The Development of a System to Control Electrical Appliances through Bluetooth-Enabled Device

By

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requirement for the
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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
Information Technology Programme
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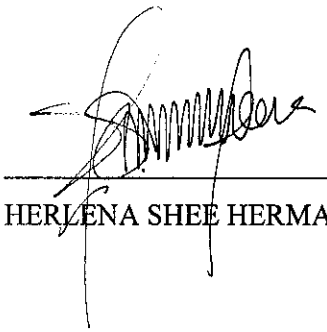
CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.



HERLENA SHEE HERMAN SHEE

ABSTRACT

The objective of this study is to develop a system and an application that helps to remotely control electrical appliances in the home domain with the usage of short-range wireless Bluetooth using Java programming technology. Basically this project will solve and expand the Infrared technology remote control used, that is only limited to straight line positioning device and to solve the inefficient storage and amount of remote controllers held in each house domain. A proposed solution can be apprehended especially for the elderly and the disabled to control their electrical appliances. As for the development, the system will use Bluetooth-enabled mobile phone that will only control the switched-electrical appliance in a single room and a single appliance for presentation purposes using point-to-point Bluetooth topology. The detected Bluetooth radius will only be 10 meters from the server location based on the Bluetooth dongle attached to the server. In realizing this project, tasks have been divided into six parts; problem definition, project analysis and review, outline design, prototype development, prototype evaluation and system integration. The design and implementation of this project is embraced from circuit implementation, mobile and server development. In order to have full understanding of the project, two main areas need to be covered first, which are the mobile remote controlling and the Bluetooth technology. This is necessary in order to develop a good concept of design and implementation into the real world. As a conclusion, the end product should be able to provide freedom and flexibility of universal remote control system by using Bluetooth-enabled devices that can be obtained in homes or even work places.

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TABLE OF CONTENTS

LIST OF TABLES 1

LIST OF FIGURES 2

LIST OF ABBREVIATIONS 3

CHAPTER 1 : INTRODUCTION 4

1.1 BACKGROUND OF THE STUDY . . . 4

1.1.1 Bluetooth 4

1.1.2 Controlling electrical appliances . . 5

1.1.3 Application development . . . 6

1.2 PROBLEM STATEMENT 7

1.2.1 Problem Identification . . . 7

1.2.2 Significant of the Project . . . 8

1.3 OBJECTIVES AND SCOPE OF STUDY . . 8

CHAPTER 2 : LITERATURE REVIEW 10

2.1 Home Automation 10

2.1.1 Remote Control 10

2.1.2 History and Evolution of Remote Control . 11

2.1.3 Universal Remote Control . . . 11

2.1.4 Mobile phone as Universal Remote Control . 12

2.1.5 Home automation using PC as controllers . 12

2.1.6 Parallel port to control appliances . . 13

2.1.7 Wireless Technologies . . . 14

2.1.7.1 Bluetooth 14

2.1.8 Mobile phone market in Malaysia . . 15

2.1.9 Bluetooth market in Malaysia . . . 16

2.1.10 Home Automation Alternatives . . 16

2.1.10.1 GSM/SMS 16

2.1.10.2 Internet 17

2.2 Review of Related projects 18

CHAPTER 3 : METHODOLOGY 21
3.1 DEVELOPMENT PROCESS. . . . 21
3.1.1 Problem Definition 21
3.1.2 Problem Analysis and Review . . 22
3.1.3 Outline Design 22
3.1.3.1 Circuit Design. . . . 22
3.1.3.2 Mobile Phone Interface Design . 23
3.1.3.3 Server Interface Design . . 23
3.1.4 Prototype Development . . . 23
3.1.4.1 Circuit Development . . . 24
3.1.4.2 Phone Interface Development. . 24
3.1.4.3 Server Interface Development . 25
3.1.5 Prototype Evaluation 26
3.1.5.1 Unit Testing 26
3.1.5.2 Integration Testing . . . 27
3.2 TOOLS REQUIRED 27
3.2.1 Hardware 27
3.2.2 Software 28
3.2.2.1 Computer Server development . 28
3.2.2.2 Mobile phone development . . 29

CHAPTER 4 : RESULTS AND DISCUSSION . . . 30
4.1 System Architecture 30
4.2 System Logic Flow 32
4.3 Bluetooth-Enabled Server Application . . 36
4.3.1 Parport IO Component . . . 36
4.3.2 BlueCove API 37
4.4 Circuit Development 38
4.5 Project Cost 41

CHAPTER 5 : CONCLUSION AND RECOMMENDATIONS . 42
5.1 CONCLUSION 42
5.2 RECOMMENDATIONS 42
5.2.1 Controlling more appliances . . . 42

5.2.2 Wireless appliance 43
5.2.3 Added function 44
5.2.3.1 Lighting systems . . . 44
5.2.3.2 Video systems (TV/VCR/DVD) . 44
5.2.3.3 Audio systems (Radio/MP3/CD) . 45
5.2.3.4 Security System . . . 45
5.2.3.5 Air-Condition/Heater System . . 45
5.2.4 Larger home appliances network environment 45
5.2.5 Interface Design 47
5.2.5.1 Server 47
5.2.5.2 Mobile phone 48
5.2.6 Security setting 48

REFERENCES **49**
APPENDICES **52**

LIST OF TABLES

Table 4.1: The cost of the project.....41

LIST OF FIGURES

Figure 1.1: a) Point-to-point piconet b) Point-to-multipoint piconet c) Scatternet.....5

Figure 2.1: DB25 connector pin outs.....13

Figure 2.2: a) Mobile phone ownership b) Purchase intentions.....16

Figure 3.1 : The system development 21

Figure 4.1: The proposed system architecture.....30

Figure 4.2: The proposed logic flow.....32

Figure 4.3: The Startup Server Interface.....33

Figure 4.4: The Mobile Interface – Room server.....33

Figure 4.5: The Mobile Interface – Switch.....34

Figure 4.6: The Server Interface –Switch 34

Figure 4.7: The Mobile Interface – Update status.....35

Figure 4.8: The electrical appliance state.....35

Figure 4.9: The circuit design.....38

Figure 4.10: Circuit image – Black box view 40

Figure 4.11: Circuit image – Circuit view.....40

Figure 5.1: ULN203 IC pin out.....42

Figure 5.2: Bluetooth adapter design.....44

Figure 5.3: Proposed scatternet formation.....46

LIST OF ABBREVIATIONS

PDA – Personal Digital Assistant

LAN – Local Area Network

PC – Personal Computer

IO – Input Output

IC – Integrated Circuit

CPU – Central Processing Unit

USB – Universal Serial Bus

IrDA – InfraRed Data Association

RF – Radio Frequency

SMS – Short Message Service

GSM – Global System for Mobile Communication

J2ME – Java 2 Platform, Micro Edition

J2SE – Java 2 Platform, Standard Edition

JSR – Java Specification Request

IDE – Integrated Development Environment

JDK – Java Development Kit

MIDP – Mobile Information Device Profile

CGI – Common Gateway Interface

API – Application Program Interface

ISM – Industrial Scientific and Medical

CHAPTER 1
INTRODUCTION

1.1 BACKGROUND OF THE STUDY

1.1.1 Bluetooth

Bluetooth is a high-speed, low-power microwave wireless link technology, intended to replace the cables between electronic devices, such as phones, laptops, PDAs and other Bluetooth-enabled devices. Unlike infra-red, Bluetooth does not require line-of-sight positioning of connected units. The technology uses modifications of existing wireless LAN techniques but is most notable for its small size and low cost.

Bluetooth uses omnidirectional wireless transmission of both voice and data in the globally available, license free 2.4 GHz Industrial, Scientific and Medical (ISM) band. Devices are categorized into three different classes, according to their power consumption and transmission range:

- Class 3 - 1 mW transmission power and a typical range of 0.1 - 10 meters
- Class 2 - Transmission power of 1-2.5 mW and a typical range of 10 meters
- Class 1 - Transmission power of 100 mWand and a range of up to 100 meters

Bluetooth provides a bandwidth of 1 Mbit/s at the physical layer. It avoids interference and noise from other devices operating in the same frequency band by using the spread spectrum technique called frequency hopping. The communication changes the transmitting/receiving frequency 1600 times per second across 79 different frequencies.

Each Bluetooth connection has a master and a slave. By definition, the device that initiates the connection automatically becomes the master. The master can establish up to 7 simultaneous connections to other devices. A network of one master and up to 7 slaves is called a piconet. All devices on the same piconet follow the same

frequency hopping and timing rules defined by the piconet master. Bluetooth piconet and scatternet topologies are illustrated in *Figure 1.1.*

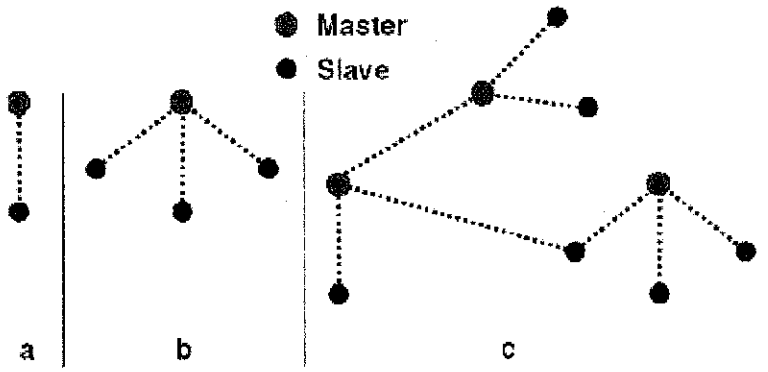

Figure 1.1: a) Point-to-point piconet b) Point-to-multipoint piconet

c) Scatternet

In this project, it will demonstrate the use of this piconet in the connection transmission between the Bluetooth-enabled server and Bluetooth-enabled mobile phone to be able to control electrical appliances in Bluetooth house radius. The master will simply be the Bluetooth-enabled server that will initiate the Bluetooth connection and wait for the client to establish the connection and start communicating. The appliances can be controlled by up to 8 Bluetooth-enabled mobile phones at one time by using this theory and the program that will be later discussed in this report.

1.1.2 Controlling electrical appliances

Parallel port is a simple and inexpensive tool for building computer controlled devices and projects. The simplicity and ease of programming makes parallel port popular in electronics hobbyist world.

PC parallel port is a 25 pin D-shaped female connector in the back of the computer. The primary use of parallel port is to connect printers to the computer and is

specifically designed for this purpose. Thus it is often called as printer port. The registers found in a standard parallel port are:

1. Data register
2. Status register
3. Control register

As their names specify, the Data, Control and Status lines are connected to three corresponding registers inside the computer. So, by manipulating these registers in program, one can easily read or write to parallel port with programming languages like 'C' and BASIC. Whatever value is written to these registers, it will appear in the corresponding lines as voltages. For example, if '1' is written to Data register, the line Data 0 will be driven to +5v. Just like this, it can programmatically turn on and off any of the Data lines and Control lines. Because of this, it makes it possible to control home appliances through parallel port with a suitable circuit with relay for this project.

1.1.3 Application development

This project presents the commands to control the devices from the mobile Bluetooth-enabled device that will be sent to the main server. After receiving the command, the received data will be analyzed by the server program and then server will make high or low status of its parallel port data pins. The switches of all the controllable devices are connected to the PC parallel port. Therefore, by sending appropriate data via Bluetooth-enabled device, the devices can be switched ON/OFF remotely.

In achieving such system, the application proposed will have both; the server and mobile client equipped with Bluetooth technology. It should also have a separate circuit development to control appliances through PC parallel port.

1.2 PROBLEM STATEMENT

1.2.1 Problem Identification

The limitation held in infra-red; IrDA remote control where it is severely limited by the short connection distance of 1 m and the line-of-sight requirement for communication is the primary problem that occurs in every remote controllers system. In expanding the technology, it is encouraged that students do further researches on such short-range wireless; Bluetooth technology application basis and expand the usage and technologies. There are numbers of important factors that make Bluetooth a useful and productive technology. With the nature of RF used in Bluetooth technology, devices will not need to be within line of sight and may even connect through walls or other nonmetal objects besides having the addition to wireless device connections that can connect up to 10 m -100 m and eight devices at one time. The mobility featured in Bluetooth gives the user the real-time access to their house domain. This ability comes without having to be hardwired into the network. And it gives the user the freedom to access their house network and having the security without having to interfere with appliances outside the domain.

The inefficient storage and amount of remote controllers held in each house domain is another problem rose in every scenario. Another problem is the inflexibility of such remote control system where it will only be able to control a specific appliance from each specific remote control. With the large number of remote controllers accumulated in each house and with no proper storage, these remote controllers tend to be misplaced and this results in complexity to every user. So this research topic creates a pilot project in designing a standard remote control system that can control each and every single appliance in house with one Bluetooth-enabled device. Mobile phone with Bluetooth-enabled technology in this case, is proposed to act as the standard remote control. It is also flexible where every mobile phone that is embedded with Bluetooth technology in each house is able to control the appliances in their domain. User will not need to find and locate their lost remote control for each specific appliance with the use of this system.

Another matter that should not be neglected is the usage of the normal system whereby constant movements is essential to control each electrical appliance. This

ongoing problem is something to look up to when it involves the elderly or the disabled people whereby their movements are limited. To a person suffering from a significant level of physical disability, the average staircase can present a formidable obstacle. With the system proposed these so called formidable obstacles would be demolished to easier use.

1.2.2 Significance of the Project

Bluetooth may be best known as a wireless technology for connecting mobile phones and PDAs to a PC, but it could become even more useful as a way of controlling home electronics and appliances from any Bluetooth-enabled devices.

This project will be able to solve the limitation of Infrared by using short-range wireless technology such as Bluetooth to remotely control an electrical appliance with no line-of-sight communication. Standard remote control system is proposed in managing all the appliances in house using the mobile phone embedded with Bluetooth technology. With this system proposed, you can have the lights inside or outside come on at the touch of your mobile phone. There will be easy to control those appliances within distance and there is no need to walk into a dark house or fumbling for the light switch anymore. A flexible and useful with simple, cost-effective and user-friendly solution is proposed to suit all stages in the community, by which the system as mentioned above can be controlled by the disabled and the elderly.

By the solution proposed, such freedom can be obtained in homes and even work places can be controlled by Bluetooth-enabled devices.

1.3 OBJECTIVES AND SCOPE OF STUDY

The objective of this project is basically to design and later develop a standard remote control system by using the J2ME-enabled mobile phone that is capable of controlling and handling all the electrical appliances in house with a single and flexible remote control system. The purpose is also to solve and expand the Infrared technology remote control used that is only limited to straight line positioning device by using the

short-range wireless; Bluetooth. With this project, all the electrical appliances allocated along the domain of each house, can be control by using this Bluetooth technology that are able to penetrate through walls as long as it is inside the range of 10m radius.

For the scope of the study, Bluetooth-enabled mobile phone with JSR-82 compatibility will be used mainly in this project. The system developed will only control the switched-electrical appliance in a single room and a single appliance for presentation purposes. The detected Bluetooth radius will be only 10 meters from the server location based on the Bluetooth dongle attached to the server and Bluetooth point-to-point piconet will be used to control the appliances. For this project, the appliances could be any electrical appliances that have no need in grounding switches. The end-product of this project would be an application that is only able to ON/OFF the electrical appliance from a Bluetooth-enabled device. By having this trial version and concept proven, this project can be implemented to the rest of the appliances as they will apply the same concept developed in this project.

CHAPTER 2
LITERATURE REVIEW

In order to gain a better perspective of the development process of the project, analysis has been conducted on previous applications and studies done in this field. This chapter starts with looking at the home automation technologies and finishes off with a review of previous work done in the related field of this project.

2.1 Home Automation

Have you ever experienced the uneasiness, "I wonder if the lighting downstairs has been turned off", while you were getting ready to sleep? With home automation, you can control the lighting on/off in your home from anywhere inside your home.

According to Wacker et. al (2004), in the near future, many common devices at home will have computational power and wireless communication capabilities. Ryan (1989) point out that one of the possible applications is wireless networks for home automation.

Based on Kwang et. al (2003), Home automation is a house or living environment that contains the technology to allow devices and systems to be controlled automatically. As a very basic definition, we tend to refer to home automation as anything that gives you remote or automatic control of things around the home. Imagine a private home equipped with remote control for opening the door, dimming the light, controlling the heating and so on. It will be easy to control those appliances within distance and there is no need to walk into a dark house or fumbling for the light switch anymore.

2.1.1 Remote Control

Remote control gives you the convenience of controlling lighting, appliances, security systems and consumer electronics from wherever you happen to be at the time like your couch, car or even in your bed. There are many advantages of using remote

controls. In almost every case, remote controls are great time and effort savers. Nowadays, remote control has become an electronic device widely used in every house in the community.

2.1.2 History and Evolution of Remote Control

The first remote controlled model airplane flew 1936 according to Wikepedia encyclopedia. The use of remote control technology for military purposes was worked intensively during the Second World War; one result of this was the German Wasserfall missile.

The first remote intended to control a television was developed by Zenith Radio Corporation in the early 1950s. The remote called "Lazy Bones" used a wire to connect to the television set. To improve the cumbersome setup, a wireless remote control was created in 1955. The remote called "Flashmatic" worked by shining a beam of light onto a photoelectric cell. Unfortunately, the cells did not distinguish between light from the remote and light from other sources. The Flashmatic also required that the remote control be pointed accurately at the receiver. In 1956 Robert Adler developed "Zenith Space Command", the first modern wireless remote. It was mechanical and used ultrasound to change the channel and volume.

In the 1980s, when semiconductors for emitting and receiving infrared radiation were developed, remote controls gradually switched to that technology which, as of 2005, is still widely used. The latest invention is to produce remotes using radio technologies, such as Bose Audio Systems and those based on Bluetooth.

2.1.3 Universal Remote Control

By the early 2000s, the number of consumer electronic devices in most homes greatly increased. According to the Consumer Electronics Association, an average American home has eight remotes. Every device has its own display, its own set of controls, and its own concept of use. People know the results: five or even more different remotes occupy space on the coffee table; leaving no space for coffee at all.

Too many remote controls are very problematic in a home, as the user generally intends to control only a particular appliance. That is where a universal remote control comes in. This allows the user to control all their appliances without using separate remote controls.

2.1.4 Mobile phone as Universal Remote Control

According to International Telecommunication Union (2005), mobile phones are becoming the most important communication tool in the world. There are now more mobile phones than computers, and the number is expected to reach 2 billion worldwide by the year 2006. The number of mobile phones in the developed world is increasing, with many countries expected to surpass the 100 percent penetration rate.

Mobile phone could become a universal remote control, replacing many single-use remote controls and increasing comfort of the end user (Hadzic, 2004). Using the mobile phone as a remote control is potentially very economical since the user already owns the mobile phone and the communication is free of charge, and no subscription fees are required. It would be very convenient for the user to use the mobile phone as a remote control, as the user already is familiar with using the phone and its technical properties.

2.1.5 Home automation using PC as controllers

Different technologies are available to control appliances from mobile phone. And there various technologies that are useable depending what appliances needs to be controlled and how long away they are from the mobile phone. One way is to connect all the appliances to PC as controllers and connect several relays to PC parallel port, and then make contacts to switch power to different appliances on and off.

This can be used to control anything from the PC and back to the appliance. When connecting mains voltage to relay board or modifying electrical appliances you need to be very careful on electrical safety issues (Engdahl, 2005).

2.1.6 Parallel port to control appliances

Torres (2005) points out that the computer parallel port is the easiest way to control devices outside the PC, like for example the home appliances. In computing, a parallel port is an interface from a computer system where data is transferred in or out in parallel, that is, on more than one wire. A parallel port carries one bit on each wire thus multiplying the transfer rate obtainable over a single cable. With this feature, it is possible to control more than 1 device with each parallel port connector.

Parallel port connectors usually have at least 25 pins. The pin outs of DB25 connector is shown in the *Figure 2.1*:

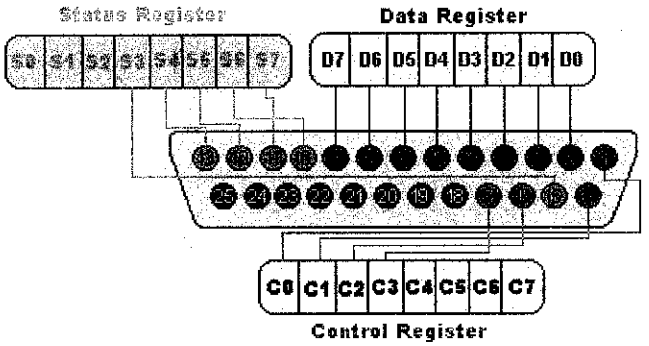

Figure 2.1: DB25 connector pin outs

The lines in DB25 connector are divided into three groups, they are:

1. Data lines (data bus)
2. Control lines
3. Status lines

As the name refers, data is transferred over data lines. Control lines are used to control the peripheral, and of course, the peripheral returns status signals back to the computer through Status lines. These lines are connected to Data, Control and Status registers internally. There are also several extra functions on the port that are used for control and status signals to indicate when data is ready to be sent or received, initiate a reset, or even to indicate an error condition.

2.1.7 Wireless Technologies

To realize the dream of home automation, wireless technology is used in communicating all the networked electrical appliances in the house through mobile phone communication. Wireless communication, as the term implies, allows information to be exchanged between two devices without the use of wire or cable. All of the remote controls either will communicate via either infrared (IR) or radio frequency (RF) signals. IR communication requires line-of-sight communication, while RF offers omnidirectional communication where signals penetrate walls and other obstacles.

2.1.7.1 Bluetooth

Although there are many home networks already in existence (Tan, 2002), combined with the advantage of the next-generation cellular systems (Webb, 2002), that have been designed to bring fast, wireless data connections to users, short-range wireless is the most upcoming preferred technology that will boom into this home automation system because it offers the highest bandwidths at the lowest power levels, in the most crowded spaces, for the most users (Leeper, 2001).

Bluetooth according to Kanma (2003) is a standard for short range, low power, and low cost wireless communication that uses radio technology (McDermott, 2005). Based on Sairam (2002), Bluetooth devices form an ad-hoc network called piconet and provided the devices are within the communication range (10m - 100m). A Piconet has one master and a maximum of seven slaves and the master slave communication is based on time-division duplex mechanism. That means one server can control to up to 7 other appliances in one time transmit using Bluetooth technology in home automation (Chakrabarti et. al, 2004; Shepherd, 2001 and Garner, 2003).

Due to its RF nature, Bluetooth is not subject to such IrDA limitations. In addition to wireless device connections up to 10 m to 100 m, devices need not be within line of sight and may even connect through walls or other nonmetal objects. This allows for

applications such as a mobile phone acting as a remote control to control the appliances (Sairam, 2002). The possibilities opened up really are limitless, and because the radio frequency used is globally available, Bluetooth can offer fast and secure access to wireless connectivity all over the world.

According to Chien et. al, (2004), a Bluetooth universal type remote controller, if developed, will replace all remote controllers from various products, resolve the integration problem and provide an integrated control interface for various home appliances. But home automation technology has not succeeded to date. This is because the system is still mostly involving high cost with the extra adapter needed to make it works. Another factor is poor user interfaces. There have been several systems offered that just were not user-friendly.

2.1.8 Mobile phone market in Malaysia

Malaysians are ready for more new mobile services reported by a comprehensive survey carried out by Ericsson ConsumerLab in 2004, which involved around 1,500 respondents across urban areas of Peninsula Malaysia. According to the results, consumers are interested in new products and services that are easy-to-use and reliable, showing a direct correlation to demand for more new mobile services. Yahoo! (2004) survey reported that as approximately 90% of Malaysia's population owns their own mobile phone and 75% current mobile users intend to either upgrade or change their phone within the next 6 months on mobile phone user in Malaysia as depicted in *Figure 2.2*,. Because of this, it is possible to integrate universal remote control through Bluetooth-enabled mobile phone as Malaysians are willing to change towards the newer technology in line.

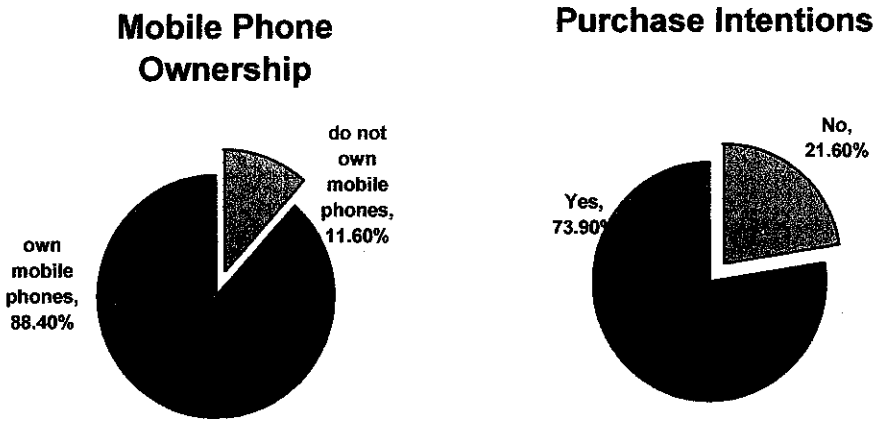

Figure 2.2: a) Mobile phone ownership b) Purchase intentions

2.1.9 Bluetooth market in Malaysia

According to Eric Schneider, Bluetooth SIG's Asia Pacific and Japan marketing director extracted from the Star (2005), the demand in Malaysia for Bluetooth is healthy. There are currently five million Bluetooth devices shipping from Asia Pacific each week. This validates the sizeable market for Bluetooth technology and in the real world, this is definitively true. Schneider once proclaimed that "Every time you blink an eye, another 10 Bluetooth chipsets go out into the world".

2.1.10 Home Automation Alternatives

2.1.10.1 GSM/SMS

GSM, which stands for Global System for Mobile Communications, is a digital cellular radio network operating in over 200 countries world-wide.

Short Message Service (SMS) is an integrated paging service that lets GSM cellular subscribers send and receive data right on their mobile phone, up to a maximum of 160 characters.

The SMS enables the user to remotely execute commands to control their home appliances using SMS as a communication medium. As an example, the user can be

roaming in outside Malaysia for example, Singapore on a holiday and turn on his porch lights in Kuala Lumpur by sending an SMS message to the SMS Gateway at his house.

At the house there is a computer connected to a GSM mobile phone or connected to GSM gateway. A program runs in the background polling the mobile for incoming SMS messages. The message is then decoded and a relative command is built and sent into the electricity circuit.

But there are always drawbacks in the SMS technology, moreover for this project. The main point is on the costs. Theoretically, there are no guarantees that this service will always work and avoid the tendency of constant breakdowns. We should also be aware with the vulnerability of the system, whereby hackers and intruders are malicious. Moreover, the system is not monitored 1440 minutes per day-24 hours a day, therefore interruption of process and sabotages could happen that could result in serious consequences. For an example, a microwave can be turned on by an intruder, thus could lead onto worst happenings such as fire in split seconds.

2.1.10.2 Internet

The Internet gateway enables user to remotely control and design their home automation via a standard web browser. At the home premises, the hardware required is a computer and the machine must be running a web server. When the user logs on their premises' homepage, a main menu is presented containing all the home appliances of the house. Relative commands then get issued by the Web Gateway at the premises using the Common Gateway Interface (CGI).

The possible limitations of using such technology in home automation include the 24 hours a day usage of Internet, and this would eventually incur a lot of costs from the internet service provider. Another point to mark is the inefficiency of security on the technology when embedded to the home automation. This is because of the large intrusion in the Web especially from hackers that could danger the performances of the appliances at home. There is not even a guarantee to the safety of this system no matter how strong the firewall could be. Besides that, if control has been passed to an

anonymous user, many probable dangers and accidents could happen without even realizing it.

2.2 Review of Related projects

This section includes a number of related projects concerned with the related field of my project.

A project done by Edlington (2005) entitled *X10 Appliances Control Using Mobile Phone* is designed to make home automation easy to control when a user is not at home. The project is designed to allow easy use of a mobile phone to control appliances in the home with the off-the-shelf product; X10. Using a mobile phone, the development of the control system carried out using SMS and WAP technologies. This will communicate with the PC which in turn controls the devices attached to X10 modules. When the action has been carried out then a response is sent to the user.

Having this kind of approach is not really efficient and user-friendly as it will burden the mobile phone users through the SMS charges besides having to spend extra in buying the X10 products adapters. The installation part is quite tedious and hard to be understood by non-IT background users. Whereas the project that is going to be developed will not charge the users with SMS charges, besides no extra product or installation needed. The approach can also be understood and handled by all generation from the community.

Technically, *HOTEL MAMA* developed by Chowdhury et. al. (2004) used Bluetooth wireless technology to connect to an access point within the household. All operations are processed by a central server which operates and maintains the networks and the devices via some wireless technology as well. Localization services may allow to determine the position of the user within the apartment and to optimize access to functions that are likely to be requested in this spatial position. The network is maintained using a 'Plug & Play' technology, so that all devices in range register themselves on the server and provide the necessary drivers to server and mobile control units.

But unfortunately, there are no details on how the actual product has been developed in this article. The details are more on the surface rather than showing the steps and architecture of the system that have been made.

A Remotely Controlled Bluetooth Enabled Environment project presented by Chakrabarti et. al. (2004) delivered one such method of remotely controlling devices present in a Bluetooth enabled environment in the home or office from any part of the world connected to the Internet. A web page applet programmed in Java can be accessed from any Java-enabled browser connected to the Internet and is used to control parameters of the devices in a remote Bluetooth environment. It is also used to display the current state of the devices in the Bluetooth environment. A very novel application of using Bluetooth devices for remote control is that passive electronic devices can be given processing power simply by connecting a Bluetooth chip to the device. Any passive device in the scatternet, which is Bluetooth enabled can have processed data send to it by the program resident in the web server. By keeping the processing part in the remote program, all the passive devices in the Bluetooth scatternet can be given the benefit of being able to have processing power.

In this project, Bluetooth is just used to communicate between the appliances to the Internet service provider and again, users will have to bear with the cost of internet service and the cost of the Bluetooth chips that will be implemented to the appliances as well. Whereas in my project that is currently under development, Bluetooth is used as the main communication, communicating appliances to server that can later be controlled from the server application without extra cost or skills.

Project by Kanma et. al. (2003) entitled *Home Appliance Control System over Bluetooth with a Cellular Phone* is about home appliances control system over BluetoothTM1 with a cellular phone, which enables remote-control, fault-diagnosis and software-update for home appliances through Java® 2 applications on a cellular phone. A communication adapter is attached to the home appliances in order to add Bluetooth communication functionality. Internet is used for downloading electric data through the Internet and fault diagnosis analysis.

Fault diagnostic application can receive an error code from a home appliance and analyze it when a home appliance needs diagnosis. This application can also display some tips and strategies for solving problem and making arrangements to call a repair engineer in a serious case. And a user can efficiently tell the contents of fault to the repair engineer.

But yet cost is the main constraint in this project where a communication adapter is needed to every single appliance in the house to be able to communicate with the Bluetooth mobile phone.

CHAPTER 3
METHODOLOGY

3.1 DEVELOPMENT PROCESS

In general, *Figure 3.1.* is the development process used as a guideline to complete the methodology of this system. The project consists of major tasks provided in *Figure 3.1.*

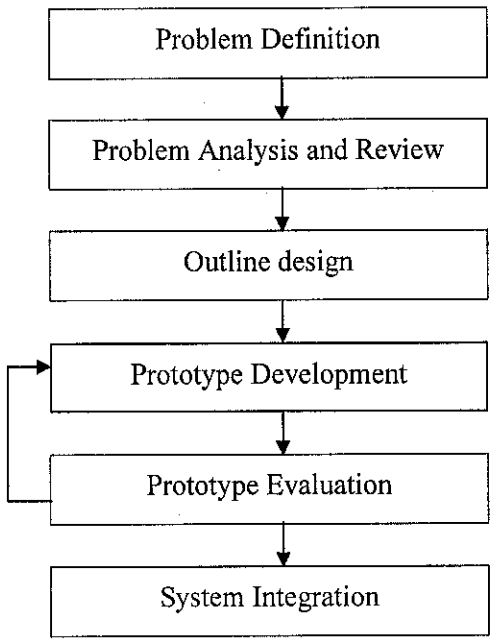

Figure 3.1 : The system development

3.1.1 Problem Definition

It must be considered as the most important phases in any project. Here, the entire possible problem will automatically affect the whole decision making process on scope and study that needs to be covered In this phase, problem identification lists down the entire possible problem held in one house domain related to remote system and appliances. For example, it is not efficient to have a specific remote control for each and every single appliance in house. Besides having the large amount of remote control system held in one house, remote control tends to get lost and misplaced in

action. The aim of the project was to create a system that is able to control every appliance in house remotely from one simple and flexible mobile Bluetooth-enabled device interface.

3.1.2 Problem Analysis and Review

Problem analysis is to be done to define a solution to the proposed problem statement. From the defined problem, solution will be made on how can appliances being remotely controlled from a distance by using Bluetooth technology. The method used in this phase is by reviewing the literature regarding Bluetooth technology, home automation and mobile cellular agent. After that, selection of hardware/software language will be made to recognize the possible hardware and software that can be design to accomplish the proposed solution to the problem statement. It is important to make sure, the chosen hardware and software language are well-recognized before start the development. Other than that, it is important to relate hardware and software language chosen with Bluetooth technology in making sure of a smooth transition and implementation of the project.

3.1.3 Outline Design

From the problem, three key areas of the project have been identified: The mobile Bluetooth-enabled device, the Bluetooth-enabled server and the circuit interface to control the appliances from the server.

3.1.3.1 Circuit Design

The first task would be to start developing the basic part of the appliances circuit control that can be attached and managed from the parallel port of the computer server. Parallel port is a useful I/O channel for connecting circuits to computer and the port is very easy to use. This port is used to control the voltage travel through it that can be used to light the appliances. They put out ideally 0V when they are in low logic level (0) and +5V when they are in high logic level (1). The circuit that is to be developed should be able to control the voltage by the high and low logic level. When value 1 is being sent out to the data pin where the appliance is connected, that

appliance will light. When value 0 is being sent to that same pin, the appliance will switched off.

3.1.3.2 Mobile Phone Interface Design

To enable the use of the program to control each and every single room inside the house, the program needed to locate the Bluetooth room server. To enable this, start up screen have been created to 'Locate Room' and provide a list of Room Server to choose on. User will then select which room to control. Once the room is chosen, the phone will attempt to connect with the computer using the Bluetooth connection on the phone. The current state of appliances is shown in the next screen. The next option is to switch and send the command to the computer server to change the state of the appliance. When the 'Switch' option is selected, a message will appear asking whether to allow the connection to Bluetooth and a simple confirmation needs to be selected. This type of message varies on different types of phones which the program is installed.

3.1.3.3 Server Interface Design

The server program will open the Bluetooth connection from the server program and wait for the client connection to connect. Once connected, the server will read the current state of the parallel port and send it to the mobile phone. After each time a command is received from the phone program, server will change the current state of the appliance whether to ON or OFF the appliance.

3.1.4 Prototype Development

In this phase, project is initialized to start developing the real prototype of the circuit and system that is able to perform the specific task mentioned above. This is the most crucial and important phase in this project.

3.1.4.1 Circuit Development

To start off and control an appliance, it is normally done by a switch. To make it control through computer, switch is replaced with a relay. To drive the relay, transistor is used. And to drive it, the base of a transistor is triggered and makes it saturate. It will then pass the current from collector to emitter, acting as a switch.

For that, an optocoupler or optoisolater is used in connection with parallel port, isolating the computer from the circuit. Parallel port 5V signal will be fed to optocoupler, by dropping its voltage down to 1.5 V through resistance. This lights the photo diode, which in turn triggers the base of phototransistor inside the optocoupler, The MCT2E is specially designed for power supply regulators and best-suited optocoupler for this purpose. And 2N2222 / BC 148 is NPN silicon planar switching transistor; it's a small signal general-purpose amplifier and switch 6V NPN silicon planar epitaxial transistor which is widely, and easily available. 6V supply is provided and connected with a capacitor, and diode to provide the DC 6V supply.

The main AC will later attached at the end of the circuit connected to the electrical appliances.

3.1.4.2 Phone Interface Development

For writing the software on the phone, choices will be either to write the program using Visual C#, or by using the Symbian development kit, or a phone specific language or using J2ME (Java 2 Micro Edition).

But J2ME is the chosen language. J2ME is minimal version of Java for mobile devices such as mobile phones or PDAs (Personal Digital Assistant). MIDP (Mobile Information Device Profile) applications written in J2ME are cross platform programs and will work on most modern phones. Because a program written in J2ME would be able to be used on most phones, the library is more limited to enable compatibility.

The Java 2 Platform, Micro Edition (J2ME) and Bluetooth technology are two of the most exciting offerings in the wireless industry today. J2ME, most compact of the

three Java platforms, is inherently portable because it shares the Java "write once run anywhere" philosophy and thus enhances developer productivity. Bluetooth and J2ME can work together to achieve this project as Bluetooth allows devices to communicate wirelessly and J2ME allow writing custom applications and deploying them on mobile devices.

3.1.4.3 Server Interface Development

To be compatible and being able to communicate between the server and the client, the language chosen should be able to adapt with the J2ME development program. And for this, J2SE suits it well because both are using Java programming and no translation will be needed to make it compatible with each other.

Java 2 Platform, Standard Edition (J2SE) provides a complete environment for applications development on desktops and servers and for deployment in embedded environments. In order to communicate with the Bluetooth-enabled mobile phone, an extra Java API is needed to support and provide standardized way to develop Bluetooth applications in Java programming language.

3.1.4.3.1 Java APIs for Bluetooth (JSR-82)

It is the first open, non-proprietary standard for developing Bluetooth applications using the Java programming language. It hides the complexity of the Bluetooth protocol stack behind a set of Java APIs that allow programmer to focus on application development rather than the low-level details of Bluetooth. The Java APIs for Bluetooth do not implement the Bluetooth specification, but rather provide a set of APIs to access and control a Bluetooth-enabled device. JSR 82 concerns itself primarily with providing Bluetooth capabilities to Java-enabled programming.

3.1.4.3.2 BlueCove JSR-82 Implementation

To provide Java APIs for Bluetooth in computer server, the BlueCove JSR-82 is the best solution in this case as it is an open source implementation of the JSR-82 Bluetooth API for Java. The implementation enables programmer to write Java-

Applications that have standard-compliant access to Bluetooth communication. It is a very viable solution to develop PC-based Java Bluetotoh applications using this library.

3.1.5 Prototype Evaluation

The prototype was wholly successful. In the evaluation, the testing that was carried out on the system focused on the performance and behavior of the system.

3.1.5.1 Unit Testing

Throughout the project, testing has been carried out on every part of the system as each part was implemented.

3.1.5.1.1 Circuit switching

From the designed, the circuit that has been developed should be able to ON and OFF the appliance from the circuit development. The status can be control through value HIGH/LOW that passes through it to ON/OFF the appliance. For testing purposes, a lamp was being used as a prototype device. The plug of the lamp is connected to the switch plug available in the circuit. Batteries are used as the power supply to the circuit. When the input value is passed through the circuit, the output voltage should be able to light and off the lamp.

3.1.5.1.2 Server-Parallel Port Testing

Parallel port is used as the communication medium between the computer and the designated circuit. And for this, it is important to make sure that the parallel port is able to pass the value from the computer to the circuit and ON/OFF the appliance as required. Parallel Port Monitor has been used as the value indicator that will show the value provided from the server program to the parallel port connection. After connecting computer parallel port with circuit parallel port, a HIGH/LOW value (0 or 1) is passed from the computer to the circuit. Whenever read and interpret by the

circuit, it should be able to light the appliance when HIGH value have been passed and vice versa.

3.1.5.1.3 Bluetooth Client-Server Testing

Bluetooth-enabled computer acting as the Bluetooth server should be able to establish the Bluetooth connection and waiting to be connected by the client. And on the client side, the Bluetooth-enabled mobile phone should be able to detect the server connection and connect through it to be able to send and receive command from each other platform. Once connected, the READ and WRITE command have been tested on both programs. First the server should be able to read the parallel port status and WRITE the status to client. Client READ and interpret this command, display the current state of the appliance in the program. After user has clicked to switch the state of the appliance, client will have to WRITE the command to the server. Server READ it and controls the appliance. After completed, server will update the status and send it back to the client to view.

3.1.5.2 Integration Testing

This phase of testing is to test the system integration between the server, client and circuitry. During this phase of testing, testing should be done after each unit testing has been performed. This is to make sure that what have been developed managed to integrate with each other to perform as one big system. Other than that, it is to make sure what have been debugged and repaired do not break the whole system functionality and performance.

3.2 TOOLS REQUIRED

3.2.1 Hardware

- J2ME-Bluetooth enabled mobile phones with JSR-82 compatible
- USB Bluetooth dongle

  Bluetooth dongle provides short-range wireless connectivity that makes communication between computers and the mobile phone.

- Integrated circuit
- Lamp (for presentation purposes)

3.2.2 Software

3.2.2.1 Computer Server development

3.2.2.1.1 Windows XP Service Pack 2 (with Microsoft Bluetooth Stack)

The protocol stack makes up the core portion of the Bluetooth implementation. This stack enables devices to locate each other and establish a connection. Through this connection, devices can exchange data and interact with one another through various applications.

3.2.2.1.2 JDK (Java Development Kit – J2SE SDK) Version 1.4.2

The Java 2 SDK is a development environment for building applications, applets, and components using the Java programming language. It includes tools useful for developing and testing programs written in the Java programming language and running on the Java platform.

3.2.2.1.3 BlueCove Stack

Open source implementation of the JSR-82 Bluetooth API for Java.

3.2.2.1.4 Parport.dll component

ParallelPort is a simple Java class that enables reading and writing bytes to and from the parallel ports on the computer.

3.2.2.1.5 Parallel port monitor (for testing purposes)

The Parallel Port Monitor is a freeware utility for viewing and manipulating the state of a parallel port on a Windows 95/98/ME/NT/2000 computer.

3.2.2.1.6 UserPort

UserPort is a simple kernel mode driver for Windows NT/2000/XP that will give programs access to I/O ports. This makes it possible to access the hardware I/O ports directly under Windows NT/2000/XP.

3.2.2.2 Mobile phone development

3.2.2.2.1 Java 2 Platform, Micro Edition (J2ME) Wireless Toolkit

The Java 2 Platform, Micro Edition (J2ME) Wireless Toolkit is a toolbox for developing wireless applications and designed to run on cell phones, mainstream personal digital assistants, and other small mobile devices. The toolkit includes the emulation environments, performance optimization and tuning features, documentation.

3.2.2.2.2 MIDP (Mobile Information Device Profile) Version 1.0.3

In development, the Mobile Information Device Profile (MIDP) is used to deploy the current written application to a wide variety of mobile information devices. MIDP has been widely adopted as the platform of choice for mobile applications. It is deployed globally on millions of phones and PDAs, and is supported by leading integrated development environments (IDEs).

CHAPTER 4
RESULTS AND DISCUSSION

The project managed to control appliances from the Bluetooth-enabled mobile phone to Bluetooth-enabled server using Bluetooth connection. This is achieved by connecting the electrical appliances to the server's parallel port connection. This project will be able to provide the flexibility to user to control the appliances while being within the Bluetooth radius.

4.1 System Architecture

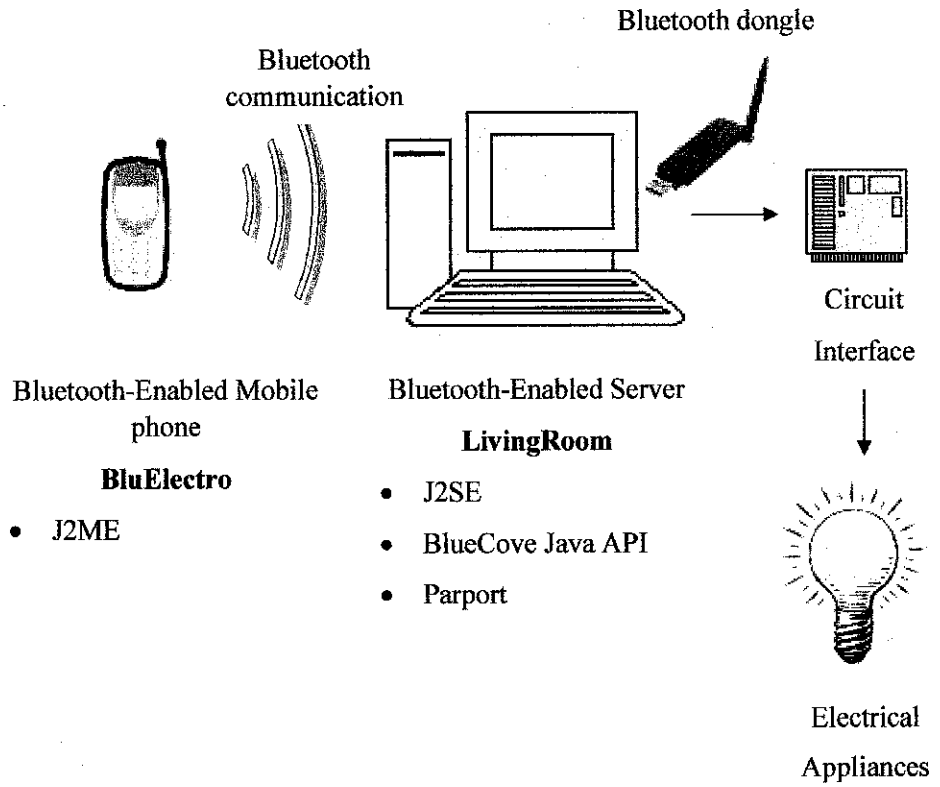

Figure 4.1: The proposed system architecture

The proposed system architecture shown in *Figure 4.1* is the architecture designed for this project where it will first start with the establishment of the Bluetooth connection between Bluetooth-enabled mobile phone and Bluetooth-enabled server. The Bluetooth-enabled mobile phone application is named BluElectro that uses J2ME.

Server is equipped with Bluetooth dongle to enable the Bluetooth communication inside the server. BlueCove API allows the connectivity to the Bluetooth from the server program and Parport components is used to control the parallel port pins from the Java program. This server uses J2SE for the development. Acting as the LivingRoom server, server will first read the parallel port and electrical appliance status and send it to mobile phone. And the mobile phone will decide whether to switch the appliance's status. When user decides to switch, Bluetooth-enabled mobile phone will send the command to Bluetooth-enabled server. Server will read the command and send the command to circuit interface by using parallel port and run the command at the electrical appliance's switch. After the operation is successful, Bluetooth-enabled mobile phone and server will update the current status of the electrical appliances in their respective side.

4.2 System Logic Flow

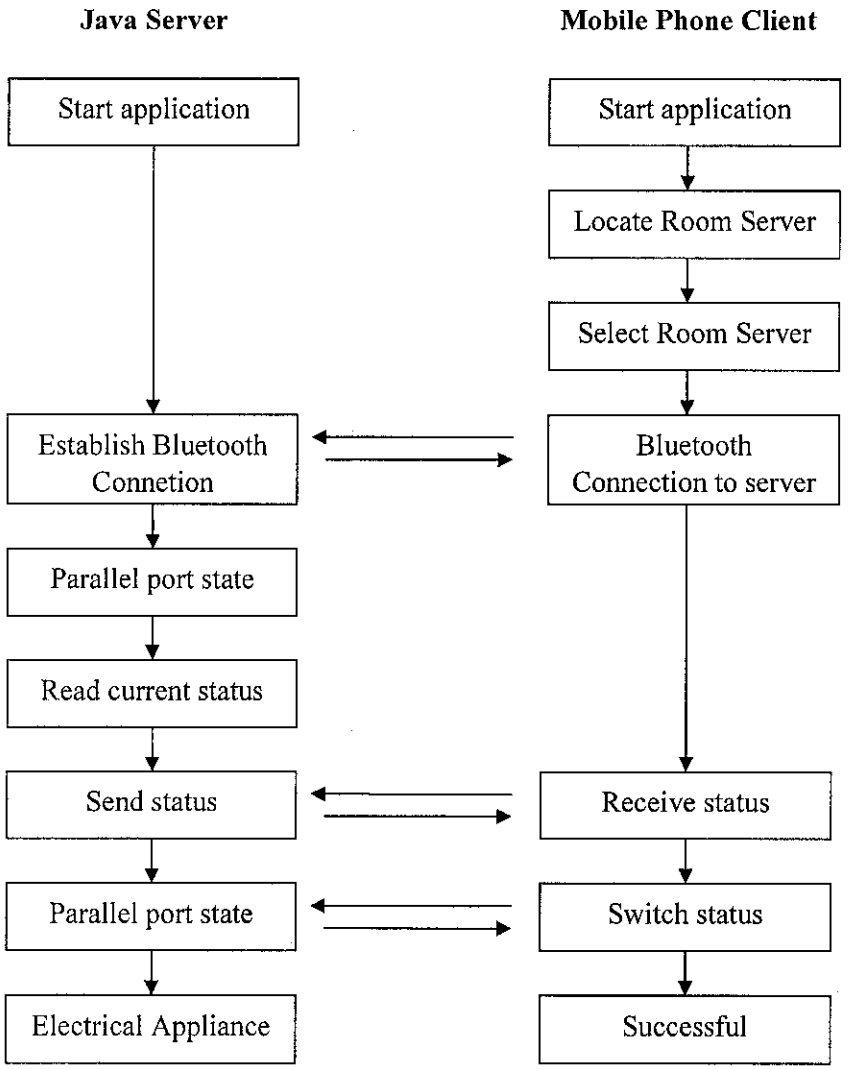

Figure 4.2: The proposed logic flow

As shown in *Figure 4.2*, the proposed logic flow of the system starts from the application in the Bluetooth-enabled server. The logic is that the server will need to open the Bluetooth connection so that the client that is the mobile phone will be able to locate and call the server to establish the connection as shown in *Figure 4.3*.

Figure 4.3: The Startup Server Interface

Then, the mobile phone's application starts to detect the Bluetooth room server within the radius. Once the list of room server has been obtained, user will select which room to control as shown in *Figure 4.4*.

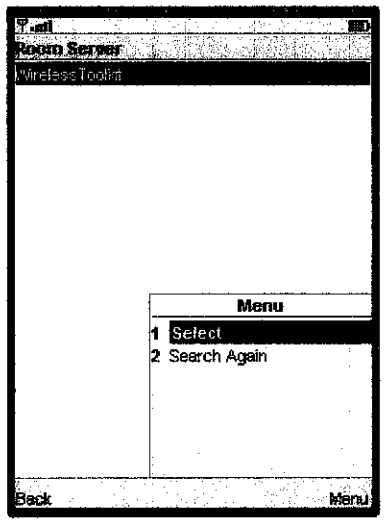

Figure 4.4: The Mobile Interface – Room server

After the Bluetooth connection has been established between the server and the mobile phone, Bluetooth-enabled sever will read the parallel port state to check the status of the appliances and send this status command to mobile phone. Bluetooth-enabled mobile phone can now read and update the state of electrical appliance using the application from the mobile phone as in *Figure 4.5*.

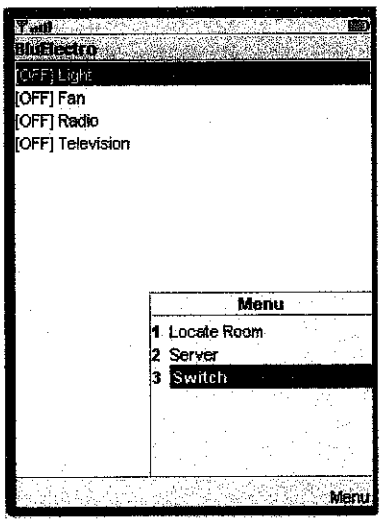

Figure 4.5: The Mobile Interface – Switch

Bluetooth-enabled server will receive the command to switch the appliance from the mobile phone and run the command through the server program as in *Figure 4.6*. After receiving the command, it will then send to the control unit via parallel port and switch the electrical appliance. The state will remain until the next command is received to switch the state.

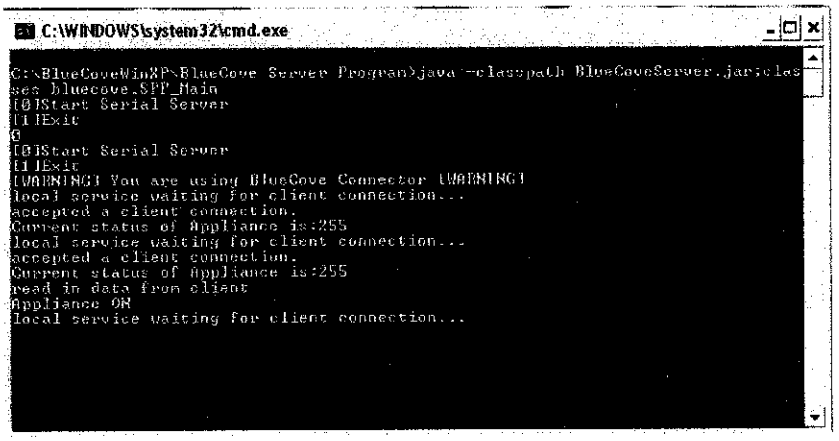

Figure 4.6: The Server Interface –Switch

After the operation is successful, Bluetooth-enabled mobile phone and server will update the current status of the electrical appliances in their respective side as shown in *Figure 4.6* from the server interface and *Figure 4.7* taken from the mobile interface.

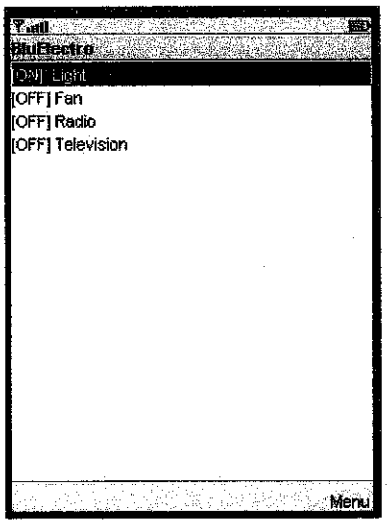

Figure 4.7: The Mobile Interface – Update status

The state of the electrical appliance can be monitored from the parallel port monitor as shown in *Figure 4.8*. Note that only pin 2 of the parallel port is being controlled for this project.

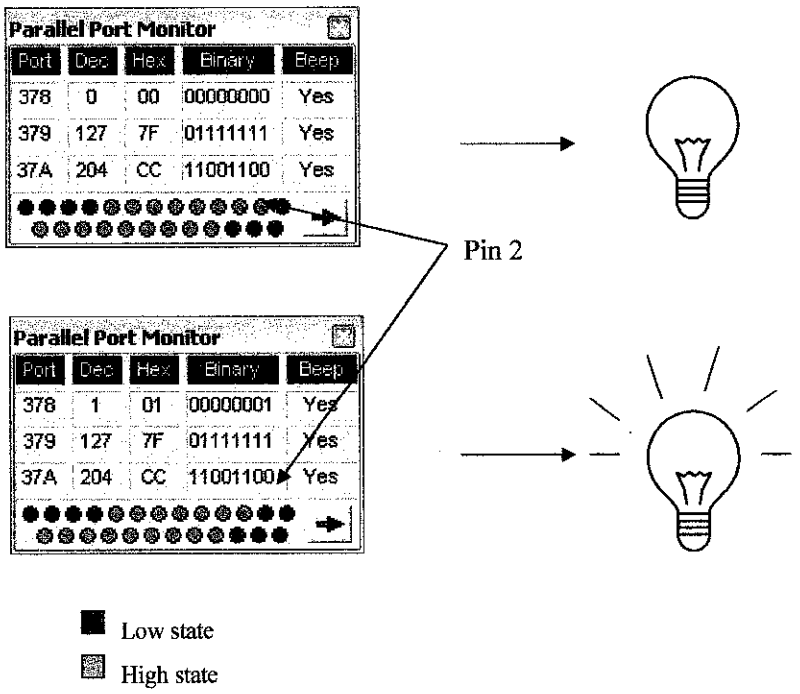

Figure 4.8: The electrical appliance state

4.3 Bluetooth-Enabled Server Application

4.3.1 Parport IO Component

To enable communication between computer and electrical appliances through the parallel port connection, server application is being developed using IO components in Java programming language.

The following function is the sample of the written program using J2SE. Before we can use the program, we will first need to copy a .DLL file into the system directory or window directory and into the same folder as the source code applied. The file name is parport.dll.

```
public class ParallelPort {
      private int portBase;
   public ParallelPort (int portBase)
   {this.portBase = portBase;}
```

This command below is used to read the status of the parallel port.

```
   public int read ()
   {return ParallelPort.readOneByte (this.portBase);}
```

And this command will be used to write the command to the parallel port datapin.

```
   public void write (int oneByte)
   {ParallelPort.writeOneByte (this.portBase, oneByte);}
```

This command will be used load the parport.dll to the system that have been developed.

```
   {System.loadLibrary("parport");}
```

4.3.2 BlueCove API

To enable communication between computer server and Bluetooth-enabled mobile phone through Bluetooth connection, server will first need to be equipped with Bluetooth dongle. This dongle will be connected through USB port and Windows XP 2 will be needed as the driver of this Bluetooth device. Once server is Bluetooth-enabled, BlueCove API is installed and programming will be done in BlueCove environment that provide the communication through JSR-82 API.

Java APIs for Bluetooth Wireless Technology (JSR-82) is developed by SUN Microsystem to provide a standardized way to develop Bluetooth applications. It is the first open, non-proprietary standard for developing Bluetooth applications using the Java programming language. It hides the complexity of the Bluetooth protocol stack behind a set of Java APIs that allow programmer to focus on application development rather than the low-level details of Bluetooth.

While BlueCove is an open source JSR-82 API that works on Windows XP and it is a viable solution to develop computer-based Java Bluetooth applications using this library.

To be able to run this server program, the source code should be in the BlueCove directory. Before the program can be used, it will first need to copy a .DLL file into the system directory or window directory. The file name is intelbth.dll.

4.4 Circuit Development

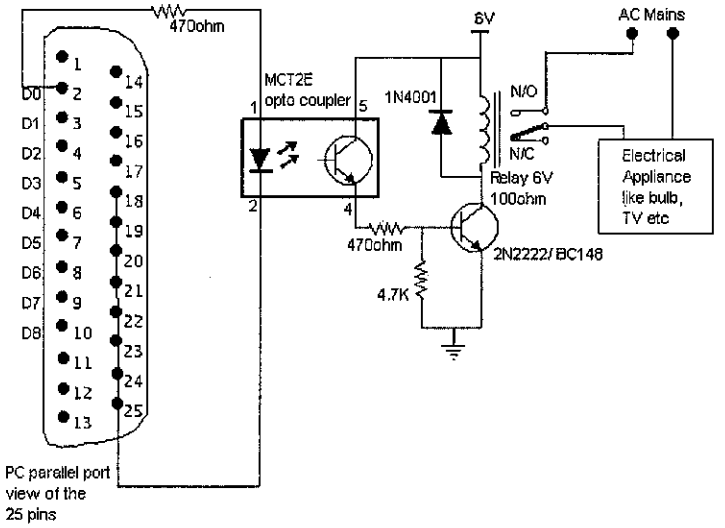

Figure 4.9: The circuit design

The circuit that have been developed, shown in the *Figure 4.5* consist of several components such as the 25 pin parallel port, opto-coupler, relay, transistor and external power supply from the batteries.

PC parallel port is 25 pin D-shaped female connector, which can be found at the back of the computer. It is normally used for connecting computer to printer, but can be used for general purpose I/O control. Parallel port are put out ideally 0V when they are in low logic (level 0) and +5V when they are in high logic (level 1). To supply the required voltage of 240V to switch the appliance, relay is needed to supply and extend those power supplied from the parallel port with the used of batteries.

If for some reason, more than +5V is sued in the relay side, the circuit can push that higher voltage to the parallel port to damage it. The opto-coupler is used to protect the port parallel. The opto-coupler's input is a light emitting diode.R1 is used to limit the current when the output from the port is on. That 1kohm resistor limits the current to around 3 mA, which is well sufficient for that output transistor driving. The output side of the opto-coupler is just like a transistor, with the collector at the top of the circuit and the emitter at the bottom.

When the output is turned on by the input light from the internal LED in the opto-coupler, current flows through the resistor and into the transistor, turning it on. This allows current to flow into the relay and current goes through R2 to the transistor base.

Turning the input on the parallel port off causes the output of the opto-coupler to turn off, so no current flows through it into the transistor and the transistor turns off. When transistor is off, no current flows into the relay and switches off the circuit. The diode provides an outlet for the energy stored in the coil, preventing the relay from back feeding the circuit in an undesired manner.

The transistor in the circuit can be used for controlling output loads to maximum of around 100 mA. The circuit is powered from external power supply which is not connected to the PC. This arrangement prevents any currents on the external circuits from damaging the parallel port.

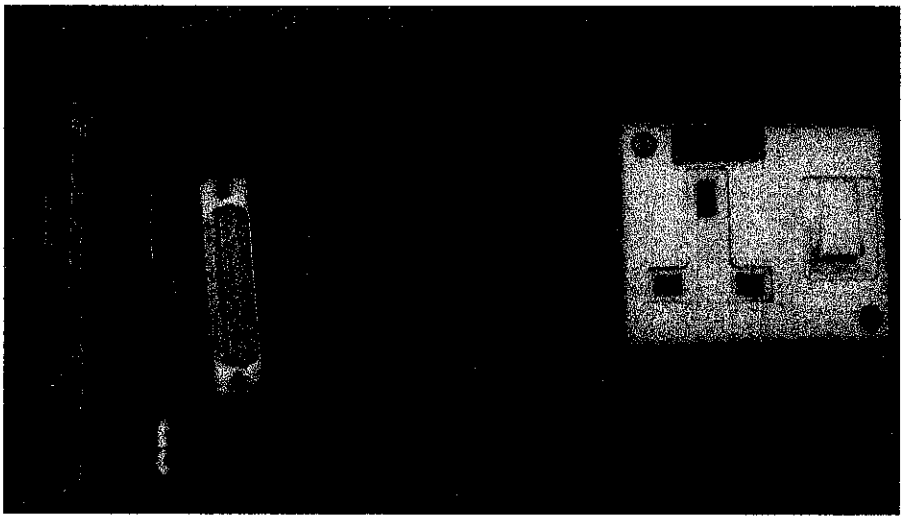

Figure 4.10: Circuit image – Black box view

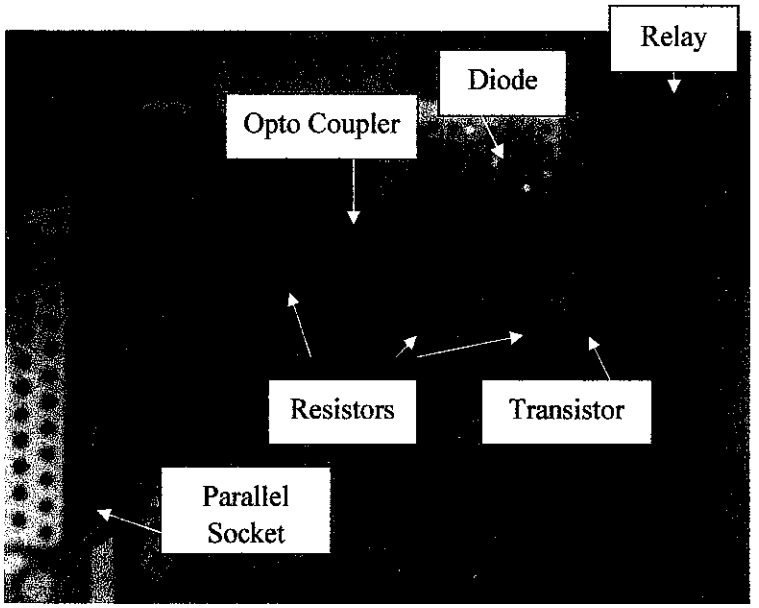

Figure 4.10: Circuit image – Circuit view

4.5 Project Cost

Listed below in *Table 4.1* is an estimate of all costs related to deployment of the product for this project.

Components	**Cost**
I. SERVER	
Bluetooth dongle	$60
II. CIRCUIT COMPONENTS	
D Size Battery	$1.20x4 = $4.80
25 pin D-shaped parallel socket	$1.50
5W Resistor	$0.05x3 = $0.15
2N222A (TO-18)	$0.40
MCT2E	$3.00
IC Socket	$0.30
Single relay 24V	$3.00
TOTAL	**73.15**

Table 4.1: The cost of the project

CHAPTER 5
CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

In this paper, a mobile home automation system based on a Bluetooth technology is proposed. This is to proof that Bluetooth can be used in such system with more advantages compare to other technologies held in the market. An application is designed for monitoring and remote control of different appliances connected over Bluetooth network in a home environment. The development includes a server program, client that is the mobile phone and connection to the appliances through parallel port.

5.2 RECOMMENDATIONS

5.2.1 Controlling more appliances

A circuit that can control many outputs can be designed by combining many individual transistor based circuits. With a compact construction with up to 8 outputs, ULN2803 IC that is manufactured by Allegro and several other manufacturers is recommended. *Figure 5.1* is the pin out of this ULN203 IC:

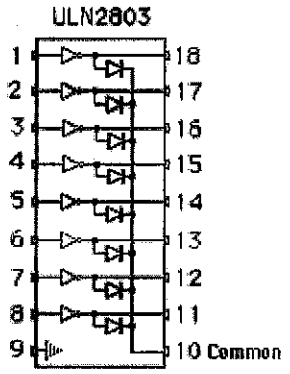

Figure 5.1: ULN203 IC pin out

ULN2803 is an 8-bit 50V 500mA TTL-input NPN darlington driver. Featuring continuous load current ratings to 500 mA for each of the drivers, the ULN2803A

high-current Darlington array is ideally suited for interfacing between low-level logic circuitry and multiple peripheral power loads. Typical loads include relays, solenoids, stepping motors, magnetic print hammers, multiplexed LED and incandescent displays, and heaters. Home appliances and other electrical appliances are also possible to include. The drivers need no power supply; the VDD common pin is the common cathode of the eight integrated protection diodes.

The ULN2803 is connected between each of the eight output lines of the printer port and the device it controls. The output device can be from a relay that is connected to the home appliances itself. The inputs on the left side of the IC are directly suitable to be connected to PC parallel port output lines. The outputs are open collector output and output gets grounded through transistor when corresponding input line goes to high state, so they are well suitable for controlling various loads powered through external power supply. The maximum controllable voltage is 50V and maximum current per channel is 500 mA. Outputs may be paralleled for higher load current capability. The input and output sides of the IC have the same common ground that must be connected also to the ULN2803 IC ground pin.

The common line is connected to a suitable over voltage protection circuitry to prevent damage to the IC when loads such as relays switch on and off. This common line can be for example connected to the power supply line that supplies power to the relays.

5.2.2 Wireless appliance

Currently, the setup of the home appliances system includes connections to a server and through the parallel ports within itself. For it to function accordingly the system will locate the room server respectively which are Bluetooth enabled and it will then locate the specific appliances. Short to say, this appliances system is using wired technology with around the clock usage of CPU power.

To enhance and make the system an even efficient and effective, a wireless system is proposed to neglect many more excessive power usage required from the CPU. Beforehand, the server acts as the Bluetooth enabled device, to then control the

appliances, whereas in this wireless case, the intended appliances are to be Bluetooth enabled itself embedded with Bluetooth module chip. It can be control straight from the main power supply of the house. But separate adapter to each of the appliances will be needed in such a way that will incur cost somehow. Example of Bluetooth adapter design is shown in *Figure 5.2.*

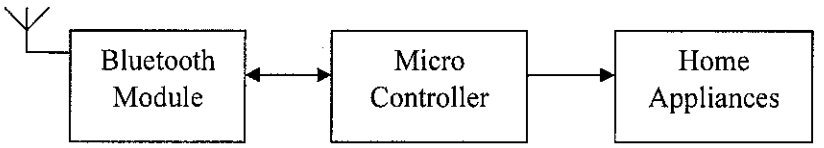

Figure 5.2: Bluetooth adapter design

From the users point of view, the can simply check the status of any identical appliances through their mobile phones and thus, make modifications at the same time. There is no need anymore to locate a CPU server to each of the room to control the appliances users intend to change. User can be anywhere and anytime to alter it since that it is on a wireless technology.

5.2.3 Added function

The added function recommended is to provide full remote control access to all appliances in house to suit the concept of smart home system of the future.

5.2.3.1 Lighting systems

The recommended high level tasks for lighting system will be to control the dimmer switch for each light fixture in room, select a different room in which to control lighting, set timers and light programs for entire house

5.2.3.2 Video systems (TV/VCR/DVD)

The recommended high level tasks for video systems will be to control volume, change channel settings, control playback (play, stop, skip, fast forward, back, repeat)

and manipulate the control buttons for viewing purposes including recording shows with timer and day settings.

5.2.3.3 Audio systems (Radio/MP3/CD)

The recommended high level tasks for audio systems will be to control volume and select specific band and channels, CD and songs, change channel, control playback (play, stop, skip, fast forward, back, repeat) and recording songs with added alarm and timer.

5.2.3.4 Security System

The recommended high level tasks for security system will be to turn on/off alarm, and lock/unlock doors.

5.2.3.5 Air-Condition/Heater System

The recommended high level tasks for security system will be to control temperature in current room, and automatic temperature settings to suit current humidity.

5.2.4 Larger home appliances network environment

The basic feature of the Bluetooth technology that uses point-to-point piconet is relevant to realize this project. But in expanding the radius and the controllable appliances in house, scatternet formation is proposed so that the range of the control of Bluetooth devices can be maximized. But the main focus was to have at least one Bluetooth enabled device to act as a bridge to overcome the 10-metre radius barrier.

Bluetooth nodes are organized in small groups called piconets. Piconet is a set of 8 active members that within every piconet there is a leading node called master, and all other nodes are referred to as slaves. Slaves do not directly communicate with each other but instead rely on the master as a transit node. With this technology, it allows node to belong to multiple piconets, and such node is referred as a bridge. The communication between nodes in different piconets relies on the bridge nodes itself.

These bridge devices effectively connect piconets into a scatternet formation. Scatternet is the network architecture that enables piconet to be connected to each other and form a larger Bluetooth network by connecting through bridges.

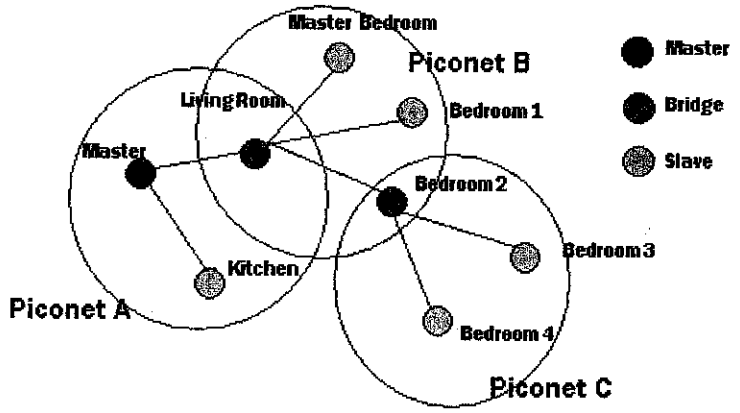

Figure 5.3: Proposed scatternet formation

By using this topology shown in *Figure 5.3*, the range of the control of Bluetooth devices can be maximized and be connected through one Bluetooth master request. It is also efficient to make the room server to be as pre-defined room so that it will not interfere with other Bluetooth devices. When establishing the connection, mobile phone should be able to detect at least one of the Bluetooth-enabled room servers that will act as a bridge to get connected to every room and appliances in house. Once connected, the detected room server will automatically define themselves as the next master scanning for other room server held in their radius.

But in future projects, more research should be done in the performance measures of the scatternet formation algorithm implementation that are used to solve the problem of connecting all the Bluetooth enabled devices in any home automation environment. The two important performance measures lie on the time complexity and communication complexity.

Time complexity is defined as the amount of time to form a scatternet. The proposed design should be able to minimize the delay for a new node to connect to the scatternet, which implies the waiting time for a user to join and list the scatternet

network.

Communication complexity is the complexity of command sent between the appliances using bridge node. Since a slave node that performs inquiry will become a master later, a slave would always become a master node even if it were trying to connect with a master. It is sometime the best approach to pre-assign the role of node to assist in more effective communication channel.

5.2.5 Interface Design

The full potential of home automation systems will not be realized unless the system is made easy for all classes of users. The proposed recommendation for the interface design is divided into 2 main areas; server and the mobile phone application.

5.2.5.1 Server

For the server system, much can be improved in the sense of appliances control. Since no direct interface has been designed for this project, next project can start with the naming convention interface of the appliances. By default, the appliances will be named based on the control pin through parallel port connection; e.g. Appliance1, Appliance2, etc connected to pin1, pin2, etc. From this, user should have the flexibility to name their own appliances based on the real environment; e.g. Light, Fan, etc. based on the same control pin assigned. They should also have the interface to add appliances, delete and rename for better user control.

Other enhancement recommendation would be by providing a server login page so that only authorized user can have the full control of the home appliances network. By then, enhancement can also be done by giving the administrator the authorization to set the user permission allowed for certain control of the appliances. For example, user A will only have the permission to ON/OFF appliances, while user B is allowed to change the TV channels, etc.

User identification is also recommended for observation purposes. This is to make sure that the system will not be misused by certain user of the house. From this,

server can also have an interface for history data to keep track of the past control of the appliances in house.

5.2.5.2 Mobile phone

In mobile phone interface, next project can concentrate on the security reason of the system. Only authorized user can have the ability to control the appliances based on the server database. Login page is recommended. And for every action taken, authentication key is to be included for the action to be process and pass to the server.

Other than that, help page is to be considered to assist navigation of a new user.

5.2.6 Security setting

In the future enhancement development, it is recommended to enhance the security elements in this system since having these new technologies at home provides many new ways for adversaries to invade an individual's personal life. An example of an attacker that would be motivated to do so might be a thief that wishes to gather information about when or if there is somebody at home by viewing the status of the appliances in house.

In order to counteract this threat, a secure communication is needed with mechanisms that provide secrecy, authenticity, integrity and freshness of messages. Encrypting the communication will provide secrecy while integrity can be provided by the use of secure hash functions and freshness by the use of counters. For authenticity, either digital signatures or unique shared keys will be needed. It follows that the main need is to place unique encryption keys on the devices and that these keys must be distributed over a secure channel.

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APPENDICES

APPENDIX 1: USER MANUAL

CONTROLLING ELECTRICAL APPLIANCES THROUGH BLUETOOTH-ENABLED DEVICE

BluElectro User Manual

A. PURPOSE

The purpose of this document is to establish a user manual for an operating procedure for this project that consist of a BluElectro computer server, BluElectro mobile phone client application and designated circuit to control the appliances.

B. TOOLS

1. **BluELECTRO SERVER**
   - A personal computer
   - Bluetooth dongle

2. **BluELECTRO MOBILE PHONE CLIENT**
   - Bluetooth-enabled mobile phone (JSR-82 compatibility)

3. **CIRCUIT**
   - Designated circuit
   - Parallel Port cable
   - Electrical appliance
   - Main source

C. REQUIREMENTS

1. Window XP Service Pack 2
2. Microsoft Bluetooth Stack installed

3. J2SE SDK 1.4 or above installed
4. J2ME SDK 2 or above installed

D. INSTALLATION

BluELECTRO SERVER

1. Download BluElectro-Server.zip to your computer.
2. Unzip the file BluElectro-Server.zip to C: drive.
3. Place intelbth.dll in "C:/windows/system32"

BluELECTRO MOBILE PHONE CLIENT

1. Download BluElectro-Mobile.zip to your computer.
2. Unzip the file BluElectro-Mobile.zip to C: drive.
3. Open "C:\BluElectro\bin"
4. Using Bluetooth connection, pass BluElectro.jar to the mobile phone.
5. Run installation procedure in the mobile phone.

E. PROCEDURES

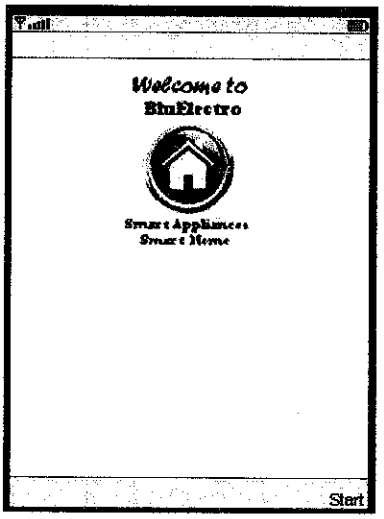
BluELECTRO SERVER

a. DESCRIPTION OF BluELECTRO SERVER

The server program is run on a personal computer. Bluetooth dongle is to attach to the USB port to Bluetooth-enabled the server.

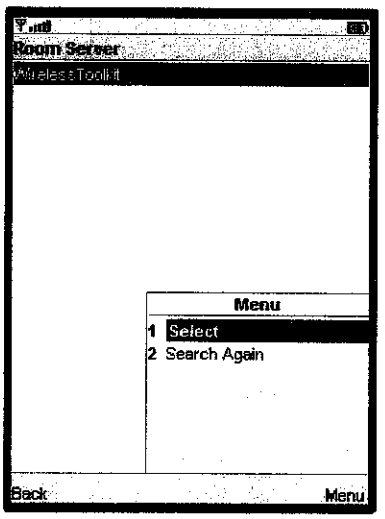
b. START BluELECTRO MOBILE PROGRAM

A splash screen with appear but user can skip the introduction by clicking 'Start'.



c. LOCATE ROOM

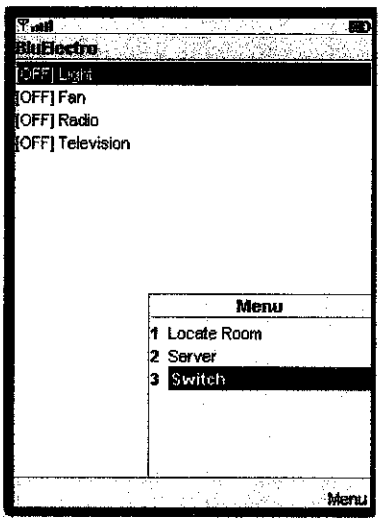
The BluElectro mobile program will now locate and list all the room server within the radius and allow user to choose with room server to control.



6. Choose room server
7. Click Select

d. CURRENT STATE OF APPLIANCE

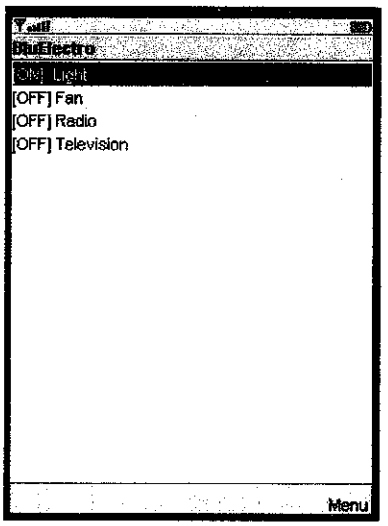
Current state of all the appliances held in the room domain will be displayed after user has chosen the room server from the list to control.



e. SWITCH STATE OF APPLIANCE

1. Choose and click appliance from the list
2. Select 'Switch'

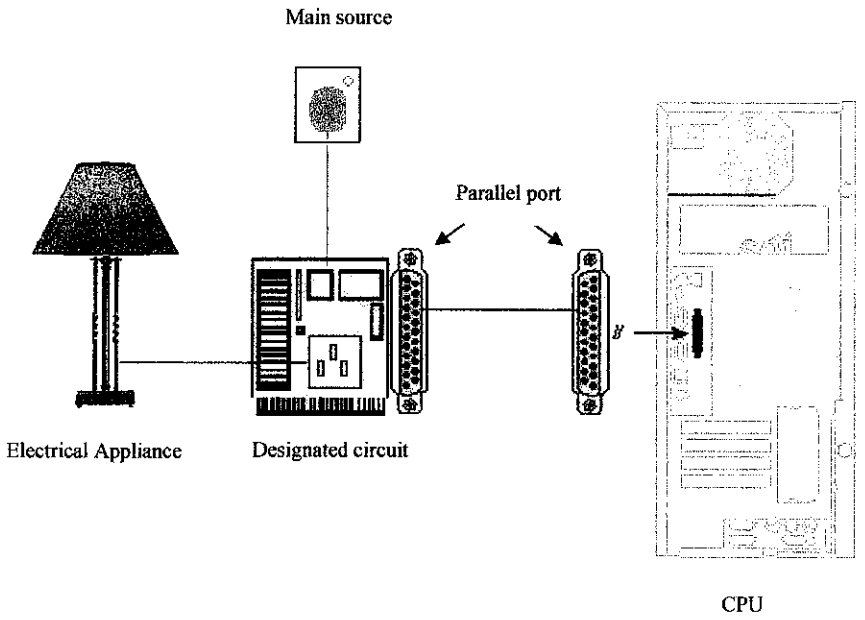
After the state of the appliance have been switch and update in the server. The next screen will show the updated state of appliances.



CIRCUIT

a. DESCRIPTION OF BluELECTRO CIRCUIT

The designated circuit will be connected with the BluElectro server through parallel port connection. The circuit will also be connected to the main source to provide the current supply used to light up an appliance plugged to the designated circuit.



APPENDIX 2: DEVELOPER MANUAL

CONTROLLING ELECTRICAL APPLIANCES THROUGH BLUETOOTH-ENABLED DEVICE

BluElectro Developer Manual

A. PURPOSE

The purpose of this document is to establish a developer manual for this project that consist of a BluElectro computer server, BluElectro mobile phone client application and designated circuit to control the appliances.

B. TOOLS

3. **BluELECTRO SERVER**
   - A personal computer
   - Bluetooth dongle
   - Microsoft Bluetooth Stack
   - JDK (Java Development Kit – J2SE SDK) Version 1.4.2
   - Forte for Java 4.0 CE
   - BlueCove Stack
   - Parport.dll component
   - Parallel port monitor
   - UserPort

4. **BluELECTRO MOBILE PHONE CLIENT**
   - Java 2 Platform, Micro Edition (J2ME) Wireless Toolkit
   - MIDP (Mobile Information Device Profile) Version 1.0.3

C. REQUIREMENTS

1. Window XP Service Pack 2

D. COMPONENTS

1. BluELECTRO SERVER

- ***Windows XP Service Pack 2 (with Microsoft Bluetooth Stack)***

The protocol stack makes up the core portion of the Bluetooth implementation. This stack enables devices to locate each other and establish a connection. Through this connection, devices can exchange data and interact with one another through various applications.

- ***JDK (Java Development Kit – J2SE SDK) Version 1.4.2***

The Java 2 SDK is a development environment for building applications, applets, and components using the Java programming language. It includes tools useful for developing and testing programs written in the Java programming language and running on the Java platform.

- ***BlueCove Stack***

Open source implementation of the JSR-82 Bluetooth API for Java.

- ***Parport.dll component***

ParallelPort is a simple Java class that enables reading and writing bytes to and from the parallel ports on the computer.

- ***Parallel port monitor (for testing purposes)***

The Parallel Port Monitor is a freeware utility for viewing and manipulating the state of a parallel port on a Windows 95/98/ME/NT/2000 computer.

- ***UserPort***

UserPort is a simple kernel mode driver for Windows NT/2000/XP that will give programs access to I/O ports. This makes it possible to access the hardware I/O ports directly under Windows NT/2000/XP.

2. BluELECTRO MOBILE PHONE CLIENT

- ***Java 2 Platform, Micro Edition (J2ME) Wireless Toolkit***

The Java 2 Platform, Micro Edition (J2ME) Wireless Toolkit is a toolbox for developing wireless applications and designed to run on cell phones, mainstream personal digital assistants, and other small mobile devices. The toolkit includes the emulation environments, performance optimization and tuning features, documentation.

- ***MIDP (Mobile Information Device Profile) Version 1.0.3***

In development, the Mobile Information Device Profile (MIDP) is used to deploy the current written application to a wide variety of mobile information devices. MIDP has been widely adopted as the platform of choice for mobile applications. It is deployed globally on millions of phones and PDAs, and is supported by leading integrated development environments (IDEs).

E. INSTALLATION

BluELECTRO SERVER

1. Download BluElectro server program
   - Download BluElectro-Server.zip to your computer.
   - Unzip the file BluElectro-Server.zip to C: drive.
   - Place intelbth.dll in C:/windows/system32

2. Download UserPort to server
   - Download UserPort.zip to your computer.
   - Unzip the file `UserPort.zip` to C: drive.
   - Run UserPort.EXE with the driver filename and path as an argument i.e. run UserPort.EXE X:\YOURDIR\UserPort.SYS. Add the addresses and remove the others
   - Click on Start

3. Download Parallel Port monitor for testing
   - Download `parmon.zip` to your computer.
   - Unzip the file `parmon.zip` to `required folder`.
   - Run `parmon.exe`

BluELECTRO MOBILE PHONE CLIENT

1. Download BluElectro-Mobile.zip to your computer.
2. Unzip the file BluElectro-Mobile.zip to C: drive.
3. Copy C:\BluElectro\src to your J2ME WTK.

F. PROCEDURES

BluELECTRO SERVER

a. DESCRIPTION OF BluELECTRO SERVER

The server program is developed on a personal computer. Forte is used for development process.

b. START BluELECTRO SERVER DEVELOPMENT

1. Open Forte for development
2. Mount "C:\BluElectro-Server\BluElectro Server Program\
3. Select until \src\BlueCove where all of the source code are placed
4. Start editing and developing.

c. RUN BluELECTRO SERVER PROGRAM

1. Open "C:\BluElectro-Server\BluElectro Server Program\
2. Run compile.bat
3. When successful, click run.bat
4. Make sure the Bluetooth dongle is connected

5. Enter 0 and run Start Serial Server
6. Wait for client to establish connection

BluELECTRO MOBILE PHONE CLIENT

a. DESCRIPTION OF BluELECTRO MOBILE PHONE CLIENT

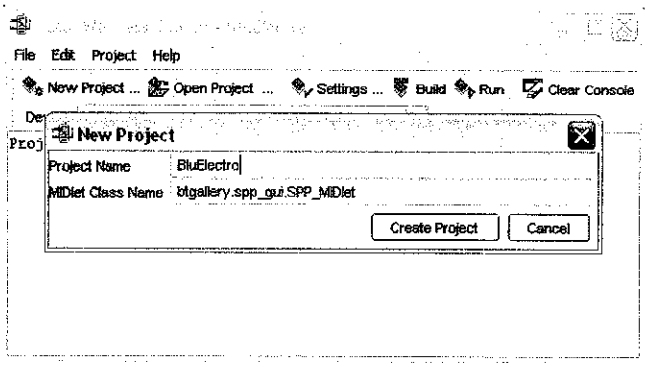
The development is done in the computer under J2ME Wireless Toolkit but Forte is still used for easy update of the source code rather than using notepad.

b. START BluELECTRO MOBILE DEVELOPMENT

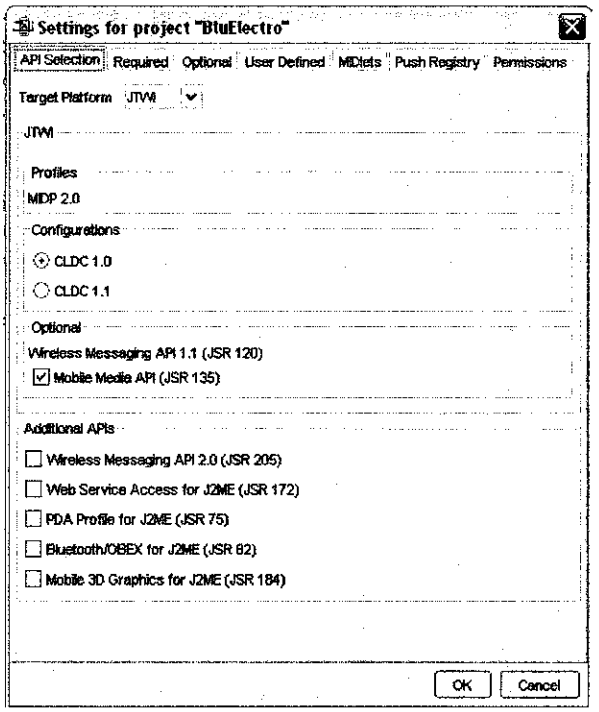
1. Open Forte for development
2. Mount "C:\BluElectro\"
3. Select until "\src\btgallery" where all of the source code are placed
4. Start editing and developing.

c. RUN BluELECTRO EMULATOR PROGRAM

1. Open J2ME Wireless Toolkit to run and test the program under emulator
2. Select New project as fill in the details as follow:



3. Set the required settings for this project



4. Place "C:\BluElectro\src" in the J2ME WTK folder. Eg: "C:\WTK22\apps\BluElectro\src"
5. To build the program, click Build
6. When the BluElectro managed to build without any errors, proceed to run the project by click to Run.