INTERNET BASED REMOTE MONITORING AND CONTROL SYSTEM

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ABSTRACT

With the growing popularity of internet and development of embedded technology, Web technology has been extended to the development and application of embedded system. It is the end of the network era which takes PC equipment as the basic network node. Besides PC equipment, the network nodes include various types of embedded devices. How to remotely monitor, control, diagnosis, manage and maintain operations of embedded devices from different subnets and physical areas, is the problem needed to be solved. Web based remote monitoring and controlling system should directly connect the equipment to the network as node using Atmega16 processor and network module. The clients do not need to install special software and may monitor and control the current condition of equipment through web browsers. This structure has the following advantages- it truly realizes seamless connection between equipment and their management. It greatly decreases the system building cost. With the development of industrial Ethernet technology, the real time performance of system is improved further.

KEYWORDS: *ASP.net, Atmega16, Internet based systems, Wiznet*

I. INTRODUCTION

Integrating web and embedded technology, the embedded equipment monitoring and controlling system based on web management can be done. Managers can remote access, monitor and maintain the on-site equipment through the network and using a web browser without limit of region and time It can realize the inter-access between the heterogeneous equipment.

The function of Web-based equipment monitoring system is to collect real-time data of the on-site equipment, publish it through a Web form, and remotely send the data in the form of the user-defined data transmission style [1]. It will provide flexible remote monitoring and diagnosis function combining the configuration software based on standard browser. The data will be published through web page form by the web server in various user defined formats. If the parameter value is different from the original set value by the user, a corrected signal will be send to the control unit automatically by the processor. The limit value can be set by the user through the web browser at any remote location. Thus the defined parameter can be controlled through the processor via internet. In a similar fashion various other parameters for control and monitoring can be added to customize the hardware to suite the user requirements. With the growing popularity of Internet and the development of embedded technology, Web technology has been extended to the development and application of embedded system. It is the end of the network era which takes PC equipment as the basic network node. Besides PC equipment, the network nodes include various types of embedded devices. How to use Embedded and Web technology to perform remote monitoring, diagnosis, management, and controlling and maintenance operation of embedded devices from different subnets and physical areas, is a problem that needs to be solved. Embedded Web based equipment condition monitoring and controlling system directly connects the equipment to network as a node [2]. The clients do not need to install special software and may monitor and control the current condition of equipment through browsers. This structure has the following advantages:

a) It truly realizes seamless connection between equipment and their management.
b) It greatly decreases the system building cost.
c) With the development of industrial Ethernet technology, the real-time performance of system is improved further.

The section two will elaborate the minute details of the whole system. The hardware contents of the system like microcontroller and sensors and the software design, languages and database systems of the remote monitoring and control system is also covered.

II. INSIDE THE SYSTEM

2.1. The Function Designing of System

The idea was to take a system with some parameters and connect the system directly to internet/server and now monitor or control these various parameters through remote location via embedded web or internet. The function of Web-based equipment monitoring system is to collect real-time data information of the onsite equipment, publish it through a Web form, and remotely send the data in the form of the user-defined data transmission style. It will provide flexible rich remote monitoring and diagnosis function combining the configuration software based on standard browser. The data will be published through web page form by the web server. The remote Computer will collect the data and running status through the network and will provide the comparison on the historical data. If the parameter value is different from the original set value a signal will be given to the fan or heater accordingly and will turn it on. Thus the processor sends the control signal to the control unit. Thus the defined parameters can be controlled through the processor via internet [3]. In order to connect the embedded devices to the Internet and enable users to monitor the embedded devices using a standard Web browser, a website will be developed and ported onto the remote computer (ISP server). The Web server provides the Web-based graphical interfaces to users of the Internet to carry out unified supervision and management of various devices linked to network. In this project, the analog parameter planned for monitoring and control is temperature. The heart of the hardware is the microcontroller ATmega 16[4].The signal is picked by the sensor (LM35). The sensed signal is fed to the analog to digital (A/D) converter in built in the microcontroller. The A/D converter converts the analog input signal into digital signal and supplies to the processor. The ATmega16 based chip set controls the A/D collections and data transmission. 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 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150°C temperature range [5].

2.2. Hardware Definition

For the purpose of definition of hardware architecture for sensor data acquisition, digitization and network establishment for internet connectivity, various books on microcontrollers / microprocessors and chip sets were studied to identify the components best suited for the intended application. The heart of the hardware architecture is the processor (ATmega16) around which the chip set is developed. The ATmega16 exchanges the sensor data with Data port module which consists of Monitoring module (A/D sub-module) and Control module (Relay driver circuit). The A/D convertor converts the sensor data into digital format and supplies to ATmega16 for data processing. The control module converts the digital command generated by ATmega16 into power signals for regulating the target outputs.

The figure 1 shows the detailed structure of hardware of the project.

The hardware part of system consists of Atmega16 core board, A/D convertor, signal conditioning, sensors, and communications interface. The Atmega16 chip consists of FLASH, 8-channel 10-bit ADC, one/two 16/8-bit timers. It is an 8-bit RISC microprocessor with the characteristics of high cost-performance, low power, small size and high integration. The ATmega16 provides the following features:

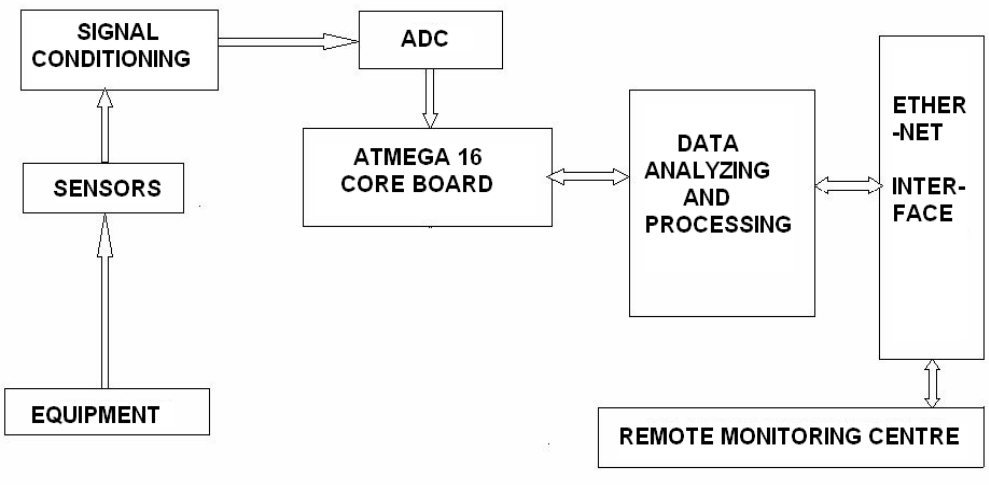

Figure 1 The Hardware architecture block diagram

16K bytes of In-System Programmable Flash Program memory with Read-While-Write capabilities, 512 bytes EEPROM, 1K byte SRAM, 32 general purpose I/O lines, 32 general purpose working registers, a JTAG interface for Boundary scan, On-chip Debugging support and programming, three flexible Timer/Counters with compare modes, Internal and External Interrupts, a serial programmable USART, a byte oriented two-wire Serial Interface, an 8-channel, 10-bit ADC with optional differential input stage with programmable gain (TQFP package only), a programmable Watchdog Timer with Internal Oscillator, an SPI serial port, and six software selectable power saving modes. The Idle mode stops the CPU while allowing the USART, Two-wire interface, A/D Converter, SRAM, Timer/Counters, SPI port, and interrupt system to continue functioning. The Power-down mode saves the register contents but freezes the Oscillator, disabling all other chip functions until the next External Interrupt or Hardware Reset. In Power-save mode, the Asynchronous Timer continues to run, allowing the user to maintain a timer base while the rest of the device is sleeping.

The ADC Noise Reduction mode stops the CPU and all I/O modules except Asynchronous Timer and ADC, to minimize switching noise during ADC conversions. The On-chip ISP Flash allows the program memory to be reprogrammed in-system through an SPI serial interface, by a conventional non-volatile memory programmer, or by an On-chip Boot program running on the AVR core. The boot program can use any interface to download the application program in the Application Flash memory. Software in the Boot Flash section will continue to run while the Application Flash section is updated, providing true Read-While-Write operation. By combining an 8-bit RISC CPU with In-System Self-Programmable Flash on a monolithic chip, the Atmel ATmega16 is a powerful microcontroller that provides a highly-flexible and cost-effective solution to many embedded control applications. The various signal of equipment are picked up by sensors and converted to digital signals by the A/D converter chip after Signal conditioning. The programmable control chip controls the A/D collection and the data transmission with Atmega16. For the purpose of streaming equipment data along with equipment operating condition information to the remote server, the Ethernet module converts the digital data into Ethernet format and transmits it to the web server through RJ45 connector.

This part will be embedded in the devices as an independent hardware module. A relay is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism mechanically, but other operating principles are also used. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits, repeating the signal coming in from one circuit and re-transmitting it to another.

Relay selected is cube type (JM-2P) which has the features like Smaller size compared to RW series (sugar cube relays), but with 25A Inrush current and has application for automotive electrical systems [6].

The hardware details can be actually seen in the figure 2.

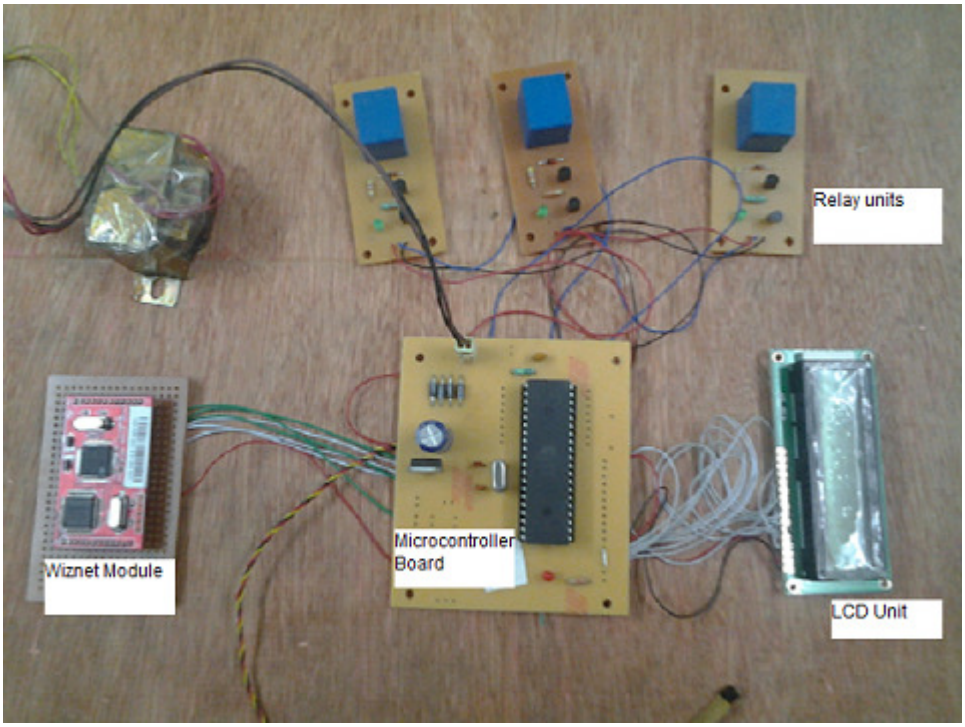

Figure 2 Hardware components of the system

2.3. Software Definition

To achieve integration of the embedded hardware with World Wide Web, various papers / books were referred to identify the right operating system and other software platforms for development of data processing and Graphical user interface (GUI) definition. The sensor data processing/control, GUI and the Databases are developed by integrating the standardized technologies, such as embedded C, ASP.NET, MySQL, and the dynamic linking library (DLL) files [7]. Remote monitoring station has includes several functions, they are initialization of serial port, sending and accepting data, database interface and so on.

There can be various possibilities scripts, Microsoft has introduced ASP. Asp.net enables to access information from data sources, such as backend database and text files that are stored on a web server or a computer that is accessible to a web server.

Asp.net enable to use a set of programming code called templates to create HTML documents. Asp.net also enables to separate HTML design from data retrieved mechanisms. Therefore, changing the HTML design does not affect the program that retrieves data from the databases. Asp.net is based on the .net frame work. Web form enables to include user interface, such as text box, list box controls and application logic of Web applications, and configuration files enable to store the configuration settings of an asp.net application. MySQL is the free database software available on net so decided to use it. It is also easy to use software and user friendly.

2.4. Ethernet Driver Module

Ethernet drivers are software programs that provide hardware-software interaction between the operating system of a personal computer (PC) and its network port.WIZ812MJ is the network module that includes W5100 (TCP/IP hardwired chip, include PHY), MAG-JACK (RJ45 with Transformer) with other glue logics. It can be used as a component and no effort is required to interface W5100 and Transformer. The WIZ812MJ is an ideal option for users who want to develop their Internet enabling systems rapidly. The W5100 is a full-featured, single-chip Internet enabled 10/100 Ethernet controller designed for embedded applications where ease of integration, stability, performance, area and system cost control are required. The W5100 has been designed to facilitate easy implementation of Internet connectivity without OS. The W5100 is IEEE802.3 10BASE-T and 802.3u 100BASETX compliant.

The W5100 includes fully hardwired, market-proven TCP/IP stack and integrated Ethernet MAC & PHY. Hardwired TCP/IP stack supports TCP, UDP, IPv4, ICMP, ARP, IGMP and PPPoE which has been proven in various applications for several years. 16Kbytes internal buffer is included for data transmission. No need of consideration for handling Ethernet Controller, but simple socket programming is required [8].
For easy integration, three different interfaces like memory access way, called direct, indirect bus and SPI, are supported on the MCU side. The structure of web based remote monitoring system is given in figure 3.

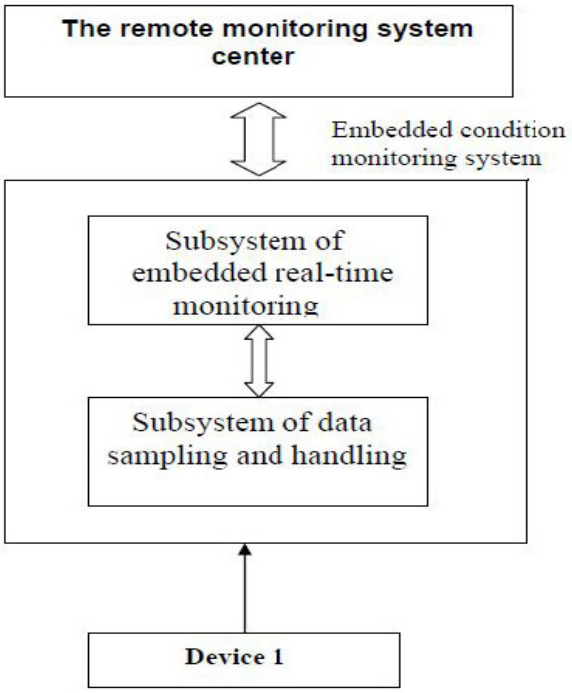

Figure 3 The structure of web based remote monitoring system

2.5. Result and Discussion

The application is taken of temperature of a room, where it is needed to have constant temperature. So the required temperature is set point. If the temperature is below set point heater will be on and if it is above set point then cooler will be on. The figure 4 shows admin panel of the web on which the current temperature is displayed which is less than the set maximum temperature. So heater is on and cooler if off. We can upgrade the set point if needed with the administrative rights.
The Issue of Communication Security: The main design considerations were security, performance, ease of use, availability, and scale. Security is paramount when we consider exporting private and confidential information outside of the firewall. We must assure that only valid users can access the web, while active attackers on the Internet cannot. We describe our techniques for authenticating clients and maintaining the privacy of the information from illegitimate outsiders.
The issue of communication security at the present scenario is handled by having the user id and password to access the website controls. The technology is advancing day by day. The security issues involved in the system will be completely removed out by applying latest concepts of internet.
Then the system like this can be easily implemented by small to large scale industries for remote monitoring and controlling the plants.

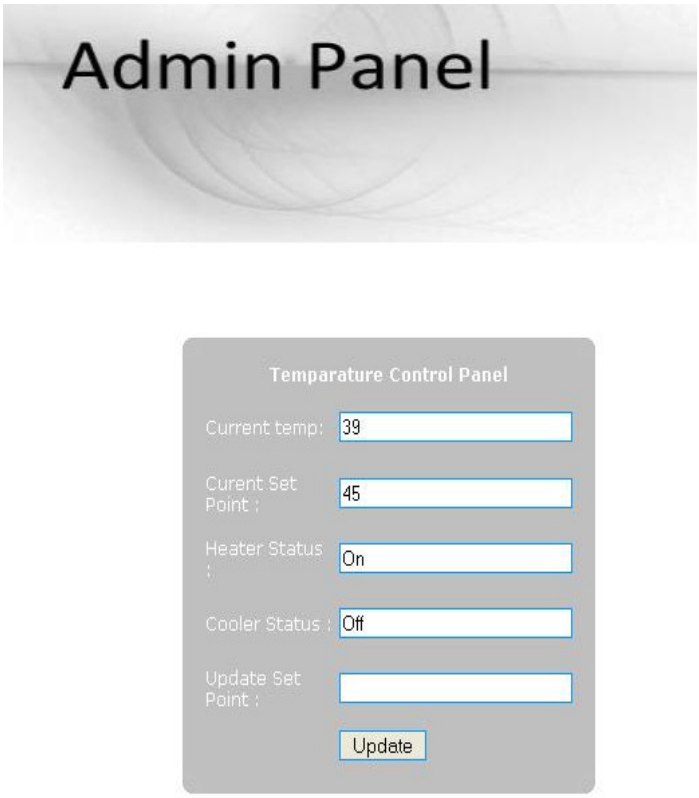

Figure 4 Monitoring and control panel

III. CONCLUSIONS

In this application, a low-cost, Internet-based control system has been designed and implemented. The application possibilities are virtually unlimited by attaching modules with appropriate interfaces, although the usage of the system is demonstrated with only a few sample devices. Compared with other applications, this system has advantages in terms of allowing direct bidirectional communication and reducing overhead, which can be vitally important for some real-time applications. The operational costs can be reduced by relinquishing the storage of large data to an FTP server on the Internet.

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