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# Managing and Monitoring the System through Internet

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***Abstract* — This paper deals with the design a system which is manage and monitor through internet the system is based on ARM microcontroller LPC 2294 and Rtl8019 Ethernet .Any device connected to this system is monitor and control through internet as well as through Lan. To check the performance of the LPC2294 microcontroller, it is used in two mode i.e. thumb mode and arm mode. With the help of performance monitoring tools like winshark and ethereal we can check the exact communication process and how exactly the communication takes place. NCS hosts a small web page, which is served with the dynamic data upon the client HTTP request. This system enables a user to monitor and control any physical quantity from a remote location through Internet, which in turn provides the capability to communicate with every corner of this planet**

***Keywords* — *Embedded, Ethernet, Temperature, Internet, Local Area Network (LAN)...***

## I. INTRODUCTION

There is a general consensus that in years to come more and more internet devices will be embedded and not PC oriented. Just one such prediction [1] is that by the end of 2012, 75% of Internet-connected devices will not be computers. So if they are not computers, what will be they? They will be embedded Internet devices.

With the integration of communication networks and distributed control in the modern manufacturing and process industries, Ethernet controlled systems (ECSs) are becoming increasingly important [2] due to its simplicity, scalability, flexibility, maintainability, and cost effectiveness. However, there are still significant challenges that result in the application limitations, such as transmission time delay and data packet dropout etc.

The transfer speed of Ethernet has developed to 10Gbps from initial 10Mbps. It makes the application of Ethernet spread from office automation to industrial automation. Due to the low price [3] [4] and robustness resulting from its wide Acceptance and deployment, there has been an attempt to build Ethernet-based networks for industrial automation.

Communication interface in industrial automation have excellent performance. The traditional communication interfaces like RS-232 and RS-485 etc. still occupy the majority numbers of domestic industrial automation, and because of its inconvenience for transmission of data and inapplicability of share information, these cannot meet need of the development of measuring and control system [5]. Using embedded and Ethernet technology for industrial network has become an important point for technology of measuring and instrument, corresponding to huge development in computer and Internet technology. The layout of this paper is as follows. In next section the paper discusses the hardware design. Section 3 describes software design. Section 4 discusses experiment evaluation and conclusion.

## II. HARDWARE DESIGN

The entire system is developed around ETM-150 ARM and ETM-121 Ethernet Controller development board [6] by Embin Technologies Pvt. Ltd. ETM-150 is interfaced with ETM-121, temperature sensor LM35 and LCD. ETM-150 board receives analog signal from LM35 on P0.29 on-chip 10 bit ADC Channel. P1.19 of LPC2294 from ETM-150 is used for relay driver circuitry, which will drive relay, as the controlling action which we have considered here is the simplest one and it is ON-OFF Controller. Ethernet data communication between the ETM-150 and a remote webclient is performed using the ETM-121. Specifically, the ETM-121 receives reference commands from the remote Web client and communicates the same to the ETM-150.

### *A. ETM-150*

ETM-150 is a general-purpose development board for ARM Controller. It is used extensively to test and validate programs. At the heart of ETM-150 development board is Philips LPC2294 [7], runs at 12 MHz clock frequency. LPC2294 provides advance features like In-System Programming/In- Application Programming (ISP/IAP). LPC2294 has 256KB on-chip flash memory, 64KB on-chip RAM and eight channels 10-bit ADC with conversion time as low as 2.44 ms. ETM-150 comes with RS-232 interface to allow user to program LPC2294 directly from PC, which can be used for debugging.

The LPC2294 has unique accelerator architecture that enables 32-bit code execution at the maximum clock rate. For critical code size applications, the alternative 16-bit THUMB mode reduces code by more than 30 % with minimal performance penalty.

The THUMB set's 16-bit instruction length allows it to approach twice the density of standard ARM code while returning most of the ARM's performance advantage over a traditional 16-bit processor using 16-bit registers. This is possible because THUMB code operates on the same 32-bit register set as ARM code. THUMB code is able to provide up to 65% of the code size of ARM, with minimum performance and 160% of the performance of an equivalent ARM processor connected to a 16-bit memory system.

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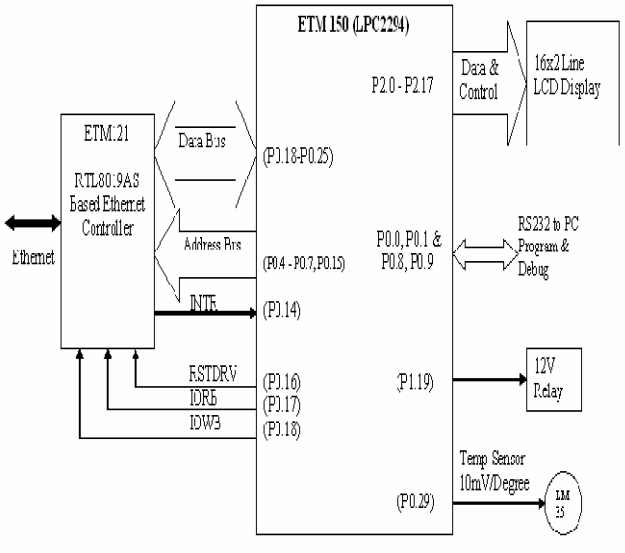


Fig.1. Network Control System (NCS

### *B. ETM-121 (Network Interface)*

The ETM-121 board is designed using Realtek RTL8019AS over which the application circuit is developed. RTL8019AS is a enerally used ethernet controller that can realize 10Mbps Ethernet communication and supports full-duplex communication. The Controller has unique features such as 16K of SRAM and 8/16 bit operations with interrupt capabilities. In 16-bit data, 16K SRAM and in case 8-bit data 8K SRAM is available. The ETM-121 is compliant to Ethernet II & IEEE802.3 10Base5, 10Base2, 10BaseT.

In sending a frame a controller receives the message to send and destination address from higher-level software, calculates the ethernet frame check sequence, places data, addresses and other information in the frames field, attempts to transmit the frame when the network is idle. Finally provides an indication of access or failure of a transmission.

In receiving a frame a controller detects and synchronizes to new received frames, ignores any frame that is less than the minimum size, ignores any frames that do not contain the interface's address or a valid broadcast address in the destination address field, calculates the frame check sequence value, compares the result with the received value and indicates the errors if they do not match, makes the received frames data and other information available to the receiving computer. Finally high-level software reads the message and does whatever needs to be done with it.

## III. SOFTWARE DESIGN

Software is divided into two parts as PC remote software and control system firmware compactness. Furthermore, this fractal antenna design allows

### *A. PC Software*

Special application or graphical user interface (GUI) which runs on a remote client computer for communication with NCS can be written. It communicates over TCP and can be developed with Delphi [14], Visual Basic, Java applet [15] etc. The easiest way for communication with NCS from remote client computer is to use Web browser (Internet Explorer). The advantage of using Web browser and not using special application or GUI is any computer on the internet can access NCS because it is available with almost all computers operating system.

### *B. Control System Firmware*

It is developed in Keil uVision3 and written 100% in Keil uVision3's Micro Assembler. It includes RTL8019AS control functions, communication protocols (ARP, IP, ICMP, and TCP) i.e. TCP/IP Protocol Stack [9] [10] [11], and HTTP web server with inbuilt HTML page for temperature controller [12] [13] and all I/O peripheral routines. NCS uses TCP Sockets in the realization of our program's transport-layer protocol. Socket is a kind of interface between communication protocol and application program, a relationship between both sides of network was established by socket. Control System firmware is divided into software routines as, Main Module, Ethernet Controller Driver, Address Resolution Protocol (ARP), Internet Protocol (IP), Internet Control Message Protocol (ICMP), Transmission Control Protocol (TCP), and Hypertext Transfer Protocol (HTTP). The main module initializes UART, LCD, ADC, RTL8019AS, & TCP Stack according to requirement. Algorithm for main module is shown as below

1. Initialize all devices, hardware and software packages.
2. Open TCP server port on TCP port 80 and wait for client to connect.
3. Setpoint = 40, Loop_count = 0
4. If (loop_count>5000)
   a. Read temperature, print on LCD
   b. Check current temperature with set point
   c. If (Temperature>Setpoint+1)
   d. Turn off relay
   e. If (Temperature<Setpoint-1)
   f. Turn on relay
   g. Loop_count = 0
   h. DataLen=0
5. If (Interrupt from RTL8019AS)
   a. Read_RTL8019AS
6. Loop_count = Loop_count + 1
7. go to step 4

The RTL8019AS is programmed to receive either broadcast destination address (FF: FF: FF: FF: FF: FF) or physical destination address. Main module reads RTL8019AS, it checks for INT0 (INTR), and finds out the cause of interrupt (TX/RX). If TX previous transmission attempt was successful else RX new frame received successfully (according to initialization of RTL8019AS). In both the cases it will inform higher-level layer (TCP/IP Protocol Stack) which takes the necessary action.

Normally Web server is a computer in which lot of Web pages are stored. Web server for hosting a corporate Web page should have the capability to handle more traffic. The aim of this work is to neither hosting a corporate Web pages nor handling much traffic.

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NCS functions as a Web server it has non-volatile memory to hold pages to be served. It support for TCP and IP, requests for Web pages and the pages sent in response travel in the data portion of TCP segments. It support for HTTP, the server must be able to understand and respond to receive requests for Web pages. The HTTP standard specifies the format for the requests and replies. It has a Local-Network or Internet connection. To serve pages on the Internet, the Web server must have an Internet connection with Public Static IP. It has one or more pages to serve.

HTTP works using TCP. HTTP Server is provided as part of the TCP/IP stack. The embedded HTTP server implementation is divided into three segments. The implementation segments are divided based upon their place within the module hierarchy as HTTP Socket Server, HTTP Message Protocol, and Dynamic Content. The HTTP Socket Server is a typical TCP stream socket server implementation. In this implementation the socket is bounded to specified port (80), and a queue of maximum 12-TCP listen ports. This allows to queue up to maximum TCP listen ports outstanding requests while server will fulfill the current one. So the HTTP server opens one or more TCP server ports on TCP port 80 and waits for client to connect. When client connects, the TCP stack acknowledges the connection.

The Web pages are blocks of text that use a form of encoding called Hypertext Markup Language (HTML). The HTML encoding specifies the formatting of text, including text size, fonts, font size, colour (for text & background) and the positioning of text and other elements on the page. In serving a Web page with dynamic content, the software must have a way of inserting the dynamic content as the page is being served

### *A. Testing of ping (Packet InterNet Groper)*

The client invokes “ping” command to send ICMP echo request to Web server. Ping command is not only used to test whether destination is reachable and responding, but also it gives statistics like, packets sent, packet received, percentage loss, and approximate RTT in ms. We found that in private network (LAN) and in public network (Internet) the performance of 32-bit processing is better than that of 16-bit processing. In private network 16-bit THUMB mode has average RTT performance penalty of 2ms and in public network it is 32ms.

### *B. Testing of Web page*

The client uses Web servers IP address in his web browser and, in response Web server delivers web page as shown in Fig. 2.Fig. 3 & Fig. 4 shows a plot of round trip times (RTT) as measured for successive TCP segments in public network, for ARM and THUMB mode respectively. It is a statistics of TCP stream graph for round trip time taken with the help of Wireshark Network Monitoring Software.

In private network (LAN) and in public network (Internet) we observed that the performance of 32-bit processing is better than that of 16-bit processing. (Private Network Plot and analysis not given) From Fig. 3, ARM mode average RTT is 0.074 seconds (74ms.) and from Fig. 4, THUMB mode average RTT is 0.081 seconds (81ms). Hence 16-bit THUMB mode has average RTT performance penalty of 0.007 seconds
(7ms) in public network..

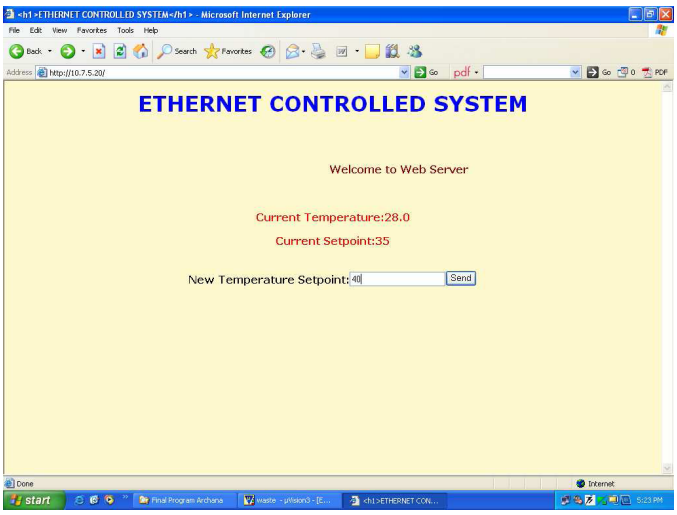


Fig.2. Snapshot of Web Page served by NCS

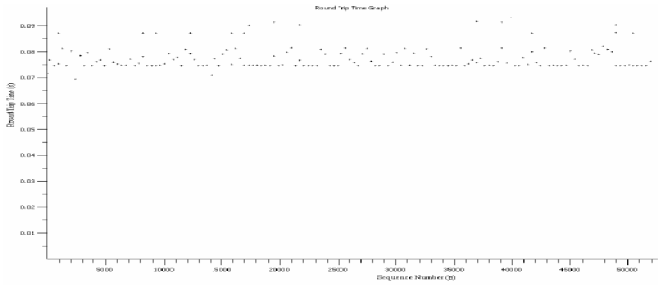

Fig. 3- A Plot of Round Trip Times ARM Mode in Public Network.

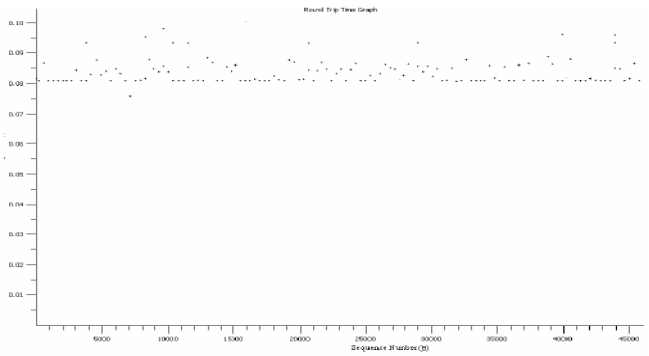

Fig. 4- A Plot of Round Trip Times THUMB Mode in Public Network.

The presented Network Control System can be used to perform real-time controls. The Network Control System is low cost and highly integrated. By using 32-bit ARM Microcontroller, the embedded system is of high precision and high performance over traditional 8/16-bit Microcontrollers. The system can also communicate with PC through RS-232 Serial Port. It supports online-supervision and control not only within Private Network (LAN) but also in Public Network (Internet). The hardware and software provide a platform for diverse control applications, including industrial process control and factory automation. Hence the Ethernet control system is a general controller that can be widely used. However, it

should be noted that no protocol guarantees timed Delivery of packets over the internet. Internet is a shared resource.

So by giving Internet Communication capabilities to any embedded system like NCS, such embedded system will then be capable to communicate with every corner of this planet.

## CONCLUSION

The performance of the NCS is analyzed in private network that is in Local Area Network (LAN) and public network (Internet) where ARM microcontroller used in 16-bit THUMB Mode and then 32-bit ARM Mode Instruction Set. In all cases Round Trip Time (RTT) is verified. RTT is a measure of relay between two hosts. RTT consists of the total time for a single packet or datagram to leave one machine, reach the other, and return. Wireshark Network Monitoring Software [12] [13] is used to capture client-server communication and for result analysis. For debugging serial communication is used. The code is written in the way that supports serial communication. With the help of HyperTerminal we can verify the internal states of program execution sequence

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