UNIVERSITI PUTRA MALAYSIA

DEVELOPMENT OF A REAL-TIME EMBEDDED REMOTE TRIGGERING AND MONITORING SYSTEM

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By

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

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Dedicated to,

My Family

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

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The Internet has become the latest medium for communication with advanced features such as file transfer, transaction application, advertising and much more. Recently, quite a number of Internet applications related to remote triggering and monitoring system have been developed. The integration of Internet technology and embedded system concept provides a way for the development of Network Embedded System. In this case, various types of electrical or electronic appliances can be connected to the Network Embedded System to obtain network-connectivity or Internet-ready functionality. For system development purpose, SC12 from BECK-IPC is selected for Network Embedded System implementation.

The ideal system can be built with improved diagnostic features and flexibility in terms of configuration parameters. So, this research will cover intelligent system design,

protocol stack implementation and manipulation techniques, and embedded system development in details.

A real-time embedded remote triggering and monitoring system has been developed. This project is an integration of three systems: Network Embedded System (NES), Local Connectivity System Toolkit (LCS) and client-side application. NES provides network connectivity features to LCS and ready to be triggered and monitored by remote client-side application. So, electrical or electronic appliances can be attached to LCS for network/Internet connectivity purpose. On the other hand, client-side application provides a user-friendly Graphic User Interface (GUI) to enhance the usability of the system.

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

PEMBANGUNAN SISTEM PENGAKTIFAN DAN PEMANTAUAN JARAK JAUH YANG MASA SEBENAR DENGAN SYSTEM TERBENAM

Oleh

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Internet telah menjadi bahantara komunikasi terkini dengan pelbagai keistimewaan seperti pemindahan fail, aplikasi urusniaga, periklanan dan sebagainya. Mutakhir ini, terdapat pelbagai aplikasi Internet yang melibatkan sistem pengaktifan dan pemantauan jarak jauh. Pembangunan teknologi Internet dengan konsep sistem terbenam telah membekal kemampuan dalam pembangunan Sistem Terbenam Rangkaian. Dalam kes ini, mekanisma pengaktifan dan pemantauan jarak jauh melalui Internet terhadap pelbagai jenis alat elektrik adalah berkemungkinan dilaksanakan dalam sistem terbenam. Untuk tujuan pembangunan sistem, SC12 dari BECK-IPC telah dipilih dalam pembinaan Sistem Terbenam Rangkaian.

Dalam sistem yang ideal, keupayaan pemeriksaan dan mudah digunakan dalam membuat configurasi terhadap parameter sistem adalah penting. Keberkesanan

mekanisma pengaktifan dan memantauan adalah subjek dalam penyelidikan dan pembangunan projek ini. Selain itu, keistimewaan rangkaian Internet dalam pembangunan sistem tersebut adalah dipentingkan.

Tesis ini menerokai keupayaan penyambungan Internet untuk sistem pengaktifan dan pemantauan jarak jauh. Sistem yang dibangunkan ini terdiri daripada tiga bahagian utama iaitu Sistem Terbenam Rangkaian, Peranti Penyambungan Sistem dan aplikasi GUI. Apabila sistem ini disambungkan dengan Internet, ia dapat melaksanakan proses pengaktifan and pemantauan terhadap Peranti Penyambungan Sistem. Peralatan-peralatan elektrik boleh disambung dengan peranti penyambungan untuk tujuan sistem berpandukan Internet. Selain aplikasi GUI yang mudah diguna telah menambah keberkesanan terhadap sistem operasi.

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CHAPTER 1

INTRODUCTION

Recently, the development of Internet-based remote triggering and monitoring system becomes one of the hottest research topics [1]. The Internet provides convenience in a time when everyone is desperate for easy solutions. As the years pass, peoples are experimenting in more adventurous ways on the Internet, making it even better. That's what makes the Internet-base connectivity theme so interesting. There are no limits other than imagination.

In fact, the trend of network connectivity technology is going forward to the development of embedded system that meets the requirement of globalization [2]. User will be able to access information and services virtually anywhere and at any time via any device, whether it is PCs, laptops, PDAs or phones. Many computers in ubiquitous environments are embedded in hand-held devices as smart appliance [3]. Thus, traditional system is no longer compromise the demand of market to accomplish a wonderful globalization system. This thesis describes the design and implementation of system architecture providing the real-time embedded remote triggering and monitoring service through network embedded system.

1.1 Objective

The objectives of this project are:

- To develop and implement a network-based real-time embedded remote triggering and monitoring system.
- To develop a client-side application to manage the operation of remote triggering and monitoring.
- To enhance and optimize the performance of the developed system.

1.2 Overview of Real-Time Embedded Triggering and Monitoring System

Real-Time Embedded Triggering and Monitoring System is an advance technology that allows remote user to manage a local system through the Internet/Intranet connection. The system is generally consisting of three main blocks: Remote Terminal (RT), Internet Connectivity Module (ICM) and Local Connectivity System Toolkit (LCST). Figure 1.1 shows the block diagram of a complete real-time embedded triggering and monitoring system.

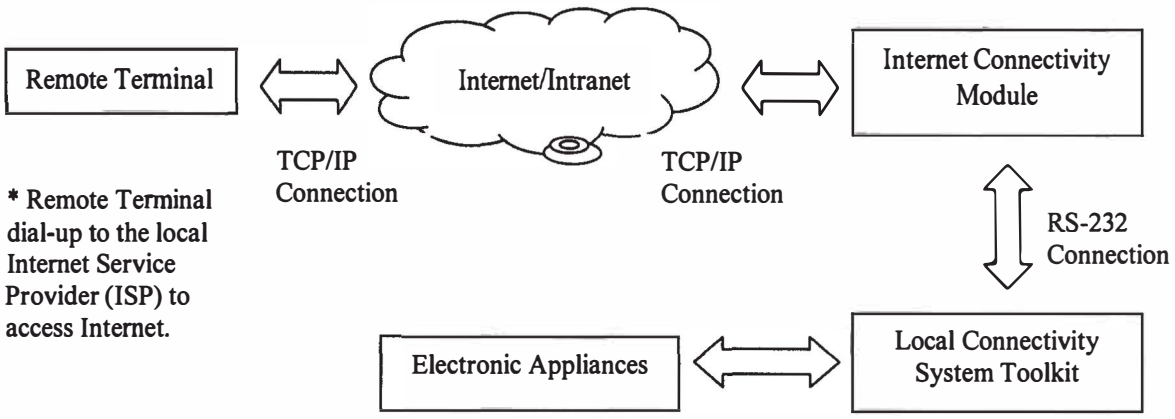

Figure 1.1: Block diagram of a complete Internet connectivity system

Remote user can dial-up to the local Internet Service Provider (ISP) to get access to the Internet connection. Through the Internet connection, the remote user allows to make a real-time connection to the ICM. In this case, the ICM will perform TCP to Serial or Serial to TCP Conversion between RT and LCST bi-directionally. A full-duplex connection established for remote user to trigger and monitor the status of electronic appliances in the most effective way.

The system is defined as real-time system because of connection-oriented protocol (TCP) is applied to accomplish the connection between RT and ICM. As a result, any operation from RT will affect the status of LCST immediately. Similarly, the status of LCST wills feedback to RT for run-time monitoring purpose.

1.3 Importance of Real-Time Embedded Triggering and Monitoring System

The ability of triggering and monitoring a remote system is very useful in the sense of system availability mobility and efficiency. Achievement of remote triggering and monitoring provides the possibility of multiple systems to be managed by a single user (System Centralization) [4].

1.4 Thesis Organization

This thesis is organized as follows: Chapter 1 gives a general background and overview of the thesis. It highlights some of the main benefits in using real-time embedded triggering and monitoring system. Chapter 2 covers the literature review. Further, it looks at some optimal remote triggering and monitoring system and network embedded system concept. Chapter 3 consists of the methodology used in designing the proposed system. The results and discussion are fully documented in Chapter 4. Finally, Chapter 5 summarizes the finding. Conclusion and suggestion for future studies are also given.

CHAPTER 2

LITERATURE REVIEW

There are various types of technology to implement modern remote triggering and monitoring system. For long distance purpose, Supervisory Control And Data Acquisition System (SCADA), MRC-2 System, Distributed Control System (DCS), Wireless and Mobile Control System, and Internet/Intranet Control System are within the most famous modern remote control system available in the market. However, X-10, IrDA, Bluetooth and WiFi are within the most popular technology implemented for short distance applications.

SCADA System refers to the combination of telemetry and data acquisition [5]. It consists of collecting information, transferring it back to a central side, carrying out necessary analysis and control, and then displaying this data on a number of operator screens. The SCADA system is used to monitor and control a plant or equipment. Control may be automatic or can be initiated by operator commands. Telemetry is usually associated with SCADA Systems. It is a technique used in transmitting and receiving information or data over a medium. The information can be measurements, such as voltage, speed or flow. These data are transmitted to another location through a medium such as cable, telephone or radio. Information may come from multiple locations.

MRC-2 System is a modular remote control system allowing maximum flexibility in interconnecting control and remote terminals [6]. The master controller PC control software emulates the control terminal and provides the user with a multi tasking system capable of time-oriented and event-oriented control functions.

DCS is usually used in factories and located within a more confined area [5]. It uses a high-speed communications medium, such as Local Area Network (LAN). A significant amount of closed loop control is present on the system. It may rely on a variety of communications links such as radio and telephone. Closed loop control is not a high priority in this system.

Wireless and Mobile Control System practice the technology of GSM to implement the anatomy of distributed control system [7]. The mechanism of GSM technology enables the globalization feature of effective remote control system.

Internet/Intranet Control System implements the backbone of communication link by using the existing technology of TCP/IP [8]. Web-Based Control System, Client-Server Service Control System and E-mail Control System are categorized in this type of control system. Web-Based Control System is implemented by using Common Gateway Interface (CGI) technology associated the practice of Web Browser. Client-Server Service Control System is developed with customize application specific program. User-defined data conversion and transferring methods are implemented to accomplish the mechanism of runtime operation. E-mail Control System applied the