UNIVERSITI PUTRA MALAYSIA

WEB-BASED REMOTE MONITORING AND CONTROLLING SYSTEM USING EMBEDDED WEB SERVER

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By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia in Partial Fulfilment of Requirement for the Degree of Master of Science

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UPM

To my husband, son and parents

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in partial fulfilment of the requirement for the degree of Master of Science

WEB-BASED REMOTE MONITORING AND CONTROLLING SYSTEM USING EMBEDDED WEB SERVER

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September 2002

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The World Wide Web (WWW) has established itself as a strong medium for distributed computing: a network user interface that is powerful and platform independent. As embedded systems become more prevalent. the need for connectivity of the devices or appliances to the WWW becomes inevitable.

This thesis proposed a system that can control and monitor appliances or devices through the web by implementing embedded web server called SitePlayer web server. The embedded web server is used to serve static or dynamic information requested by user through the standard web browser such as Internet Explorer and Netscape.

Web page which contains dynamic data that acts as a user interface is designed using HTML language. These Web pages is downloaded into the SitePlayer web

server through the SiteLinker Program. The downloading process is done through the Ethernet line. From the web page, user from remote site can open a link to control or monitor the status of the application at local site using Web browser such as Internet Explorer.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

SISTEM PENYELENGGARAAN DAN KAWALAN JAUH BERASASKAN WEB MENGGUNAKAN PELAYAN WEB TERBENAM

Oleh

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Jaringan Sejagat (WWW) adalah salah satu media yang berpengaruh terhadap pengkomputan teragih: di mana ianya adalah rangkaian antramuka pengguna yang berkuasa dan berdasarkan pelantar yang bebas. Oleh kerana system terbenam telah menguasai pasaran, keperluan menghubungkan peralatan elektrik kepada WWW menjadi suatu kepentingan.

Tesis ini mencadangkan sistem yang boleh memantau dan mengawal peralatan melalui web dengan menggunakan pelayan web terbenam yang dikenali sebagai "SitePlayer". Pelayan web terbenam ini digunakan untuk melayan maklumat static atau dinamik yang diminta oleh pengguna melalui pelayar web seperti "Internet Explorer" dan "Netscape".

Halaman web yang mengandungi data dinamik di mana ianya berfungsi sebagai antaramuka pengguna dihasilkan menggunakan bahasa "HTML". Halaman web ini akan dimasukkan ke dalam pelayan web "SitePlayer" menggunakan aturcara "SiteLinker". Proses ini dijalankan melalui talian "Ethernet". Pengguna dari kawasan yang jauh boleh klik rangkai pada halaman web untuk memantau atau mengawal status aplikasi yang berada di kawasan setempat menggunakan pelayar web seperti "Internet Explorer".

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

Siti Mariam binti Shafie @ Musa

Date:

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LIST OF ABBREVIATIONS

ADC	Analog to Digital Converter
ASCII	American Standard Code for Information Interchange
ASPs	Active Server Pages
CGI	Common Gateway Interface
CMOS	Complementary Metal Oxide Semiconductor
COM Port	Communication Port
CPU	Central Processing Unit
EEPROM	Electrical Erasable Programmable Read Only Memory
FTP	File Transfer Protocol
GUI	Graphical User Interface
HTML	Hyper Text Markup Language
HTTP	Hypertext Transfer Protocol
IC	Integrated Circuit
ICMP	Internet Control Message Protocol
ISA	Industry Standard Architecture
ISP	Internet Service Provider
I/O	Input/Output
LAN	Local Area Network
LCD	Liquid Crystal Display
LED	Light Emitting Diode
MIME	Multimedia Interface Main Extensions
MMI	Man Machine Interface
PC	Personal Computer
PIC	Peripheral Interface Controller

PLC	Programmable Logic Controller
RAM	Random Access Memory
ROM	Read Only Memory
RTPS	Real Time Publish Subscribe
SLIP	Serial Line Internet Protocol
SPB	SitePlayer Binary
SPD	Siteplayer Definition
SSL	Secure Sockets Layer
TCP/IP	Transmission Control Protocol/ Internet Protocol
TINI	Tiny Internet Interface
UART	Universal Asynchronous Receiver/Transmitter
URL	Uniform Resource Locator
WWW	World Wide Web

CHAPTER I

INTRODUCTION

The Internet has grown explosively in the 1990's, with tens of millions of people now surfing the Net. Most experts expect the Internet to have a greater impact on society than television and radio, the two major communication mediums that preceded it (Cohn, 1997).

WWW has the potential to become a complex and powerful client-server application environment. The client-server relationship is based on two computers communicating with each other to share information. One computer called the server, hosts the information which the other computer called the client, retrieves by sending out a request. The server responds to the client by sending back the information to be displayed or used by the client. The web uses a protocol called HTTP (HyperText Transfer Protocol) which allows remote hypermedia collaboration through the Internet backbone. Web browsers, such as Netscape Navigator and Internet Explorer, act as clients to translate the protocols into a format we can understand. The format which the Web browser uses to interpret protocols called HTML (Ahsmore, 1997).

Nowadays, many projects and researches related to small web server have been carried out in order to design a low-cost, low power, fully functional, stand alone Web Server and network-enabled. They are called embedded system. Embedded devices are used to control, monitor or assist an operation. They are used in cars,

cameras and computer components among other equipment (Boppuri, 2000). Embedded devices may be connected to the Internet to achieve global remote access, which means that these devices can be monitored or controlled thousands of miles from their original location.

With the wide spread deployment of the Internet and WWW, both as a public and as corporate resources, people have come to recognize the utility of attaching low-cost devices to networks for the purpose of communicating with these devices using standard networking protocols, including TCP/IP (Transmission Control Protocol/ Internet Protocol) and HTTP. In fact, connecting almost any device to a network immediately increases the utility of that device because it can now be accessed remotely for the purposes of data display, remote monitoring and control, communication, etc. If connected to the Internet, that device becomes instantly accessible from virtually any place in the world through web browser.

Web browser not only shows the information it has fetched from a web server, but it can also be used to make selections, click on switches and check-boxes, enable or disable features and change settings and send them over to the remote computer and have the settings to take effect. It means that the devices or appliances that are connected to a network can be monitored or controlled from the other place.

Problem Statement

Obtaining data from an embedded application can be somewhat cumbersome. Traditionally, the data has been transferred through a serial connection. To increase throughput on this relatively slow connection, the application would write the data to the connection in a raw format. A dumb terminal connected to the embedded device would then collect the data for the user to interpret. Multiple embedded system required one serial link per system loading the host system I/O (Input/Output) space. If the terminal supported graphics, it might also be necessary to write a graphical interface, otherwise the data would dump out as straight text.

By using an embedded Web server, the same data can be formatted and displayed with HTML through any standard web browser. The user's response to the data can include input to modify the embedded device's configuration. Moreover, communication with the embedded application can use Ethernet and HTTP can handle the transfer of larger amounts of data to any device on the same network.

Scope of Project

In this research, the system is concentrated on three main parts. They are web server, web page and hardware interface. For the web server, a small embedded Ethernet web server is used instead of normal web server. The server support TCP/IP, HTTP, ICMP (Internet Control Message Protocol) protocols. For the Web page, it is developed using HTML language as an interface to the real devices that is connected to the server. The hardware interface is one of the important parts of

the system. It must have the ability to send or receive data to/from the web server. Figure 1.1 shows the scope of the project.

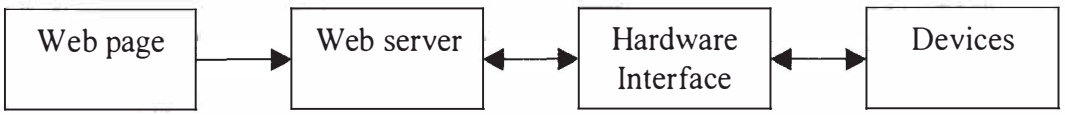

Figure 1.1: Project scope

Objective

The main objective of the project was to provide a prototype of the Remote Monitoring and Controlling system, which was affordable to the user and capable of being monitored the room temperature and controlled appliances from the Internet using embedded web server.

Thesis Organization

The thesis consists of five chapters. Chapter I give an overview about the World Wide Web, the Internet, the Web server, problem statement, scope and objectives to be achieved. Chapter II presents a literature reviews on various aspects related to the concepts of remote monitoring and controlling system through the web. Chapter III describes the methods involved in developing the system and the details of implementation in development process. Results of the testing circuits and system evaluation are discussed in Chapter IV while chapter V present a conclusion of the overall project and recommendation for future work.

CHAPTER II

LITERATURE REVIEW

Monitoring and controlling system through the Internet has become essential due to technological advances in multimedia. Therefore many researches have been done to improve the system to become more effective and efficient. In this chapter, some vital elements that were required to implement this project and previous predecessor project on the remote monitoring and controlling system will be discussed.

Dramatic advances in networking technology and computing paradigm, coupled with significant advances in creation and management of standardized multimedia documents has resulted in explosive growth of the Internet. There are several services on the Internet: File Transfer Protocol (FTP), telnet, e-mail, WWW, etc. Especially, WWW is the very remarkable service on the Internet. We can transfer and view not only text data, but also a multimedia data - images, animated images, sounds etc. The emergence of WWW promotes the growth of the Internet hosts and users. In 1995, it is estimated as 4 millions the number of hosts connected with the Internet around the world, relatively to 0.1 millions in 1989. And it is estimated as over 40 millions the number of users. In the last 5 years, growth of the Internet has been nothing short of phenomenal. There are already an estimated 25,000 merchants in 150 countries selling or advertising their products on-line. It is estimated that nearly 20 million individuals will use the Internet for commercial purposes by the end of this millennium. So, there remains the potential consumer

of electronic commerce over 30 million (Sung, 2000).

Embedded Systems

Industry analysts see embedded Internet systems as poised for rapid growth in the manufacturing sector in the next few years (Finch, 1998).

The use of microprocessors/microcontroller based products in office, home and industrial environment is growing exponentially. The term 'embedded system' is nebulous and encompasses just about everything except desktop PCs, workstations and mainframes. An embedded system is one which is preprogrammed to perform a dedicated or narrow range of functions as part of larger system, usually with minimal end-user or operator intervention. Embedded systems have traditionally been differentiated from desktop systems on the basis of functionality. Desktop systems provide a wide spectrum of technologies to serve a broad range of application needs, while embedded devices are fitted with just enough software to handle a specific application. These systems such as routers, hubs, printers, fax machines and photocopiers are growing in numbers. In all these systems, embedded processors implement significant functionality by executing dedicated programs autonomously with minimal operator intervention.