

# Design of ARM based Surveillance System with Ethernet interface

Rekha George<sup>1</sup>, Dr. Varghese Paul<sup>2</sup>

<sup>1</sup>(Research Scholar, Anna University, Chennai)

<sup>2</sup>(Professor, Toc H Institute of Science & Technology)

**ABSTRACT** : Embedded systems are now used in almost all areas like industries, medical, military, household appliances. As the communication technologies are advancing day by day we should think about improving the range of usefulness of embedded systems by including network connectivity to it. In this paper the design of an embedded system with Ethernet interface is proposed which can be used for surveillance in hazardous environments. Ethernet has the advantages of stability, upgradeability and reliability. Ethernet has a speed from 1Mbps to 100Gbps with a maximum range of 100km over optical fiber cable. The protocol used is micro internet protocol (MicroIP) which is a tiny version of TCP/IP used in embedded systems with limited memory resources.

**Keywords** - ARM, Wi-Fi, Biometric Device, LAN, Ethernet

## 1. INTRODUCTION

Embedded systems can no longer be an independent unit with no network connection which limits its usage. As the network technology and the communication technology are developing very fast we need to utilize its advantages in the embedded world too. Rapid changes in process technology demand production systems that are themselves easily upgradeable, and into which new technologies and new functions can be readily integrated [1]. In order to transmit the data from an existing device with SPI interface to network, embedded Ethernet interface design was done by Zhao Ruimei and WangMei [2]. The designed embedded system with Ethernet interface can be used to monitor and protect the people working in hazardous environments like various mines. Using this system we can keep track of the people who are working and can identify in case of their absence. The traditional TCP/IP protocol stack is complex and need substantive system resources[8]. Therefore we use here a thin model of TCP/IP stack called MicroIP.

## 2. HARDWARE DESIGN

The hardware modules of the system are biometric reader, ARM processor module, Wi-Fi module, Server System. Modular Design technique is used in designing the hardware part since that will be easier in case of any future enhancement.

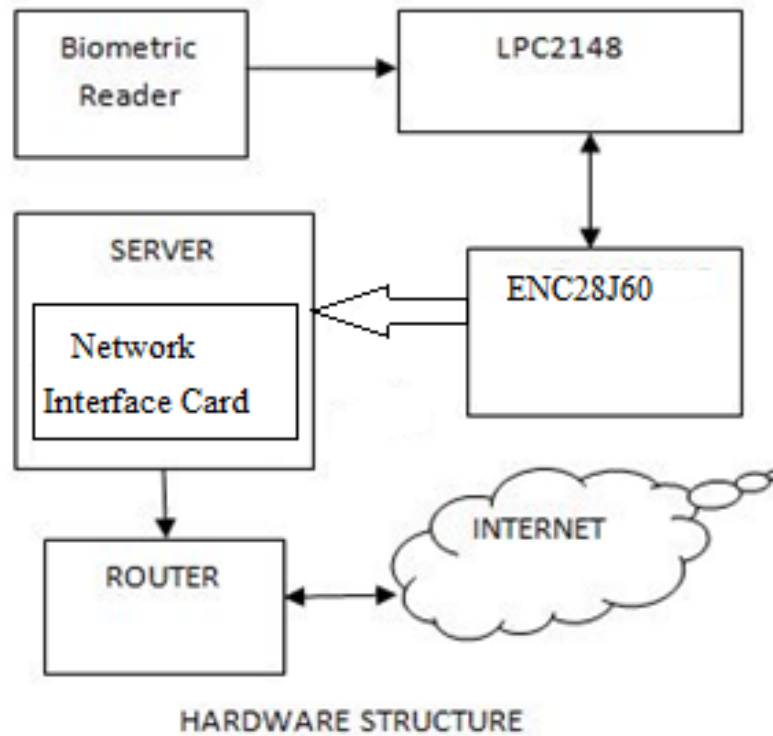


Fig 1. Hardware structure

## 2.1 BIOMETRIC READER

The identification of humans by their characteristics or traits is referred to as biometrics (biometric authentication). Here we use a finger scanner to scan the finger print. A sophisticated software that is inbuilt in the scanner will convert the scanned information into digital form and compared with the database for match points. Biometrics is highly reliable, low costly and is highly accepted. The data is transferred to processor module using serial port.

## 2.2 PROCESSOR MODULE

The processor module used is LPC2148 which uses the ARM7TDMI processor. The processor has inbuilt RTC, USB port and 512K on-chop memory which made it highly useful in real time monitoring and control applications. ARM7 is a 32-bit processor with high efficiency, low cost, high code density, low power consumption and its memory characteristics made them ideal for implementing stacks that require much memory. The data from the biometric device is received by the processor module over the UART which is universal asynchronous receiver transmitter which is a serial mode of data transfer. The data from the processor module is transferred to the Ethernet controller using SPI mode of transfer.

### 2.3 UNIVERSAL ASYNCHRONOUS RECEIVER TRANSMITTER - UART

UART in this module takes bytes of data received from the biometric device and transmits in a sequential form. The data transmission is synchronized at the transmitter and receiver side using the start bit. If we want to transmit 8 bit data then the frame size will be 10 or 11. The data starts with a start bit then the 8 data bits are send, followed by 1 parity bit which is optional and a stop bit. The steps for transmitting and reception are as follows.

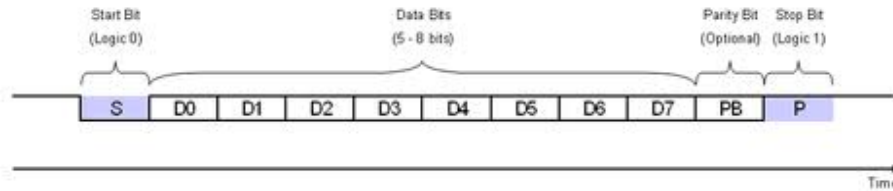


Fig.2 UART Data Stream

### 2.4 SERIAL PERIPHERAL INTERFACE – SPI

SPI allows 8 bits of data to be synchronously transmitted and received simultaneously. The serial interfaces can handle multiple masters and slaves being connected to a given bus. At a time a single master and a single slave can communicate on the interface during a given data transfer[4]. The interface between the processor module and the Ethernet controller is shown in the figure below. The master always starts the data transfer and is indicated by the master having a byte of data ready to be transmitted. The master activates the clock and begins the data transfer. Here Processor module acts as the master and the Ethernet controller the slave. The transfer ends when the last clock cycle of the transfer is complete. The slave device starts the transfer when the slave select signal SSEL goes active and ends when SSEL goes inactive. The basic send and receive functionalities of Ethernet are controlled by sending appropriate commands to the ENC28j60 and configuring the registers of ENC28j60 through SPI port [6].

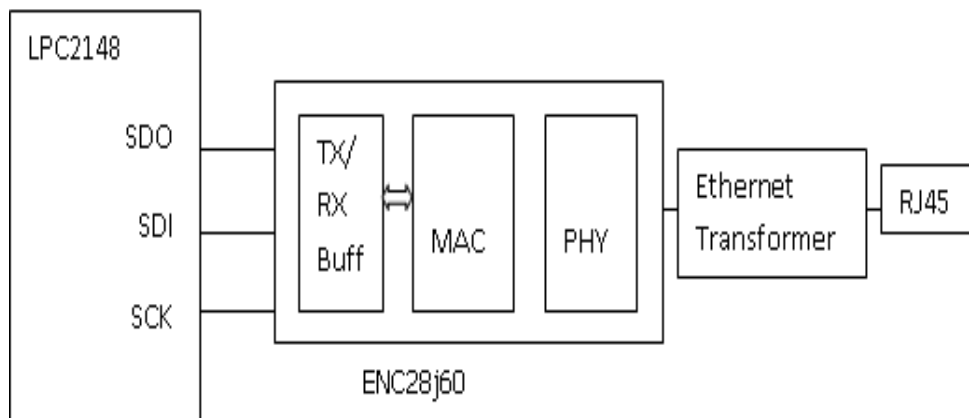


Fig 3. Interfacing processor module with ethernet controller

### 2.5 ETHERNET CONTROLLER

ENC28j60 is an IEEE 802.3 compatible Ethernet controller which is fully compatible with 10/100/1000Base-T networks. The device comes with an on-chip 10 Mbps Ethernet Physical Layer Device (PHY) and Medium Access Controller (MAC), providing reliable packet data transmission/reception based on

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an industry standard Ethernet protocol. The PHY contains analog circuitry to encode and decode the data on the twisted pair interface while the MAC contains digital circuitry to control when to transmit, handle automatic retransmission when a collision occurs, and do other necessary tasks. The Medium access controller will do the collision detection and error checking on the data that is to be transferred over the Ethernet. The serial data received over the serial port is framed according to the Ethernet frame format by the protocol and is transmitted according to the application program.

802.3 Ethernet Frame Format						
Preamble (7)	SOF (1)	Destination Address (6)	Source Address(6)	Length (2)	Data (1500)	FCS (4)
SOF-Start of Frame Delimiter, FCS- Frame Check Sequence						

Fig 4. 802.3 Ethernet frame format

### 3. SOFTWARE DESIGN

#### 3.1 Micro Internet Protocol (MicroIP)

As the embedded systems have a few kilobytes of RAM available which will not be enough for storing TCP/IP stack. MicroIP uses a single global buffer for holding packets and it is large enough to contain one packet of maximum size. When a packet arrives from a network the device driver will place that in the global buffer and if it contains valid data the protocol stack informs application program. Single global packet buffer that is used for incoming packets is also used for TCP/IP headers of the outgoing data. When dynamic data is send by the application it will use the global buffer that is not used by headers as a temporary storage. For sending data, application will pass a pointer to the data and also the length of the data to the stack. The headers are written into global buffer and it is send by the device driver and the application will send the data out on the network. MicroIP implementation can be as small as 200 bytes of RAM. In order to reduce memory usage, uIP utilizes the fact that the application may be able to regenerate sent data and lets the application take part in retransmissions. The protocol is stored in the memory of processor module.

#### 3.2 Embedded software

The functions of embedded software are reading the data from a biometric reader and transferring that to the Ethernet controller The data and time of entry/ exit of a particular person will be based on the real time clock of the microcontroller. At the time of exit the data stored in the memory is transferred to the Ethernet controller using SPI interface. The program will read the digital data from the biometric reader and checks whether the person is valid and if so, adds the time and saves in a register. When the person signs out, that time is added with the previous stored data and is transferred to the Ethernet controller using the SPI port.

#### 3.3 Application Software - Server side

The application software on the other hand will create a TCP connection and keeps on listening to the port and as soon as data is available it will be read and stored in the database of the server. The memory of the embedded device is not used for storage rather server with a larger memory capacity is made use of. Database is developed using MySQL database server which fast, reliable, scalable and easy to use relational database management system which runs as a server. The application software is written in JAVA. Java, which is robust, portable, with high performance and familiarity with write once run anywhere environment that made it the most apt embedded software developing language. The flowchart of application software is shown in Fig.1. Fig.2 shows the flow chart of the program used for reading the database by a valid person..

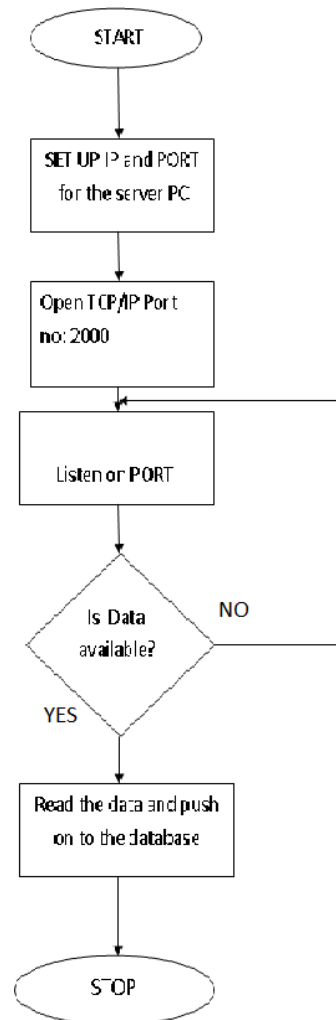


Fig.5

Fig 5. Flowchart for reading data from the embedded system

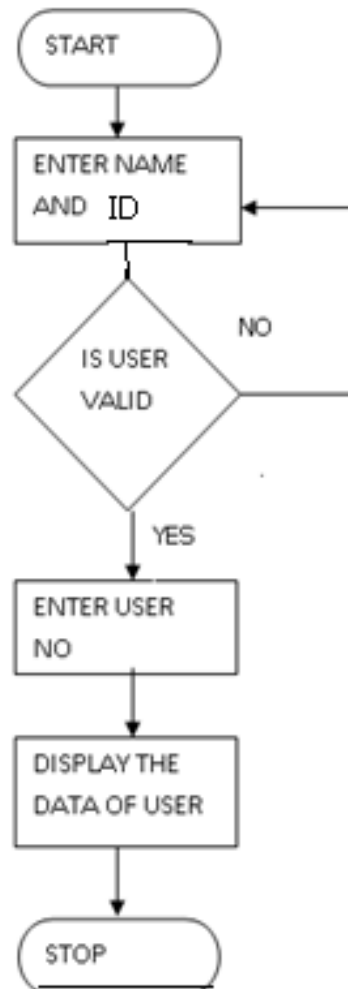
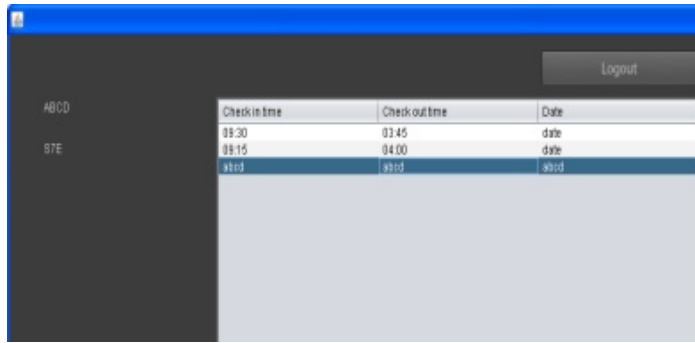


Fig.6

Fig.6 Flowchart for displaying data from the database by a valid user

#### 4. Conclusion

The result shows that the data is read, checked and is transferred over the Ethernet network and is stored in the database. The output screen displaying the details is shown below. A person who is geographically far from the server can also access the database over the internet.



Check in time	Check out time	Date
08:30	03:45	date
08:15	04:00	date
08:00	04:15	date

**Details of a Person Displayed**

## 5. REFERENCES

- [1] Rui Yang, Hong Cai, Mingzhan, "Research and Implement of Ethernet Interface Based on Embedded System" DOI 10.1109/ISCID.2009.218
- [2] Zhao Ruimei, Wang Mei, "Design of ARM-based Embedded Ethernet Interface" 978-1-4244-6349-7/10/ 2010 IEEE
- [3] Lu Xiao-chun , Huang Jiao , Wu Ming-chun , LiuXiu-feng , Ding Yan "IP-based Connectivity with IEEE 802.11 Embedded Networks", 978-1-4244- 7618-3 /10/2010 IEEE
- [4] ENC28j60 User's manual
- [5] Allen Bradley "EtherNet/IP network Configuration" user manual
- [6] Arul Prbakar A, Brahmandha Prabhu R, "Development of A Distributed Data Collection System based on Embedded Ethernet", 978-1-4244-9799-7 □ 11 □ \$26.00 ©20 11 IEEE
- [7] YU Cheng-bo, LIU Jie, and TAO Hong-yan, "Research on remote monitoring technology of equipment," Information and Control, Magn. China, vol.31 (3), pp.236-240, June 2002.
- [8] B. Srinivas Raj and G. Srinivas Babu, " Design of Web based Remote Embedded Monitoring system", *International Journal of Technology And Engineering System(IJTES):Jan –March 2011- Vol.2.No.2.*