Ethernet are controlled by sending appropriate commands to the module.

Ethernet communication between the PIC and the PC is accomplished by the S2E converter in which the TCP/IP stack is ported and implementing User Datagram Protocol (UDP) over the TCP/IP stack. The Remote PC IP address (destination IP address), sensor module IP address (Source IP address), destination port and source port are configured on the TCP/IP stack. The program which is residing in the microcontroller reads the data from the sensors and after encryption, give to the S2E which encodes the same as UDP data packet. The program initiates and performs all data exchange to and from the microcontroller, in UDP datagram format through the S2E Converter.

An application program on the remote PC, handles the UDP communication from PC side. This application program will be responsible for monitoring sensor data at the remote location and taking necessary actions like making an alert and sending control signal. The GUI will be having the decrypting logic and the values will be displayed in the window. It also shows alert if there is any critical situation. Based on the values of the parameters displayed in the window, we can control the respective module by enabling the remedial systems.

The UDP protocol is used for transmitting sensor data, since its datagram packet's size is compact compared to TCP. The application software on the microcontroller reads the sensors continuously. It encrypts this data and send to the S2E Module. It formats the UDP header and inserts the sensor data in the place of UDP data and also calculates the UDP checksum. Then it will hand over the formatted packet to the TCP/IP stack. TCP/IP stack will fill the required fields in IP header like source IP address, source port no, destination IP address, destination port no, length and checksum.

Through Ethernet, data from multiple terminals will count into the server – the monitoring PC. The software architecture is based on C/S model. Software on the PC acts as a “server” and will poll all the terminals, which work as clients. When a terminal received the request from PC, it will immediately send all data acquired before. When the data arrived at PC, the server program will analyze the datagrams and display the data acquired from each terminals.

This system is very suitable for acquiring data or signals form a large scale industry field. Hundreds of such terminals can be grouped within an intranet. One PC is enough for monitoring so many terminals. Link from terminals to the internet can be also established to realize remote monitoring.

### Flow Chart

The flow chart summarizes the process logic and steps

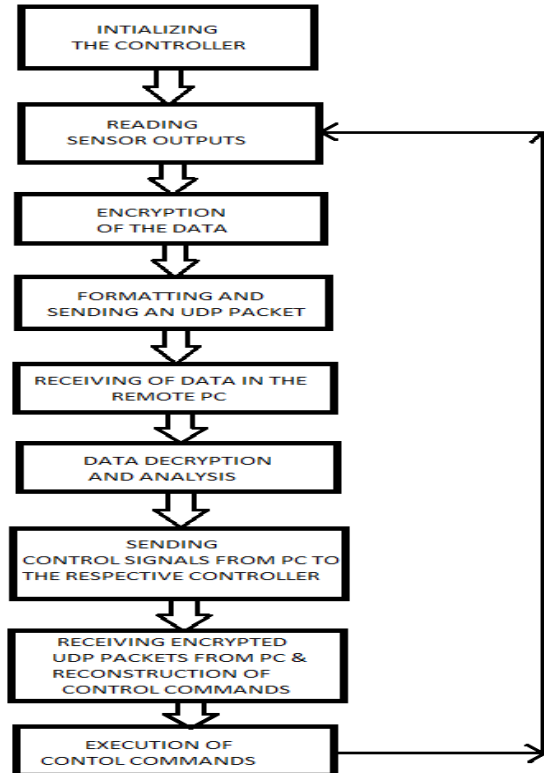


Figure 2: Flowchart

## RESULTS AND DISCUSSIONS

### System Implementation

The microcontroller has been programmed with Embedded C. The LDR will be sensing the light intensity, LM 35 is sensing the temperature and the Pot is detecting the voltage variation. These analog values are given to the ADC. Then they will be converted in to digital value. The microcontroller is doing simple encryption on the value. This will be given to the S2E module. The S2E module is converting this serial data in to UDP packets. These UDP packets are sending to the PC by the wireless Router

The Data is decrypted and presented in the GUI. The GUI consists of the application software done in JAVA. The window is divided in to 2. One part for module 1 and other part for module 2. Each part consists of the current readings from the respective modules. There is a provision to find the previous values in the GUI. Also there will be an alert button if the value exceeds the upper threshold value and falls below the lower threshold. We are having on/off button for each of these systems. If there is an alert, we can put off or put on the control system for the parameters from the GUI. Hence the project is implemented and we got the result as expected.

### Advantages and Applications

The system is said to be advantageous because of the major benefits shown below

- The system less costly
- Data encryption ensures the secure communication
- It can be implemented easily with less modification to the existing framework
- The device operates at low power
- The system can be easily monitored and controlled with the help of user friendly GUI.
- We can have Remote monitoring and controlling of the system by exploiting the possibilities of Internet

The system can be modified with different sensors to suit with different requirements. This framework can serve to numerous applications. The major application fields of the system include the following

- Surveillance Systems
- Intelligent Lighting System
- HVAC Control Systems
- Industrial Automation Systems
- Home Automation Systems
- Temperature Control System etc.

### Future Work and Suggestions

We have developed an embedded Ethernet module which is capable of acquiring data from various sensors and transmitting the data to the remote server or PC for further processing. We are able to control the field parameters also from the remote PC by exploiting the possibilities of computer networking.

We can have fully fledged Temperature control systems, Intelligent lighting systems etc with a little enhancement of the project. With the Intelligent Intrusion detection and surveillance systems by connecting PIR sensor to the module, we can monitor the secured premises for any intrusion from the remote location. Like these examples, different sensors can be interfaced with the microcontroller to make different kind of applications. This Embedded Ethernet module is paving the way to numerous applications to be developed in the area of industry control, home monitoring and automation systems. Even we have the possibility of live streaming of video and audio.

This study mainly focuses on the infrastructure for using web pages as user interfaces. We do not address web page design for better user interfaces. Therefore, the methods of generating user friendly interfaces as web pages may be investigated in the future.

We have done a simple encryption to the data by adding 10 to the string value. Instead of this we can have complex encryption algorithms to have higher degree of security.

Our system was partially wireless as the system and the PC are communicating wirelessly. But we have connected

the sensor module to the router through cable. This can also be replaced with wireless transmission to have an absolute wireless system.

Our system is capable of incorporating 255 sensor modules in the same LAN. But we have included only 2 modules for demonstration purpose.

## CONCLUSIONS

We have developed a data acquisition and control system based on Embedded Ethernet. This design can be used widely in remote data acquisition and control system in industry. These embedded Ethernet modules have the capacity to perform as a true Ethernet device. We can interface different kind of sensors with these modules and make various applications. So we can monitor embedded system operation state through Internet, achieving network monitoring purposes. We can construct a distributed data collection system by connecting several embedded Ethernet modules on the network. The PIC based system is found to be fast, cheap, reliable and real-time. In addition, they can be also applied for on-line monitoring, remote fault diagnosis system etc.

## REFERENCES

1. Shaikh Y H, Khan A. R. and Behere S. H, "AVR Microcontroller Based Data Acquisition System for Laboratory Experiments", Pelagia Research Library Advances in Applied Science Research, 2012, 3 (1):208-215
2. Chavan V M., Deotare. V.V., Babar. R.V., Baru. V.B, "Performance of Ethernet protocol conversion on an ARM7 embedded processor", International Journal of Engineering Trends and Technology- Volume 3 Issue 2- 2012, Page 172
3. Nagula V, Rao M.V, Vishnu T.R, "Embedded. Ethernet monitor and controlling using web browser", International Journal of Engineering Science & Advanced Technology, Volume - 2, Special Issue - 1, 1 – 5 IJESAT | Jan-Feb 2012
4. Roy V.B R, Dessai S and Shiva Prasad Yadav S. G, "Design and Development of ARM Processor Based Web Server", International Journal of Recent Trends in Engineering, Vol. 1, No. 4, May 2009
5. Filibeli M C, Ozkasap O and Civanlar M. R, "Embedded web server-based home appliance networks", Journal of Network and Computer Applications 30 (2007) 499–514
6. Hoang H. 2004. Real-time communication for industrial embedded systems using switched Ethernet. In Proceedings of the Los Alamitos, Calif.: IEEE Computer Society; April 26-30, 2004. p. 127-130.
7. Ahmed I, Wong H, and Kapila V. 2003. Internet-Based Remote Control using a Microcontroller and an Embedded Ethernet Board. Technical Report. Department of Mechanical, Aerospace, and Manufacturing Engineering, Polytechnic University, Brooklyn.
8. Clausen D. 2000. Design of a Microcontroller-Based Ethernet Messaging Device. Technical Report. Stanford University.
9. Hendrey G R and Koopman P(1999) 'Standard Ethernet as an Embedded Communication Network' Department of Electrical and Computer Engineering, Carnegie Mellon University, Pittsburgh, April 26, 1999