Design and Implementation of Network Based Data Acquisition and Control System for Industrial Applications Using ARM-Linux

Ranga Pravalika
Scholar,
Vidya Jyothi Institute of Technology.

G.Sreenivasa Rao
Associate Professor,
Vidya Jyothi Institute of Technology.

S.Anil Kumar
Sr. Application Engineer,
Unistring Tech Solutions Pvt Ltd.

Abstract:

The places such as greenhouses, grain depot and nuclear radiation measurement require real-time monitoring of environmental temperature and humidity, temperature and humidity sensor nodes based on ARM-Linux platform is designed. The concept is analyzing the operating mechanism and timing sequence of temperature and humidity sensors in detailed and studying data format and the processing method of sensor. The temperature and humidity sensor node corresponding Linux drivers are programmed, then the temperature and humidity acquisition program porting to the ARM9-Linux platform. ARM microcontroller can communicate with serial data acquisition equipment's at the terminal through SPI interface and can transmit data to remote host computer through Ethernet interface. The web page will allow monitoring of transducers and status of the different devices.

Keywords:

Arm-Linux, Temperature and humidity sensor.

1. Introduction:

Embedded real-time operating system and dedicated hardware structure of Internet users around as long as you can at any time, any place using the system remote monitoring and control of embedded devices. Embedded system is an intelligent system that has the capability of processing, monitoring and controlling. It may comprise of Sensors, Microcontrollers, etc. The TCP/IP protocol is a widely used standard for modern digital communication. A portable System which can remotely monitor the status of our embedded system using a web browser or if sends an alert when it needs a service or is sold out of specific items. These things are all made possible with Embedded Ethernet. So a solution need be found to realize the communication between industrial control devices and Ethernet.

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. Implementing a portable web server using Friendly ARM 9 and Ethernet controller to monitor and control the devices. Implementing an embedded web server using ARM Microcontroller and Ethernet device. Monitor and Control Embedded Applications (like sensor, devices) Using Any Browser using LAN/Wi-Fi/internet. The WI-FI protocol is a widely used standard for modern digital communication. Main objective of the project is to make Internet/IP enabled embedded device serving as advanced remote data logger which can be accessed remotely via workstation. A Wireless sensor network (WSN) is a network consisting of distributed devices that provide sensing features such as temperature, humidity, gas, smoke, motion etc. An added feature in any embedded system is its ability to communicate. The communication can be via WI-FI, or Ethernet cables.

2. Proposed System:

•Implementing an embedded web server using ARM Microcontroller and Ethernet device.

•ARM microcontroller can communicate with serial data acquisition equipment's at the terminal through SPI interface and can transmit data to remote host computer through Ethernet interface.

•ARM acting as a standalone web server, with controls for various input and output transducers. The web page(s) will allow monitoring of traducers and status of the different devices.
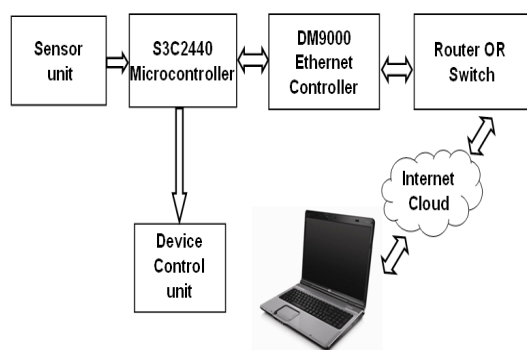
Fig 1: Block Diagram

Temperature, humidity & gas sensors are interfaced to sensor node. At the remote station PC displays the Webpage with updated geographical parameters.

3. Hardware Implementation:
Hardware design:

LM35 and SYHS220 are temperature and humidity sensors respectively. These sensors give analog outputs. S3C2440 has 8 ADC channels. It will support 8 analog inputs. ADC converts analog to digital data. The outputs of the sensors should be connected to ADC channels of the S3C2440 microcontroller through connecting wires. LM35 have 3 pins. One pin is connected to Vcc. one pin is connected to ground and another pin is connected to one of the ADC channel of the microcontroller. SYHS220 humidity sensor has 3 pins. One pin is connected to the ground, one pin is connected to Vcc and another pin is connected to the one of the ADC channel of the microcontroller.DM9000 Ethernet controller connected to the Router through RJ45 cable. Destination pc monitors the temperature and humidity parameters by using LAN/wifi/Internet technology.

Software design:

Writing c code for data acquisition and send the data to clients. Sensor module will measure the temperature and humidity and that data is sent to the user module. ADC drivers read the adc output. embedded c code is implemented for taking ADC drivers value and refracting analog value from that and send it to the webpage when client request. Implemented HTML code for creating webpage. Based on client requests the server will place the equivalent value of sensors output will be updated into web page.

ARM9 S3C2440A:

The ARM processor is a Reduced Instruction Set Computer (RISC). The ARM920T processor is a member of the ARM9TDMI family of general purpose microprocessors includes the ARM9TDMI core plus cache and MMU.

ARM9TDMI processor:

•Harvard architecture
•5-stage pipeline
•32-bit ARM instruction set and 16-bit THUMB instruction set.
Samsung's S3C2440A is designed to provide hand-held devices and general applications with low-power, and high-performance microcontroller solution in small die size. The S3C2440A is developed with ARM920T core. It adopts a new bus architecture known as Advanced Micro controller Bus Architecture (AMBA). ARM920T views memory as a linear collection of bytes numbered upwards from zero. The S3C2440A offers outstanding features with its CPU core, a 16/32-bit ARM920T RISC processor designed by Advanced RISC Machines, Ltd. The ARM920T implements MMU, AMBA BUS, and Harvard cache architecture with separate 16KB instruction and 16KB data caches, each with an 8-word line length. Bytes 0 to 3 hold the first stored word, bytes 4 to 7 the second and so on. ARM920T can treat words in memory as being stored either in Big-Endian or Little-Endian format.

Humidity sensor:

Humidity is an important factor in personal comfort and in quality control for materials, machinery etc. Now we are using SYH2 and SYH-2S humidity sensors in most of the circuits.Humidity sensors are gaining more significance in diverse areas of measurement and Control technology. Manufacturers are not only improving the accuracy and long-term drift of their sensors, they are improving their durability for use in different environments, and simultaneously reducing the component size and the price. Following this trend, Swiss-based Sensation AG has introduced a new generation of integrated, digital, and calibrated humidity and temperature sensors using CMOS "micro-machined" chip technology. The new products, SYH2 and SYH-2S, are a single chip relative humidity and temperature multi sensor module with a calibrated digital output which allows for simple and quick system integration. Conventional sensors determine relative air humidity using capacitive measurement technology. For this principle, the sensor element is built out of a film capacitor on different substrates (glass, ceramic, etc.).

Features:
• Operating humidity 20-95%RH
• Standard characteristics 33KQ (At 25degree centigrade, 60%RH)
• Storage temperature -30—85° centigrade
• Storage humidity within 95%RH
• Humidity accuracy +/- 5%RH (at 25degrees centigrade,60%RH)
• Humidity response time <60sec (40-80%RH)

Temperature sensor (LM35):

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient centigrade scaling. The LM35 can be applied easily in the same way as other integrated-circuit temperature sensors. It can be glued or cemented to a surface and its temperature will be within about 0.01°C of the surface temperature. This presumes that the ambient air temperature is almost the same as the surface temperature; if the air temperature were much higher or lower than the surface temperature, the actual temperature of the LM35 die would be at an intermediate temperature between the surface temperature and the air temperature.

Features:
1. Calibrated directly in ° Celsius (Centigrade)
2. Linear + 10.0 mV/°C scale factor
3. 0.5°C accuracy guarantee able (at +25°C)
4. Rated for full -55° to +150°C range

Ethernet:

The network controller implements the electronic circuitry required to communicate using a specific physical layer and data link layer standard such as Ethernet, Wi-Fi, or Token Ring. This provides a base for a full network protocol stack, allowing communication among small groups of computers on the same LAN and large-scale network communications through routable protocols, such as IP. Systems communicating over Ethernet divide a stream of data into individual packets called frames. Each frame contains source and destination addresses and error-checking data so that damaged data can be detected and re-transmitted. The standards define several wiring and signaling variants.

In this project DM9000 Ethernet controller is used. DM9000 is fully integrated and cost effective single chip fast Ethernet MAC controller with a general processor interface a 10/100 PHY and 4K Dword SRAM. It is designed with low power high performance process that supports 3.3V and 5V tolerance. DM 9000 also provides a MII interface to connect HPNA device or other transceivers that support MII interface. The DM 9000 support 8-bit, 16-bit and 32-bit up interfaces to internal memory accesses for different processors. The DM9000 also supports IEEE802.3x full duplex flow control. This programming of the DM9000 is very simple, so user can port the software drivers to any system easily.

HTTP:

HTTP is the protocol to exchange or transfer hypertext. Hypertext is structured text that uses logical links (hyperlinks) between nodes containing text. HTTP is the foundation of data communication for the World Wide Web. HTTP functions as a request-response protocol in the client-server computing model. A web browser, for example, may be the client and an application running on a computer hosting a web site may be the server. The client submits an HTTP request message to the server. The server, which provides resources such as HTML files and other content, or performs other functions on behalf of the client, returns a response message to the client. The response contains completion status information about the request and may also contain requested content in its message body.

Wi-Fi (IEEE standard 802.11):

Wi-Fi is the wireless way to handle networking. It is also known as 802.11 networking and wireless networking. The big advantage of Wi-Fi is its simplicity. Mobile connectivity for computers is a rapidly growing requirement. Of the schemes that are available the IEEE 802.11 standard, often termed Wi-Fi has become the de-facto standard. With peak operating speeds of around 54 Mbps it is able to compete with many wired systems. As a result of the flexibility and performance of the system, many Wi-Fi "hotpots" have been set up and more are following. These enable people to use their laptop computers as they wait in hotels, airport lounges, cafes, and many other places using a wireless link rather that needing to use a cable.

Router:

Router is meant to act as a data Forwarder thus enabling the end nodes to Communicate with the Master node. The Master node specifications are different from end node and router.

4. Hardware Results:

The concept is developed on the ARM9 based S3C2440 micro controller.
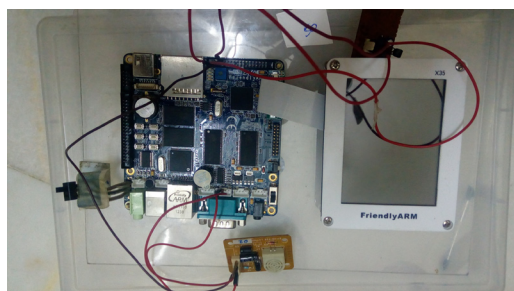

Fig 2: Micro Controller Node

The sensors used in the project are Temperature and Humidity sensors. These sensor data is captured by ADC of the microcontroller and calculates the mathematical equations and computes the results. The data is then framed to a HTML page data and the sensor data is updated in the page and displayed through WIFI. HTML page is used to display the data in an understandable format.

Fig 3: HTML Page

5.Conclusion:

The system designed in this paper is applied to monitor physical parameters of the remote field temperature and humidity. The server collects information from the entire remote field and transmits to the monitoring station i.e. through WI-FI.

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Authors Details:

Ranga Pravalika, is presently pursuing final semester M. Tech in Embedded Systems at Vidya Jyothi Institute of Technology, Telangana, India.

Gadela Sreenivasa Rao, Associate Professor in Vidya Jyothi Institute of Technology (VJIT), Hyderabad. He received M.Tech in Embedded Systems from JNTU Hyderabad and B. Tech in Electronics and Communication Engineering from JNTUCEA, Anantapur. He is having 12 years teaching experience in Electronics & communication and interest in Embedded Systems field.

S. Anil Kumar, is presently working as Sr. Application Engineer in Unistring Tech Solutions Pvt Ltd, Hyderabad, Telangana, India.