# Design of ARM based Embedded Web Server for Agricultural Application

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*Abstract*- **This paper introduces design of WEB server based on ARM7 processor and ENC28j60 Ethernet controller chip. Through the Ethernet we could acquire the different real-time information, based on this information we can also implement control through internet. It allows user to interface real time application. Data acquisition plays an important role in real time control and online supervisions. In various internet application based on client/server architecture, it is better to use embedded web server other than PC server for decreasing volume, cost and power consumption. This Embedded WEB server can be used in various application like industrial, medical and agriculture. Here we used this embedded web server for data acquisition in agricultural field monitoring. Monitoring agricultural parameter remotely is most important criteria for maximizing production. In this paper we will be using LPC2148 32 bit ARM processor**

*Keyword*s- **ARM processor, Embedded web server, Ethernet controller**

## 1. INTRODUCTION

Data acquisition systems with remote accessibility are in great demand in industry and consumer applications. In some applications, human beings have been replaced by unmanned devices that will acquire data and relay the data back to the base. There are data-acquisition and control devices that will be a substitute for a supervisor in a multisite job operation. With the ability to access the application remotely, corporation can eliminate the need to send a service person to the application and thus save the labor time and money. The implementation of chosen embedded networking is achieved by means of the embedded web server. A web server provides access to the end devices for the client by uploading web pages as per the client request. When the configured IP address is enter in the web browser, the predesigned HTML web pages gets displayed through which the client can remotely monitored the sensor status respectively. The heart of communication is TCP/IP protocol. Network communication is performed by the IEEE802.3 Ethernet standard. ARM7 processor is as the brain of web server. ARM Processor is chosen because ARM has high data processing capability. It also has multi parameter acquisition and multi level monitoring and networking.

## 2. SYSTEM ARCHITECTURE

The architecture of agricultural field monitoring system is shown in fig.1. Here system consists of three different parts. First is the embedded web server second is the user part or client and third one is the sensors. The client thus monitors various parameter statuses through sensors. When network access is interfaced along with ARM processor

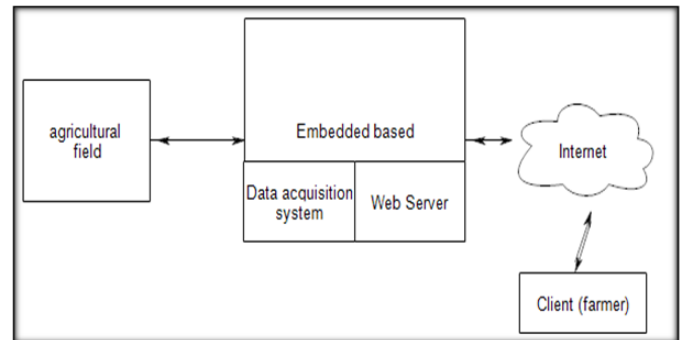this makes user to easily meet the monitoring requirements through web page.



Figure. 1 System overview

## 3. HARDWARE DESCRIPTION

The general hardware structure of remote I/O data acquisition system based on ARM processor is given. Sensors are used for process monitoring. Each I/O channel can select a variety of electrical and non-electrical signals like current, voltage, resistance etc. This signal is taken into LPC 2148 and digitized using the inbuilt ADC. Measured data are stored in memory. Memory is act as a data based during accessing web server. ARM processor has internal SPI module which directly support the Ethernet service communication.

This System utilizes a stand-Alone Ethernet controller IC which handles most of the network protocol requirements. The IC communicates directly to the LPC2148 controller using a standard SPI interface. The system hardware include an Ethernet controller IC ENC28J60, RJ45 socket with link/activity lights, Ethernet transformer, host LPC2148 controller and input/output devices like sensors. By using this Ethernet enabled digital I/O control system, application like embedded web server can easily developed.
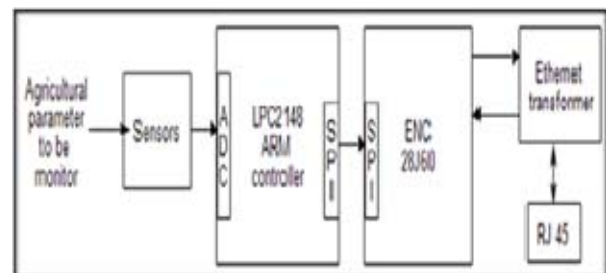


Figure 2. Block diagram of Embedded based web server

## 4. COMPONENT REQUIRED

### 4.1 LPC2148

LPC 2148 used ARM7 TDMI-S as its core and two type of buses to increase the board performance. The modules inside are connected by the CPU high performance bus Called Advanced-high-performance Bus (AHB) and the peripheral are connected by VLSI peripheral Bus (VPB). The data between the two buses are exchange at the AHB and VPB bus connection ARM7 TDMI-S has two sets of instruction set, the 32-bit standard and 16-bit Thump instruction set. The used of Thump instruction set can reduce the size of the control program up to 65. LPC 2148 has 2 types of memory Flash memory and static RAM memory. Flash memory is 512Kb out of which 12Kb used for storing the boot loader firmware(software resides in a chip) and 500Kb is used for working space that can store the program or data. Static RAM is 40Kb out of which 32Kb is used for program or data and 8Kb is used for DMA when USB is in used.

### 4.2 ENC28J60

The ENC28J60 is a stand-alone Ethernet Controller with an industry standard serial peripheral interface (SPI).It is designed to serve as an Ethernet network interface for any controller equipped with SPI. The ENC28J60 meets all of the IEEE 802.3 specification. It incorporates a number of packet filtering schemes to limit incoming packets. It also provides an internal DMA module for fast data throughput and hardware assisted checksum calculation, which is used in various network protocols. Communication with host controller is implement via an interrupt pin and the SPI, with clock rate of up to 20MHz. Two dedicated pins are used for LED link and network activity indication. With the ENC28J60, two pulse transformer and a few passive components are all that are required to connect microcontroller to an Ethernet network.

### 4.3 RJ-45 connector socket

Ethernet uses a bus (old coaxial cable) or star topology (standard UTP cable). Most Ethernet networks use unshielded twisted pair (UTP) cable. Category 5 (CAT5) cable widely used, but other variations are available. EIA/TIA specifies RJ-45 connectors- properly called 8P8C (ISO 8877) for UTP (unshielded twisted pair) cable. A standard LAN cable can be connected here using RJ-45 connector.

### 4.4 Ethernet transformer

On the TPIN+/TPIN- and TPOUT+/TPOUT- pins of ENC28J60, 1:1 center taped pulse transformers, rated for Ethernet operations, are required. When the Ethernet module is enabled, current is continually sunk through both TPOUT pins. When the PHY is actively transmitting, a differential voltage is created on the Ethernet cable by varying the relative current sunk by TPOUT+ compared to TPOUT-. A common-mode choke on the TPOUT interface, placed between the TPOUT pins and the Ethernet transformer, is not recommended. If a common-mode choke is used to reduce EMI emissions, it should be placed between the Ethernet transformer and pins 1 and 2 of the RJ-45 connector. Many Ethernet transformer modules include common-mode chokes inside the same device package.

## 5. FUNDAMENTAL COMPONENTS

This section gives information about various components related to the system and various options available for using them. Some of the important components and protocols are listed below.
- Ethernet Standard
- SPI interface
- HTTP protocol

### 5.1 Ethernet Standard

A typical Ethernet frame format is shown in Table 1. It consists of 7 bytes of preamble and this is used for bit synchronization. Start frame delimiter is of size 1 byte which is a frame flag that indicates the start of the frame. Source and destination addresses are of same size that is 2 to 6 bytes which is the 48-bit MAC address. Data size of 1500 bytes is allowed and frame checksum for checking errors is of 4 byte size that cyclic redundancy check .

TABLE 1
ETHERNET FRAME FORMAT

| Pre-amble | Start frame delimiter | Dest address | Source address | Type of length | Data | Pad | Check sum |
|---|---|---|---|---|---|---|---|
| 7 bytes | 1byte | 2-6bytes | 2-6bytes | 2bytes | 0-1500 bytes | 0-46 bytes | 4 bytes |

The Ethernet block of the system 10Mb/s or 100Mb/s Ethernet MAC that provides optimal performance through the use of DMA hardware acceleration. It has automatic frame transmission or reception with half or full duplex operation. The Ethernet block interfaces between the off-chip Ethernet PHY using Reduced MII protocol and the on-chip Media Independent Interface Management serial bus.

### 5.2 SPI interface

The SPI has a 4-wire synchronous serial interface. Data communication is enabled with a low active Slave Select or Chip Select Signal (SS) or (CS). Data is transmitted with a 3-wire interface consisting of wires for serial data input (MOSI), serial data output (MISO) and serial clock (SCK).
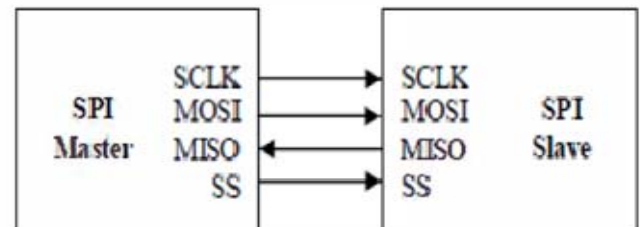


Figure3. Serial peripheral interface

### 5.3 HTTP Protocol

The protocol used for the communication between web server and web browser is Hyper Text Transfer Protocol or HTTP protocol. This protocol defines all the basic frame work of web communications by handling requests and also by providing control information to be transferred between browser and server. To obtain a web document, the browser and server should establish a connection at Port 80.

## 6. SOFTWARE REQUIREMENT

### 6.1 KEIL ARM

μVision is a window-based software development platform that combines a robust and modern editor with a project manager and make facility tool. It integrates all the tools needed to develop embedded applications including a C/C++ compiler, macro assembler, linker/locator, and a HEX file generator. The μVision IDE and Debugger is the central part of the Keil development tool chain and has numerous features that help the programmer to develop embedded applications quickly and successfully. The Keil tools are easy to use, and are guaranteed to help you achieve your design goals in a timely manner.

### 6.2 FLASH MAGIC

Flash Magic is loaded being performed. This means that other applications that need to use the COM Port, such as debugging tools, may be used while Flash Magic is Windows software from the Embedded Systems Academy that allows easy access to all the ISP features provided by the devices. Flash Magic provides a clear and simple user Under Windows, only one application may have access the COM Port at any one time, preventing other applications from using the COM Port. Flash Magic only obtains access to the selected COM Port when ISP operations are being performed. This means that other applications that need to use the COM Port, such as debugging tools, may be used while Flash magic

is loaded loaded. To download the hex file into the microcontroller board we use a programmer called flash magic tool.

### 7. DIFFERENT APPROCHES FOR EMBEDDED WEB SERVER

From review of related work and published literature, it is observed that many researchers have designed embedded web server for different application.

#### A. EWS for monitoring weather

A design of embedded web server based on Ethernet technology for remote monitoring of weather parameters is presented in [7]. This web server monitors parameters viz. temperature and humidity and transmits this information in the form of HTML web-page. They used the input sensors LM35 semiconductor temperature sensor and SY-HS-220 humidity module have been employed, providing accuracy about 1 centigrade and 2.

#### B. EWS for monitoring Home appliances

A development of a low-cost electronic prototype , which is design for monitoring and controlling home appliances via web browser  is given in[5].At the same time , users can monitor the security situation at home in real-time through different sensors installed at the home. They used low cost WIZ220IO as the embedded web server for implementation of the prototype remotely via internet.

#### C. EWS for monitoring temperature and CO2 in industry

The system which consists of an ARM cortex processor LPC1768 with an integrated Ethernet interface and the whole system can function as a web server [2].They used this system to monitor the temperature and concentration of $CO_2$ in the industry. For monitoring temperature and gas concentration they used LM35 temperature sensor and $CO_2$ gas sensor. The web page shows three data. The first data is the temperature, second data is concentration of $CO_2$ gas and third data shows that the motor for fan control is on when the temperature has rosen above a cut of value the fan becomes on to cool the remote industrial area.

## 7. CONCLUSION

The basic aim of the project was to create an embedded web server that enables agricultural field monitoring. An embedded web server occupies less space. Hence there would not need a fully-fledged computer but just a microprocessor that has an inbuilt TCP/ IP stack with minimum operating system software required for networking. Our system can be extended for sensing malfunctioning in industrial machines and making corrective measures in it.

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