Perpustakaan SKTM

Smart Home Simulation

Submitted by
Ahmad Jazzri Jamaludin
WEK 990290

Supervisor
Dr Rosli Salleh

Moderator
Mr Yamani Idna

A FINAL YEAR PROJECT REPORT

Submitted to the

Faculty of Computer Science and Information Technology

University of Malaya

Dissertation submitted in partial fulfillment of the requirement for the Degree of Bachelor of Computer Science

Submission date: 22nd January 2003

University of Malaya

ABSTRACT

The project entitled "Smart Home Simulation" is a project that shows simulating of Smart Home in a real world application. This simulation system is a simulation just like other simulation system such as circuit simulator which show exactly like a real application of how does it work.

This project emphasize in how to control the system via Internet. In order to simulate how the system will operate, this project consist a user interface, a virtual home module and simulation control. The user interface and simulation control will be installed in one computer and a virtual home module in another. These computers will be connected to the Internet or LAN in order to act like controlling home from anywhere over the net.

This project is not involving any hardware or circuit such as home automation controller or hi-tech gadget or even a simple circuit. This project is totally a simulation system to guide people to understand how does it work in general and help them how to manage the house with this brand new technology system. This project involving developing a user interface, virtual home module and simulation control module to make these computers that contain these two modules communicate with each other.

At the end of this project, The Smart Home Simulation is expected to be such as other simulator that existence to provide an overview to understanding about real world Smart Home especially to customer that interested to own this technology in their home.

University of Malaya

ACKNOWLEDGEMENT

Bismillahirrahmanirrahim

Uttermost gratitude goes to the Almighty God for all the confidence and patience in the completion of the thesis.

I would like to express my heartfelt appreciation and gratitude to Dr.Rosli Salleh for the tremendous help, useful advises and guidance he has given to me during completing this project.

My appreciation is also dedicated to my moderator Mr.Yamani Idna for his suggestion and thoughtful comment on my system and for sharing his great experience and knowledge.

To my beloved family, thank you ever so much for the never ending support and love that I have from them that always keep me close to successful.

Last but not least, I would like to express my thanks to all my fellow members and who directly or indirectly helped me to complete my project.

Wassalam

University of Malaya

TABLE OF CONTENTS

Abstract		**ii**
Acknowledgement		**iii**
Table of Contents		**iv**
List of Figures		**x**
List of Table		**xii**

1 Introduction

1.1	**Introduction**	**1**
1.2	**What is the Smart Home?**	**1**
1.3	**Project Overview**	**2**
1.4	**Project Objectives**	**3**
1.5	**Project Scope**	**4**
1.6	**Project Schedule**	**4**
1.7	**Expected Outcome**	**8**
1.8	**Conclusion**	**8**

2 Literature Review

2.1	**Introduction**	**9**
2.2	**Fact finding**	**9**
2.2.1	Observation	10
2.2.2	Interview	12
2.2.3	Research and Reviews	12
2.2.4	Surfing The Internet	13
2.3	**Operating System / Platforms**	**13**
2.3.1	Windows 98	13

University of Malaya

	2.3.2	Windows 2000	14
	2.3.3	UNIX	15
2.4	**Interface Development Tools**		**15**
	2.4.1	Visual Basic	15
	2.4.2	Delphi	17
	2.4.3	PowerBuilder	17
2.5	**Interface Tools Comparison**		**18**
2.6	**Socket Programming**		**23**
	2.6.1	Java Language	27
	2.6.2	C++ Language	28
	2.6.3	Python	28
2.7	**Comparison For Socket Programming Language**		**29**
	2.7.1	Java vs C++	29
	2.7.2	Python vs Java	34
	2.7.3	C++ vs Python	38
	2.7.4	Benchmark Comparison	39
	2.7.5	Conclusion of Java, Python and C++	40
2.8	**TCP/IP**		**41**
	2.8.1	TCP/IP Layers	42
	2.8.2	Operation of TCP/IP	43
2.9	**Computer Configuration**		**47**
	2.9.1	Peer-To-Peer	47
	2.9.2	Client-Server	48
2.10	**Research on Existing System**		**49**
2.11	**Conclusion**		**51**

University of Malaya

3 Methodology

3.1	**Introduction**	**52**
3.2	**System Development Model**	**53**
	3.2.1 Waterfall Model	53
	3.2.2 Prototype Model	55
	3.2.3 V Model	56
3.3	**Conclusion**	**59**

4 System Analysis

4.1	**Introduction**	**61**
4.2	**Functional Requirement**	**62**
	4.2.1 User Interface	62
	4.2.2 Virtual home module	63
	4.2.3 Simulation control	65
4.3	**Non-Functional Requirement**	**66**
	4.3.1 User Interface	67
	4.3.2 User friendliness	67
	4.3.3 Reliability	67
	4.3.4 Expandability	67
4.4	**Software Requirement**	**67**
	4.4.1 Platform	68
	4.4.2 User Interface and Virtual Home Module Tools	69
	4.4.3 Simulation Control Tools	69
4.5	**Hardware Requirement**	**70**
4.6	**Conclusion**	**71**

University of Malaya

5 System Design

5.1	**Introduction**	**72**
5.2	**Overview of Smart Home Simulation System Architecture**	**72**
5.3	**System Functionality Design**	**73**
	5.3.1 System Structure Chart	73
	5.3.2 Data Flow Diagram (DFD)	77
5.4	**User Interface Design**	**79**
5.5	**Virtual Home Design**	**81**
5.6	**Conclusion**	**82**

6 System Implementation

6.1	**Introduction**	**83**
6.2	**Development Environment**	**83**
	6.2.1 Hardware Used	83
	6.2.2 Software Tools Used	84
	6.2.3 Platform Development	84
6.3	**System Development**	**85**
	6.3.1 Interface Coding	87
	6.3.2 Virtual Home Coding	90
	6.3.3 Winsock Coding	91
6.4	**Conclusion**	**93**

7 System Testing

7.1	**Introduction**	**94**
7.2	**Unit Testing**	**95**

University of Malaya

7.3 **Integration Testing** 95
7.4 **Overall System Testing** 96
7.5 **Acceptance Testing** 96
7.6 **Conclusion** 97

8 Discussion

8.1 **Objectives Achieved** 98
8.2 **System Strength** 98
8.2.1 User Friendly 98
8.2.2 Transparency 99
8.2.3 Simple Operation Maintenance 99
8.3 **System Limitation** 99
8.3.1 Graphic User Interface 99
8.3.2 Lack of Features 99
8.4 **Problem Encounter and Solution** 99
8.4.1 Problem in development tools 100
8.4.2 Problem in Winsock Coding 100
8.5 **Recommendation and Future Enhancement** 100
8.5.1 Enhance Function and Scope 100
8.5.2 System Security 101
8.5.3 Hardware Involves 101
8.6 **Experience and Knowledge Gained** 101
8.7 **Summary** 102

University of Malaya

1.0	**A Brief Overview**	**104**
2.0	**Hardware and Software Requirement**	**104**
	2.1 Hardware Requirement	104
	2.2 Software Requirement	104
3.0	**Entering the System**	**105**
4.0	**Connection Setting**	**106**
5.0	**Home Area**	**108**
6.0	**Mode Option**	**109**
7.0	**Virtual Home**	**110**

REFERENCES **112**

APPENDIX

University of Malaya

LIST OF FIGURE

Figure 1.1	First stage network task diagram	5
Figure 1.2	Second stage network task diagram	7
Figure 2.1	Processes communicating through TCP sockets	24
Figure 2.2	Client socket, welcoming socket and connection socket	25
Figure 2.3	Client program has three streams and one socket	27
Figure 2.4	Benchmark comparison between Python, Java and C++	39
Figure 2.5	TCP/IP concept	43
Figure 2.6	Protocol Data Units in the TCP/IP Architecture	46
Figure 2.7	Simple peer-to-peer network	47
Figure 2.8	Simple client-server network	48
Figure 2.9	Smart Home demo	49
Figure 2.10	Visual of dark house	50
Figure 2.11	Visual change after user key in an input	50
Figure 3.1	The V model	57
Figure 4.1	Conceptual diagram for user interface module	63
Figure 4.2	Conceptual diagram for virtual home module	64
Figure 4.3	Conceptual diagram for user interface and virtual home module	65
Figure 4.4	Basic communication diagram for Smart Home simulation	66
Figure 4.5	Hardware require for this system	70
Figure 5.1	Two-tier architecture	73

University of Malaya

Figure 5.2	Structure chart for Smart Home Simulation System	74
Figure 5.3	Structure chart for user interface module	74
Figure 5.4	Structure chart for Smart Home Mode	74
Figure 5.5	Structure chart for Home area	75
Figure 5.6	Structure chart for virtual home module	76
Figure 5.7	Data flow diagram for Smart Home Simulation System	78
Figure 5.8	Interface of main page	79
Figure 5.9	Interface of Home area option 1	80
Figure 5.10	Interface of Home area option 2	80
Figure 5.11	Interface of Mode option	81
Figure 5.12	Virtual home interface	82
Figure 6.1	5 Steps of System Implementation	85
Figure 7.1	System Testing Process	94
Figure 7.2	The integration of the components in Smart Home Simulation	96
Figure A	First page of the System	105
Figure B	Main Page of the System	106
Figure C	Connection Setup of the System	106
Figure D	Main button for Connection Setup	107
Figure E	Home Area Controller	108
Figure F	Mode Option Controller	109
Figure G	Virtual Home Page	110
Figure H	Event simulation button	111

University of Malaya

LIST OF TABLE

Table 1.1	First stage development management	5
Table 1.2	First stage Gantt chart	6
Table 1.3	First stage task details	6
Table 1.4	Second stage development management	7
Table 1.5	Second stage Gantt chart	7
Table 1.6	Second stage task details	8
Table 2.1	Prices for TMnet Streamyx packages	11
Table 2.2	Price for TMnet ISDN services	11
Table 2.3	Comparison between Visual Basic and Delphi	20
Table 2.4	Comparison between Visual Basic and PowerBuilder	23
Table 2.5	Comparison between Java and C++	34
Table 2.6	Benchmark result table	40
Table 2.7	General comparison between Python, Java and C++	41
Table 4.1	Requirement of PC A (server machine)	71
Table 4.2	Requirement of PC B (client machine)	71
Table 5.1	Four basic symbols in DFD	77
Table 6.1	Summary of software used	84

University of Malaya

CHAPTER 1: INTRODUCTION

1.1 Introduction

The Internet. It's changing our lifestyle, the way we work, live, play and learn. Today almost all of Malaysian household own a computer and most of them access the Internet from home.

Broadband services will open it up even more. Allowing high-speed, high-quality services such as online music and shopping, and virtually free international communication.

More than that, cable modems and satellite are always on. Providing the freedom to see and control a home and office from virtually anywhere, anytime over the net.

1.2 What is the Smart Home?

A Smart Home is a home that features an advanced design and incorporates with intelligent electrical and IT systems that integrates with various appliance within the home to provide the owner with a seam-less, and easy to operate their home management system.

Security can actives lights, telephones can communicate with thermostats, touch screen can control all the home systems and also via Internet. These High Tech systems provide residential convenience, increase security, and improved comfort for enhanced lifestyles.

University of Malaya

The real world Smart Home typically consist LCD keypad inside the house and Graphic User Interface to control the systems. LCD often uses to control the system when you are home and Graphic User Interface when you are away by log-on to the Internet. The system's developer also provided home automation controller which consists every single circuit that controlled all the home appliance and input from LCD keypad or from the web. Besides to control the home appliance, the system usually consist security features such as smoke or heat detector to avoid any fire. It's also consists movement detector to detect any intruder or stranger in the house. Some system provides camera surveillance or telephone control features depend on packages offered by the company to customer.

In the real world Smart Home, user interfaces typically stored in a server that can be accessed by user via Internet. Every security features such as passwords, user identification and requesting serial number provided by the company to avoid hackers from accessing the system.

1.2 Project Overview

The Smart Home Simulation is a simulator that shows how to manage the home with the Smart Home technology. It consists of three core module. The first module is user interface, the same interface that will be used in real world application. The second module is virtual home modules that act like a home with the real system. The last module is simulation control, which it will control the signal that transmits from user interface to virtual home module and vice-versa. In this simulation system, user will interact with the interface to control the home appliance such as fan, light, air-condition and so on.

University of Malaya

The first module, the user interface will be installed in a computer which is PC A. The computer must be a high-end computer to avoid any error during the simulating. This computer will execute all simulating instruction before it sending the signal to virtual home module.

Virtual home module will be installed in another computer, PC B, and will show the effect from input that has been entered from the user interface. For example user switch-on the bedroom light from the user interface and from the virtual home module user can see the light will switch-on virtually and it is exactly like a real world Smart Home.

Simulation control will be installed in PC A which is the same computer with the first module. All the simulation process will be generated in PC A before the signal is sending to the output computer.

1.3 Project Objectives

The objectives of this project are:

- To provide a simulator to be used for company that developing smart home technology.
- To develop a mobile Smart Home model. The developers company easy to simulate a virtual Smart Home to people anywhere.
- To reduce cost by developing a simulation system instead of building many real Smart Home show room.

University of Malaya

- To allow people to understanding about how to communicate and to interact with the system and generally about how does the system works.
- To provide people especially to customer about the system before they decide to install it at their home.
- To provide people with the knowledge of brand new technology in order to encourage a new technology and invention in Malaysia.

1.4 Project Scope

Scope in this project is focus to several aspects. Therefore in this project, the system is focused to:

- Developing a Smart Home simulation using software and not involving any hardware or circuit.
- This system will provide home in virtual and user interface as an input point.
- Developing simulation control.
- Develop a socket to enable interface module to communicate with virtual home module.

1.6 Project Schedule

This project will be carried out in two stages. First stage is involves activities such as project initiation, research and literature review, requirements analysis and the system design. This first stage will explain and schedule the project development process. Second stage is emphasis on coding and testing activities. The schedule for the activities of both stages is as follows:

University of Malaya

Symbol	Task	Duration (week)	Predecessor
A	Project initiation	4	null
B	Literature research	9	A
C	Requirement analysis	9	null
D	System design	6	C

Table 1.1: First stage development management

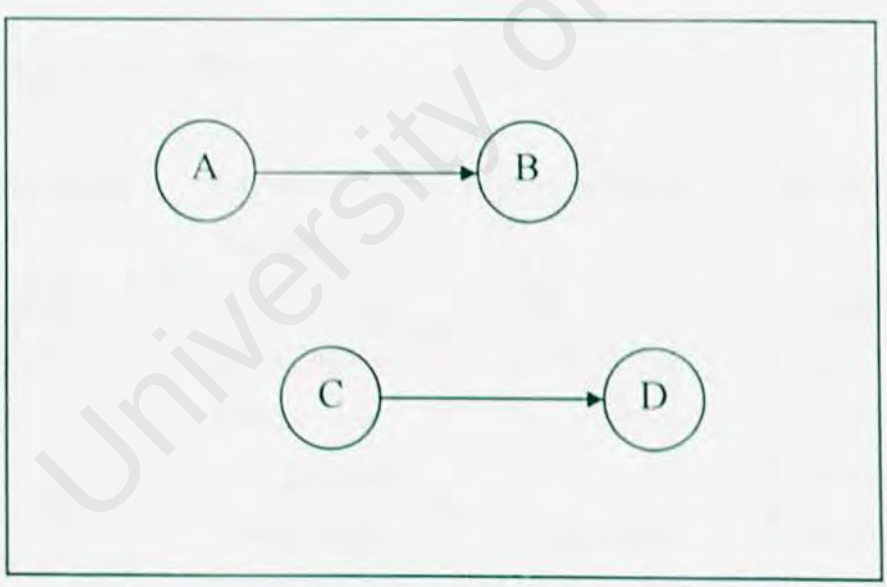

Figure 1.1: First stage network task diagram

University of Malaya

	June				July					August				September			
Task \ Week	1	2	3	4	1	2	3	4	5	1	2	3	4	1	2	3	4
Project initiation																	
Literature research																	
System analysis																	
System design																	

Table 1.2: First stage Gantt chart

First stage task details is shown as below:

Project Initiation	**Literature Research**	**System Analysis**	**System Design**
✓ Overview ✓ Objective ✓ Scope	✓ Information collecting ✓ Research on tools required ✓ Research on network configuration	✓ Analysis on methodology ✓ Review of the entire project requirement (software and hardware)	✓ Review on user requirement ✓ Interface design ✓ Virtual home design ✓ Report

Table 1.3: First stage task details

University of Malaya

Symbol	Task	Duration (week)	Predecessor
A	Coding	9	null
B	Testing	10	A
C	Documentation	9	null

Table 1.4: Second stage development management

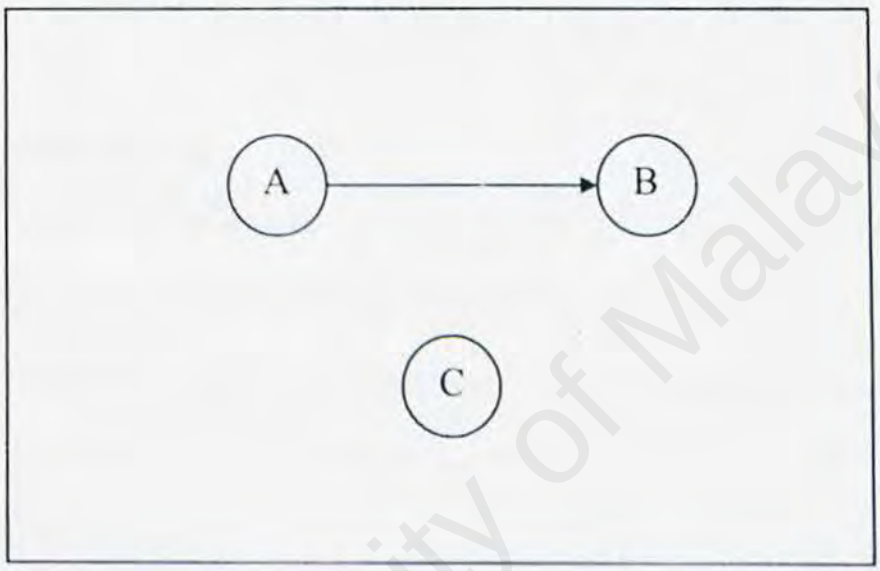

Figure 1.2: Second stage network task diagram

	October					November				December				January				
Task \ Week	1	2	3	4	5	1	2	3	4	1	2	3	4	1	2	3	4	5
Coding																		
Testing																		
Documentation																		

Table 1.5: Second stage Gantt chart

University of Malaya

Second stage task details is shown as below:

Coding	Testing	Documentation
✓ Develop interface ✓ Develop virtual home	✓ Unit and integration testing ✓ System testing ✓ Correction and enhancement	✓ Completing of project documentation ✓ Submission of documentation

Table 1.6: Second stage task details

1.7 Expected Outcome

From the study and information gathering I have done, there is some expected outcome from Smart Home Simulation. The following are the expectations:

- A simulation that provides an easy way to understanding a real Smart Home.
- A simulation that helps developer to enhance a real Smart Home features by running this system.
- To be a simulation such as other simulator that existence to provide an overview to understanding about real world Smart Home.

1.8 Conclusion

This chapter provides a general description about the proposed project. Statement of project objectives, significance and scope are stated. Schedule of the project and its report layout are described before ending with summary. The next chapter will discuss literature review of this system.

University of Malaya

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Literature review is a background research on information gathered to develop a project or system. The research intended to equip the developer with development environment and some knowledge of the strengths and limitations of several development tools. It will also help the developer in choosing the right tools to develop the system. Literature review is also done to help the developer of a system to know some of the existing features offered by a similar existing system. If there are no existing system has been developed, literature review is a useful step to develop a system within user's requirements met.

In this chapter, emphasis is given on fact finding, tools research and computer configuration.

2.2 Fact finding

To develop a system, a lot of information needs to be gathered about the system itself, the procedures involved to develop the system and the methodologies used to develop the system. All this information can be obtained from various sources. Different sources will yield different information and facts and it depends on how the search is done. Information can be obtained from intended system users, computer programs, procedure manuals and reports, forms and documents. Several fact finding methods have been used in this project to collect all information needed. Below are the descriptions of each method, which has been used in this project development.

University of Malaya

2.2.1 Observation

This observation method is emphasis on people and technology.

Smart Home technology is a brand new technology in Malaysia. Not many people are realizes about this technology especially in a small town. From my observation, I had learnt that this technology is restricts by cost which it would be a main reason why some people is not interested. Also from my observation, I had found that i-Home show room in Mid Valley is not visited frequently. According to i-Home Malaysia, cost for installation could be RM 2,988 to RM 20,839 depends on house type and wired/wireless packages.

Internet connection will also produce cost problem for applying this technology at home. According to Peremba Jaya Holding Sdn. Bhd, there are two suitable packages provide by tmnet, which are both quite expensive. These are Streamyx and TMnet 1525.

Streamyx is a package that provides subscriber with 'always on' connection to the internet with speed/bandwidth from 384k up to 2Mb/s. Below are the prices for tmnet streamyx packages provided by tmnet.

University of Malaya

Package Type	DSL Type	Download	Upload	Telephony Services	Monthly Charges	Additional Usage	IP Address Allocation	E-mail Account Allocation
Home 60 (Without Modem*)	ADSL	384k	128k	Yes	RM60 X for 60 hours	1 cent/min	Dynamic IP	1 E-mail
Home 88 (Without Modem*)		384k	128k		RM88			
Home 111 (With Modem)		384k	128k		RM111			
Enterprise		1.0M	384k		RM588	None	1 fixed IP address	3 E-mails
		2.0M	384k		RM988			
Corporate		1.0M	384k		RM888		5 fixed IP addresses	
		2.0M	384k		RM1688			
Enterprise	SDSL	1.5M	1.5M	None	RM888		1 fixed IP	
Corporate		1.5M	1.5M		RM1488		5 fixed IP	

Table 2.1: Prices for tmnet Streamyx packages

TMnet 1525 package provides subscriber with Integrated Services Digital Network (TMISDN) line, which subscriber will be able to communicate through high speed, high quality voice and data transmission lines. Below are the rates for this service.

1. Registration Fee (One time charge)		
a. Personal		RM 25.00
b. Schools & Institutes of Higher Learning		RM 25.00
c. Organisations		RM 50.00
2. Annual Subscription Fee		
a. Personal		RM 24.00
(* for handicapped, disabled or students)		RM 18.00
b. Schools & Institutes of Higher Learning		RM 24.00
c. Organisations		RM 60.00
3. Usage Charges (for 8,7 or 6 digit access code)		
	Access Fee (per 64k channel)	Call Charge (per 64k channel)
a) Residential line	3 sen / min	4 sen / min
b) Business line	3 sen / min	4 sen / min
Note: Call charge for the 8/7/6 digit ISDN access numbers above is based on local call charge. Long distance charge may apply if you dial outside your local area.		
4. Usage Charges (for 1525 access code)		
	Access Fee	Call Charge
a) Residential line	3 sen / min	2 sen / min
b) Business line	3 sen / min	2 sen / min
Note: Call charge varies according to distance.		

Table 2.2: Price for TMnet ISDN services

2.2.2 Interview

This method involves several people that have experience and knowledge about Smart Home technology, Internet and networking. All of these people are currently working in organizations or companies around Klang Valley. An informal interview session was held in July to obtain information and to hear their comment and suggestion for this project. Below are the respondents that have been interviewed:

1. Mr Mohd Ros Hamiza bin Abdul Hamid.
   Application Engineer.
   Syarikat Telekom Malaysia Berhad.

2. Mr Azri bin Alwi
   Electrical Engineer
   Peremba Jaya Holding Sdn. Bhd.

3. Mr Lee Boon Ching.
   Senior General Manager.
   i-Home Mid Valley.

4. Mr Yap Chee Seng.
   Sales Consultant.
   i-Home Mid Valley.

2.2.3 Research and Reviews

This part of the preparation of the system consists of researching and reviewing books, journals, conferences paper and newspaper articles. It also involves

University of Malaya

summarizing related info, comparison of software tools which are required for the system and other relevant tasks that will be useful in the preparation of the Smart Home Simulation.

2.2.4 Surfing The Internet

In today's ever changing world where new technologies are being introduced almost every day, Internet surfing is a very efficient way of gathering information. Information that can be gathered on the Internet ranges from very general to very specific. There are many web sites available that provides very useful information. The main objective of this activity is to analyze the features, interfaces, system designs and user friendliness characteristics.

2.3 Operating System / Platforms

A type of suitable platform is important in completion of Smart Home Simulation. Therefore, characteristic of each platform are studied before choosing the correct platform. Below are the background and overview of each platform.

2.3.1 Windows 98

Windows 98, also called "Memphis" during development and previously call "Window 97" based on early schedule, is a widely-installed product in Microsoft's evolution of the Windows operating system for personal computer.

Windows 98 provides a 32-bit file allocation table that allows you to have a single-partition disk drive larger than 2Gigabytes. Other features in Windows 98 include:

- Support for Universal Serial Bus, which makes it easy to plug in new devices.

University of Malaya

- Support for Digital Versatile Disc (DVD).
- Support for a new industry standard form of power management called Advanced Configuration and Power Interface (ACPI).

2.3.2 Windows 2000

Windows 2000 (W2K) is the latest commercial version of Microsoft's evolving windows operating system. Windows 2000 is designed to appeal to small business market for which the NT was designed. Below are the product line of Windows 2000 and its characteristic:

- **Windows 2000 Professional**, aimed at individuals and businesses and for all sizes. It includes security and mobile use enhancement. It is the most economical choice.
- **Windows 2000 Server**, aimed at small-to-medium size businesses. It can function as a Web server and/or a workgroup (or branch office) server. It can be part of a two-way symmetric multiprocessing system. NT 4.0 server can be upgraded to this server.
- **Windows 2000 Advanced Server**, aimed at being a network operating system server and/or an application server, including those involving large databases. This server facilities clustering and load balancing. NT 4.0 servers with up to eight-way SMP can upgrade to this product.
- **Windows 2000 Datacenter Server**, designed for large data warehouses, online transaction processing (OLTP), econometric analysis, and other applications requiring high-speed computation and large databases. The Datacenter Server support up to 16-way SMP and up to 64 gigabytes of physical memory.

University of Malaya

Windows 2000 is reported to be more stable (less possibility to crash) than Windows 98/NT systems.

2.3.3 UNIX

UNIX is an operating system that originated at Bell Labs in 1969 as an interactive time-sharing system. In 1974, UNIX became the first operating system written in the C language. UNIX has evolved as a kind of large freeware product, with many extensions and new ideas provided in a variety of versions of UNIX. A composite of the C language and shell (user command) interface from different versions of UNIX were standardized under the auspices of the Institute of Electrical and Electronics Engineers as the Portable Operating System Interface (POSIX). The "official" trademarked UNIX is now owned by The Open Group, an industry standards organization, which certifies and brands UNIX implementation.

2.4 Interface Development Tools

There are a many good software development tools available in the market. Many of these tools have their own strengths and weakness. Different tools provide different functions. Studies have been done on few tools, either through web sites or printed resources. Below are the results of the research.

2.4.1 Visual Basic

The Visual Basic Programming System are encompass a set of tools and technologies to create computer software component and applications.

Visual Basic is very easy to learn and use, not only because the programming language is not an OOP language and thus it's easy to learn and code (in the end it

University of Malaya

comes from BASIC), but also because the IDE is simple and conformable to use, and the database objects that come with Visual Basic provide an interface that makes them easier to use.

Visual Basic does many things for the programmer. For example, objects are reference counted, and this means that for example if we create an object referenced by a local variable, the object will be automatically released when the function or procedure ends (unless we assign it to a non-local variable). Visual Basic has a sophisticated memory management system and uses a garbage collector so it's fast de-allocating memory.

Database access in Visual Basic is simple as well. With just one component is used to open the Recordset, offer a navigator visual interface and link to the data controls. This architecture may look bothersome for Visual Basic programmers, but it has its advantages, like the freedom to combine different dataset and navigator components at will and the possibility to place the dataset and/or the datasource components in a different unit (for example in a centralized data module).

Even though Visual Basic has many advantages, it is only good for simple front-end applications but it is unsuitable for more complex stuff. For more complex stuff, some others tools such as Delphi or Visual C++ is ideal for both the front-end and the back-end.

Product support is usually a critical factor when deciding which tool to use. Microsoft has physical presence in almost all major cities of the world. Mostly people prefer to use Microsoft's product to avoid any error or problem when it is

University of Malaya

needed to link or get resource from operating system or other software application which Microsoft's product is widely used.

2.4.2 Delphi

"Visual Basic makes the easy things easier, Delphi makes the hard things easier" (Computerworld, 1998).

Delphi is harder to learn, but not for people who are familiar with Turbo Pascal or FreePascal. It is also harder to use, but has its advantages. Programmer has more freedom in manipulating the object and can release it when don't need it anymore, no matter how many variables point to it. Delphi has its own memory management system optimized for small blocks of data, although it doesn't have a garbage collector. Database access is cumbersome compared with Visual Basic, but very flexible and extensible. One big fact about Delphi is it can "easily" reach everything that machine and operating system has to offer. The Delphi IDE offers programmers advanced features like the ability to debug multi-threaded applications or to execute the code step by step in assembler.

Portability is also a critical factor for programmer. There is Delphi version for Linux called Kylix, where Visual Basic does not have.

2.4.3 PowerBuilder

PowerBuilder 8.0 was released with support for Windows NT, Windows 2000, and Windows 98. It will also support Windows XP shortly after the 8.02 release.
Just like Visual Basic it is also provide with easy step-by-step interface. Support drag and drop file and folder, will select automatically the image file and music file in selected folder.

University of Malaya

More than that it has supported most popular media formats and supports 27 of the most popular graphics and media formats including Bitmap Graphics(*.bmp;*.dib) , JPEG Graphics(*.jpeg;*.jpg;*.jpe) , GIF Graphic(*.gif) , PCX Graphic (*.pcx; *.pcc) , Photoshop Graphic(*.psd, *.pdd) , PaintshopPro Graphic(*.psp) , Targa Graphic(*.tga; *.vst; *.icb; *.vda; *.win) , PortableNetwork Graphic(*.png) , SGI Images(*.bw;*.rgb; *.rgba; *.sgi) , AutoDesk Images(*.cel;*.pic) , Shockwave Flash file(*.swf) , Movie file(*.avi;*.mpg;*.mpeg).

2.5 Interface Tools Comparison

Below is comparison between Visual Basic and Delphi based on several categories:

Category	Visual Basic	Delphi
Performance	• Visual Basic uses Microsoft Basic as its underlying language. • Visual Basic produces semi-interpreted code. • Visual Basic interpreted p-code and it is slower.	• Delphi is based upon Object Pascal (a significant extension of the popular Borland Pascal 7.0) • Delphi's performance is significantly better because it generates compiled executable files. • Delphi is built around native code compiler and more faster
Controls	• Visual Basic custom controls are referred to as VBXs, and a limited selection is supplied with Visual Basic itself. Additional controls are sold	• Delphi's Visual Component Library (VCL) is a comprehensive suite of high- performance controls that support all standard Windows functionality,

University of Malaya

	by third-party manufacturers, although these not only cost additional money but also extend the overall learning curve, due to variations in product styles. • Visual Basic owners must obtain third-party VBXs. Some of the controls supplied with Visual Basic suffer from memory and other limitations, making it necessary to purchase third-party alternatives.	along with additional features such as tabbed folders, notebooks, database grids and 3D list boxes. • Delphi also supports third-party VBXs, providing access to a wide range of third-party components.
Debugging and Object Inspecting	• Visual Basic provides program debugging capabilities such as variable watches and a call stack monitor but this functionality is limited in that it cannot break on a specific condition. • The call stack is modal, so it cannot be viewed during the entire debug session.	• Delphi provides a full-featured debugger with conditional breakpoints and a modeless call stack viewer. • The debug window and viewers can be saved from session to session, allowing developers to create a comfortable custom environment
Components	• VBXs can be developed for Visual Basic with functionality that is usable across different projects, but	• Delphi components are more easily created because Delphi components are built within the Delphi

University of Malaya

	a significant disadvantage of VBXs is the complexity involved in creating because VBXs must be built using an external compiler such as C/C++.	development environment itself.

Table 2.3: Comparison between Visual Basic and Delphi

Below is comparison between Visual Basic 6.0 and PowerBuilder 8.0 based on several categories:

Category	Visual Basic 6.0	PowerBuilder 8.0
General	• Other than being able to develop ActiveX controls for MTS/IIS environments, VB is not for distributed environments. There is no access to CORBA® or Java without an additional ActiveX control to do so. This limits the distribution model that is natively supported by VB. • Other than a Microsoft-oriented environment (IIS/MTS) its role in the distributed development environment appears somewhat hazy—often viewed as a good tool to develop ActiveX controls but nothing more. • Access to develop components is more complex than PB because it requires that custom controls be added to the component library before	• The IDE is productive, providing access to all aspects of an object including its inheritance. Access to components is straight-forward with a component palette containing the standard PowerBuilder controls, with extensibility provided by adding custom controls to the toolbar, or by selecting objects directly from the development libraries. • The IDE is completely customizable and the developer can save different layouts for different tasks. AutoText features aid in developing code by providing dropdown lists of available options, including functions and events.

University of Malaya

	being accessible. This results in higher out-of-pocket costs for the controls and administrative costs for managing more vendor relationships. Also, many of the companies providing controls are small and potentially financially unstable.	• Object Property sheets are dynamically generated so that inherited object automatically show ancestor variables as properties in the descendant. Ancestor event and function scripts are also easily viewed within the class. • Wizards and Assistants are included to aid in developing common and not so common tasks such as building a component for EAServer. Generator wizards allow you to specify the target(s) for every component developed. • Every PowerBuilder object developed in a project is automatically an inheritable class. PowerBuilder does not require the building of "Templates" as VB does. • Database access is built through the DataWindow Painter which provides a full-featured SQL designer, "live" data display, custom presentation styles including graphs, OLE object imbedding and nested reports. DataWindows can be sourced from SQL, Stored Procedures or from external sources such as Component Methods when accessed via the included application server, EAServer.
Code Handling	• VB's code display window is not as structured as PowerBuilder's. All code for a form (a window) is	• Syntax-highlighted code and auto-indenting features highlight the code handling capabilities within

University of Nevada

	displayed in a continuous stream. With larger, more complex objects, this can lead to confusion as the demarcation between one function/event and another is not necessarily clear. • Where method code exceeds 20 lines, development becomes unwieldy and requires greater effort to organize and track. • VB does not support the Java contexts Throw, Catch and Finally error handling. It is still very dependent on the basic On Error syntax which is less comprehensive when handling errors.	PowerBuilder. Access to all "Code Block" structures is available through a popup menu. System Functions are also available through this method. • The display window's events and functions are clearly identified and code display is limited to a single method at a time. PB maintains every event/function in a separate stream so there is no overlap or possible confusion. • Supports Java context Throw, Catch and Finally for graceful and comprehensive error handling. • Error-handling functions are provided to aid in developing automatic error-handling. System errors are automatically handled, and may optionally be handed off directly into the debugger. • Garbage Collection aids in cleaning up execution code due to code omissions by developers. • Code Profiler aids in analyzing code for potential problems or bottleneck analysis. • The System Tree allows object functions or properties to be dragged and dropped into the code window.
Built-in Reporting Capabilities	• VB's reporting scheme has less robust Web-reporting and its ADO scheme is not as robust and comprehensive. • VB's reporting styles are	• PB contains the patented DataWindows within the product and the InfoMaker® query and reporting tool for user-enabled report generation.

University of Malaya

	restricted versus PB's built-in capabilities.	• The Web DataWindow is used for both data entry and reporting on the web. PSR's are used for distributable, actionable reports. User can still modify certain aspects of the report even though the producing application is long since out of the picture.

Table 2.4: Comparison between Visual Basic and PowerBuilder

2.6 Socket Programming

Socket programming is core of a network application consists of a pair of programs -- a client program and a server program. When these two programs are executed, a client and server process are created, and these two processes communicate with each other by reading from and writing to sockets. When a creating a networking application, the developer's main task is to write the code for both the client and server programs.

The processes running on different machines communicate with each other by sending messages into sockets. Each process was analogous to a house and the process's socket is analogous to a door. As shown in figure 2.1, the socket is the door between the application process and TCP. The application developer has control of everything on the application-layer side of the socket; however, it has little control of the transport-layer side. (At the very most, the application developer has the ability to fix a few TCP parameters, such as maximum buffer and maximum segment sizes.)

University of Malaya

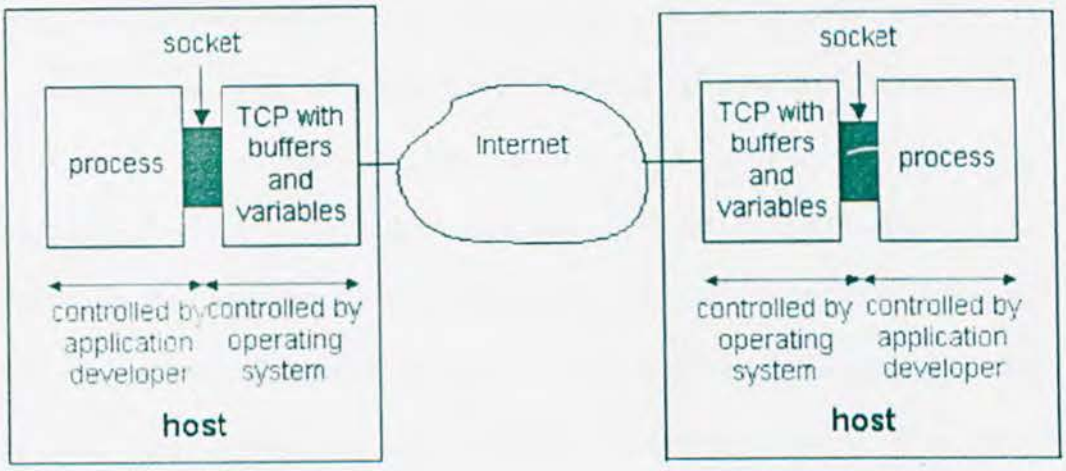

Figure 2.1: Processes communicating through TCP sockets

The client has the job of initiating contact with the server. In order for the server to be able to react to the client's initial contact, the server has to be ready. This implies two things. First, the server program can not be dormant; it must be running as a process before the client attempts to initiate contact. Second, the server program must have some sort of door (i.e., socket) that welcomes some initial contact from a client (running on an arbitrary machine). Using our house/door analogy for a process/socket, it will sometimes refer to the client's initial contact as "knocking on the door".

With the server process running, the client process can initiate a TCP connection to the server. This is done in the client program by creating a socket object. When the client creates its socket object, it specifies the address of the server process, namely, the IP address of the server and the port number of the process. Upon creation of the socket object, TCP in the client initiates a three-way handshake and establishes a TCP connection with the server. The three-way handshake is completely transparent to the client and server programs.

University of Malaya

During the three-way handshake, the client process knocks on the welcoming door of the server process. When the server "hears" the knocking, it creates a new door (i.e., a new socket) that is dedicated to that particular client. In the example below, the welcoming door is a ServerSocket object that called the welcomeSocket. When a client knocks on this door, the program invokes welcomeSocket's accept() method, which creates a new door for the client. At the end of the handshaking phase, a TCP connection exists between the client's socket and the server's new socket. Henceforth, the new socket will be referred as the server's "connection socket".

From the application's perspective, the TCP connection is a direct virtual pipe between the client's socket and the server's connection socket. The client process can send arbitrary bytes into its socket; TCP guarantees that the server process will receive (through the connection socket) each byte in the order sent. The client process can receive bytes from its socket and the server process can also send bytes into its connection socket. This is illustrated in figure 2.2

University of Malaya

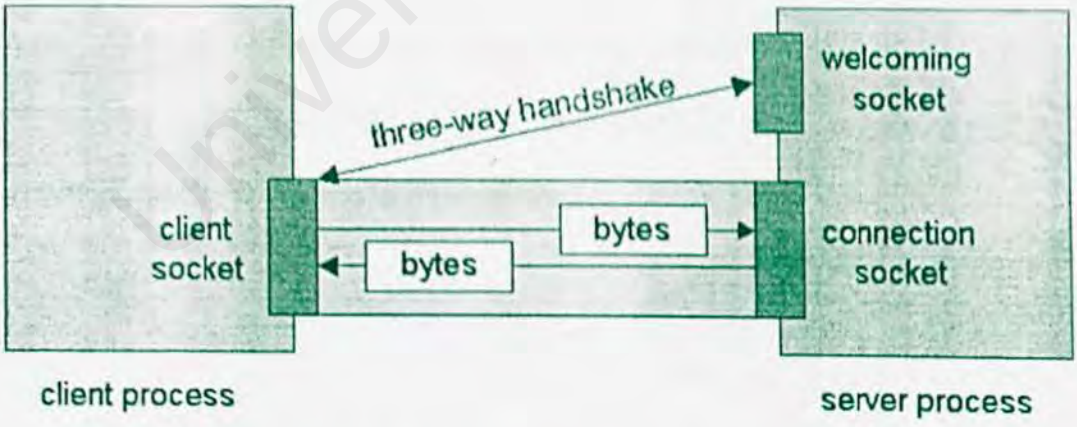

Figure 2.2: Client socket, welcoming socket and connection socket

Because sockets play a central role in client-server applications, client-server application development is also referred to as socket programming. A stream is a flowing sequence of characters that flow into or out of a process. Each stream is either an **input stream** for the process or an **output stream** for the process. If the stream is an input stream, then it is attached to some input source for the process, such as standard input (the keyboard) or a socket into which characters flow from the Internet. If the stream is an output stream, then it is attached to some output source for the process, such as standard output (the monitor) or a socket out of which characters flow into the Internet.

TCP implementation for certain application can be programmed. The program must be written in the both side; client side and server side. Once the two programs are compiled on their respective hosts, the server program is first executed at the server, which creates a process at the server. As discussed above, the server process waits to be contacted by a client process. When the client program is executed, a process is created at the client, and this process contacts the server and establishes a TCP connection with it. The user at the client may then "use" the application to send a line and then receive a capitalized version of the line. Figure 2.3 show how the program client socket creates three streams and one socket.

University of Malaya

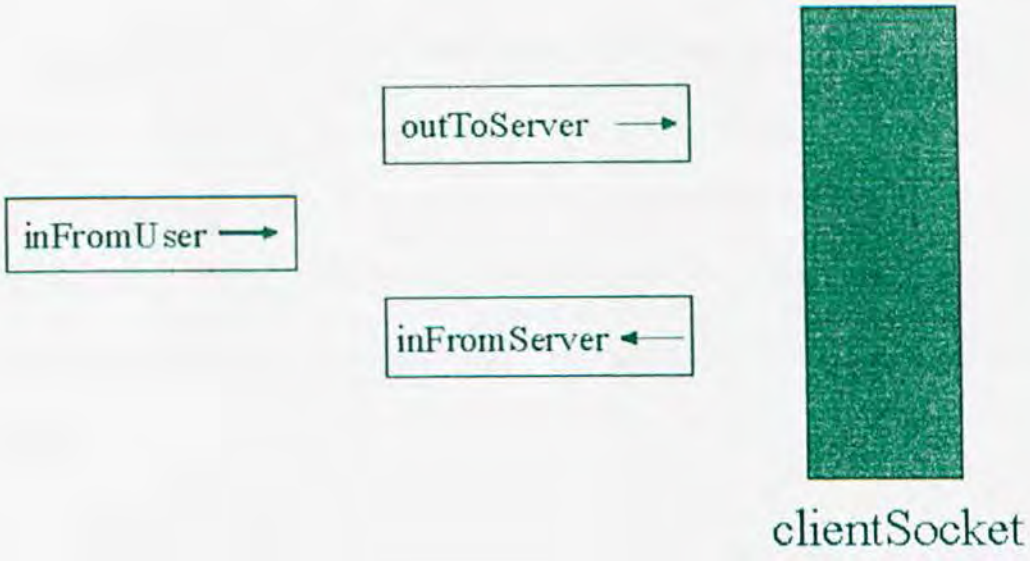

Figure 2.3: Client program has three streams and one socket

Server program has many similarities with client program. A few lines of programming are quite different such as welcoming socket and connection socket. The code can be written in Java, C++, C or Python.

2.6.1 Java Language

The Java programming language is designed to meet the challenges of application development in the context of heterogeneous, network-wide distributed environments. Paramount among these challenges is secure delivery of applications that consume the minimum of system resources, can run on any hardware and software platform, and can be extended dynamically.

The Java programming language originated as part of a research project to develop advanced software for a wide variety of network devices and embedded systems. The goal was to develop a small, reliable, portable, distributed, real-time operating platform. When the project started, C++ was the language of choice. But over time the difficulties encountered with C++ grew to the point where the problems could

University of Malaya

best be addressed by creating an entirely new language platform. Design and architecture decisions drew from a variety of languages such as Eiffel, SmallTalk, Objective C, and Cedar/Mesa. The result is a language platform that has proven ideal for developing secure, distributed, network-based end-user applications in environments ranging from network-embedded devices to the World-Wide Web and the desktop.

2.6.2 C++ Language

C++ is a programming language of many different dialects, just as each spoken has many different dialects. In C++, dialects are not because the speakers live in the North or South; it is because there are several different compilers. There are four major compilers: Borland C++, Microsoft Visual C++, Watcom C/386, and DJGPP. Each of these compilers is slightly different. Each one will support the ANSI/ISO standard C++ functions, but each compiler will also have nonstandard functions. Sometimes the use of nonstandard functions will cause problems when you attempt to compile source code (the actual C++ written by a programmer) in a different compiler. C++ fully supports object-oriented programming, including the four pillar of object-oriented development: encapsulation, data hiding and inheritance polymorphism.

2.6.3 Python

Python is a portable, interpreted, object-oriented programming language. Its development started in 1990 at CWI in Amsterdam, and continues at CNRI in Reston, Va. Python combines remarkable power with very clear syntax. It has modules, classes, exceptions, very high level dynamic data types, and dynamic

University of Malaya

typing. There are interfaces to many system calls and libraries, as well as to various windowing systems (X11, Motif, Tk, Mac, MFC). New built-in modules are easily written in C or C++. Python is also usable as an extension language for applications that need a programmable interface. Besides, it can be extended in a systematic fashion by adding new modules implemented in a compiled language such as C or C++.

2.7 Comparison For Socket Programming Language

Every language has it advantages and disadvantages. Some language may have advantages in certain functions .Below is comparison for those programming language.

2.7.1 Java vs C++

Java is designed to be simple, object oriented and similar to C++ while removing the unnecessary complexities of C++. It is also said to be a robust, architecturally neutral, portable, interpreted, threaded, dynamic and high performance language. Java enables the development of robust applications on multiple platforms in heterogeneous, distributed networks. C++ is not truly portable nor is it suited to heterogeneous, distributed networks. While C++ excels in high performance, its powerful features and complexities are often the source of many errors. Below is comparison of Java and C++ based on several categories:

Category	Java	C++
Inheritance model	Implements a single inheritance model, where a class can only inherit from one superclass. To	Implements the multiple inheritance model, where a class can inherit from one or more

University of Malaya

	provide the desirable features of multiple inheritances, Java provides interfaces. A class can inherit from multiple interfaces, where the interface only declares the methods and does not implement them. Therefore the class must implement the methods of the interfaces. As a result a reasonable alternative to multiple inheritances is provided by interfaces.	superclasses. While it may be considered a powerful feature, many find it complicated and confusing and thus creating problems for the programmer.
Module system and linking regime	Packages form the module system in Java. Packages consist of classes and interfaces, with no separate header and source files as in C++. It is important that classes and interfaces which relate to each other are the same package due the default "friendly" members which are only accessible to objects within the same package. As in C++, the primary use of the module system is to break large applications into smaller, more manageable units. Packages, however, do not get linked to form one executable or one large bytecode file. Instead classes are loaded and linked on the fly as needed from a variety of sources, even across networks.	Modules in C++ usually consist of a .H header file and a .CPP source code file. The header file contains the declaration or interface of classes, functions, unions, structures, etc. while the .CPP source code file contains the implementation of the classes, functions, etc. When a module is compiled a binary object file is generated with the same file name as the .CPP source code file, but with an .OBJ file extension. Once all modules of the application are compiled into binary object files, they are linked to form the executable. The binary object files do not need to be distributed to the end user with the executable. Binary object files are, however, often distributed to

University of Malaya

	The language and run-time system are thus dynamic in their linking stages. The dynamically linked code is verified before it is interpreted and executed.	programmers with the corresponding header file. In this way the programmer can access the classes, functions, etc. in the module without having access to the full source code. While there are no rules as to what should and should not go into a certain module, it makes sense to group classes, functions, etc., which relate to each other in some way, into the same module.
Program processing	Portability and architecture neutrality are probably the two main attractions of Java. To achieve this Java programs are both interpreted and compiled. Java programs are compiled to bytecode to form packages or .class files. This bytecode can then be run on any system on which the Java virtual machine (JVM), which consists of the Java interpreter and run-time system, has been implemented. The JVM then interprets and executes the Java bytecode. The main advantage of this approach over just using an interpreter is that bytecode executed by the JVM achieves near machine code performance.	Programs written in C++ are compiled into machine code specific to a particular hardware architecture and operating system. The result is an executable binary which runs directly on the hardware. The advantage of compilation is a program which can run easily more than one hundred times faster than a program which is interpreted. The main disadvantage is that C++ programs are not portable once compiled and although it is possible to compile one and the same C++ program to various platforms, this is usually done with great difficulty, to say the least.

University of Malaya

Reference semantics	Java only uses reference semantics. Since there are no pointers in Java, all references to the object are through symbolic "handles" and memory must be explicitly allocated using the "new" operator. The garbage collector deallocates the memory when no more references to the object exist.	In C++, one has a choice of whether or not to use reference semantics. If one does not use reference semantics, the variable is the object and memory is automatically allocated and deallocated when the variable goes out of scope. The memory for the object is allocated on the run-time stack. This method is efficient but does not support dynamic binding and polymorphism. If one uses reference semantics, the variable is a pointer to the object and memory must be explicitly allocated and deallocated. The memory for the object is allocated on the heap. Dynamic allocation is therefore more flexible but has a higher overhead.
Concurrency	Clearly for multithreading to be viable, it must be implemented at the language level. Java supports threads at the syntactic level, from its run-time system and thread objects. Java's multithreading capability provides the means to build applications with many concurrent threads of activity, which results in a high degree of user interactivity. Although	Programs written in C++ are typically single-threaded, meaning that only one thing happens at a time. The language does not have built in support for threads, although there are libraries to simulate multithreading, this is usually done with great difficulty. Also given any library function, there is no way of ensuring that the implementation of the function

University of Malaya

	multithreading is built into the language, one should still take care to implement thread-safe classes and methods, like the Java run-time libraries are implemented.	allows it to be executed by multiple concurrent threads of execution.
Compile-time and run-time checking	The Java compiler also employs strict and extensive compile-time checking, to eliminate syntax-related errors before the bytecode is distributed. Java is strongly typed and the compiler does not allow automatic coercions as in C++, instead requires an explicit cast. The run-time checking is equally extensive and repeats many of the type checks done by the compiler. Since there are no pointers or automatic coercions in Java many of the problems associated with such constructs are removed. If run-time errors due occur, an exception is raised and handled, as in C++, by an exception handler.	The compile-time and run-time checking is thorough and C++ is strongly typed. Due to aspects of C++ such as pointers and automatic coercions, it is very difficult for the compiler to pick up problems relating to these constructs. If an error occurs at run-time, such as an invalid pointer, an exception is raised and the program is most likely to be terminated.
Access control	A member of a class can be private, protected or public as defined in C++, with the exception that there is no such thing as friends of a class in Java. Members of a class are "friendly" (which has nothing to	A member of a class can be: i) private: the member can be used only by member functions and friends of the class in which it is declared. ii) protected: the member can be used only by member functions

University of Malaya

	do with friends in C++) by default, meaning that the members of the class are accessible to all objects within the same package but inaccessible to objects outside the package.	and friends of the class in which it is declared and by member functions and friends of classes derived from this class. iii) public: the member can be used by any function. Members of a class defined with the keyword "class" are private by default. Members of a class defined with the keywords "struct" or "union" are public by default. The keyword "friend" denotes a function or class which is a friend of a class. This friend has full access rights to the private and protected members of the class. Many feel that friends violate the principle of data hiding.

Table 2.5: Comparison between Java and C++

2.7.2 Python vs Java

Java and Python languages are interpreted, which makes sense considering their intended application. Being interpreted means that they can be largely platform independent, and more easily migrate programs and objects from location to location as desired. Both of the languages have made is the support of "programming-in-the-large " features, in the form of reasonably well developed module systems that allow the programmer to create a larger project with a coherent organization.

University of Malaya

In terms of differences, the languages each have unique features that set them apart from each other and from their predecessors. Java is the least novel of the languages.Java's designers were aiming to produce a language that was similar to C++ so that the language would be popular, and their strategy is proving very successful. The main feature that sets Java apart from other languages is the investment in secure transmission of code so that the users of the object programs can execute any program provided on a web page without worrying about trojan horses.

Python seems to be originally designed to be a scripting language but has all the features that would enable it to compete with Java, including a web browser that can download and execute Python applets. The implementation focuses on the language itself as opposed to issues specific to distributed programming, and provides a rich set of functionality built-in to the language with the intention of making programming with Python easy. Unfortunately, the plethora of built-in operations on objects also gives the language's semantics a "fat" feeling, and places a large burden on even the simplest objects. Below is comparison of Python and Java based on several categories:

Common gateway interface programming

While there's nothing preventing the use of Java as a language for Common Gateway Interface (CGI) programming, no CGI specific library support appears to come with the JDK. Conversely, Python has a number of modules that make CGI programming easier.

University of Malaya

Python's cgi module provides a number of classes that allow simple management of CGI program input and output. The FieldStorage class, for example, provides a simple interface for getting the clients uploaded information. This can be in the environment, part of a URL query string, or on standard input. This information is returned in an object which is operated on like a standard Python dictionary.

CGI programming is an application area that illustrates how Python is more suitable for general purpose programming than Java. Scripting in the style of Java, is typically done with a separate language called JavaScript. Delivered with Netscape Navigator, JavaScript could be considered to be similar in functionality to a very small part of Python. JavaScript has a Java-like syntax and is targeted at the craft of formatting HTML. Since there is no object-orientation, JavaScript, as a language, is much less capable that either Python or Java.

Execution environment

Both applets in Python and applets in Java have additional restrictions that they must follow over and above those placed on stand-alone programs. In Java, in order to create an applet, you must extend the Applet class. Java applets have no public instance variables. Instead, programmers must define methods to access the instance variables of an applet. All subclasses of Applet must be defined as public to insure that they can be accessed outside of the source files in which they are defined. While not a requirement for an applet, it's often a good idea to designate your Applet sub-class to implement the Runnable interface when doing long-running CPU intensive tasks such as animation. Runnable defines an interface which allows execution content in a separate thread.

University of Malaya

The Python environment for applets is much more lightweight. Other than a Python applet's entry point having to be a class, Python imposes no specific restrictions on what language constructs are used. Python comes with a number of modules that allow for convenient access to network resources as well as support for audio and animation. While Python supports threads on a number of platforms, programming in threads has not made an appearance in Python applets as of yet. This is probably due to the inherent complexity associated with threads management.

Mobile software agents

Because both Python and Java provide platform-independent byte-code representations as well as restricted execution environments, an application area that is showing promise for both of these languages is the area of mobile software agents. Mobile software agents differ from applets in a subtle way. Applets are dead-on-arrival when they reach the hosting browser. They are then started from the beginning each time they are loaded. Many examples of mobile software agents, on the other hand, have the capability of directing themselves, during run-time, to move to another machine and resume execution there. Upon arriving at the new machine, the previous state of the program is reactivated and the program continues. Mobile software agents have the benefit of being able to move specific algorithmic processing closer to large amounts of data. We can find that both Python and Java appear to be well positioned in this area.

Conclusion of Python vs Java

In general, Python programs are expected to run slower than Java programs, but they also take proportionally less time to develop. Python programs are typically 3-5

University of Malaya

times shorter than equivalent Java programs. This difference can be attributed to Python's built-in high-level data types and its dynamic typing. For example, a Python programmer wastes no time declaring the types of arguments or variables, and Python's powerful polymorphic list and dictionary types, for which rich syntactic support is built straight into the language, find a use in almost every Python program. Because of the run-time typing, Python's run time must work harder than Java's. For example, when evaluating the expression a+b, it must first inspect the objects a and b to find out their type, which is not known at compile time. It then invokes the appropriate addition operation, which may be an overloaded user-defined method. Java, on the other hand, can perform an efficient integer or floating point addition, but requires variable declarations for a and b, and does not allow overloading of the + operator for instances of user-defined classes.

For these reasons, Python is much better suited as a "glue" language, while Java is better characterized as a low-level implementation language. In fact, the two together make an excellent combination. Components can be developed in Java and combined to form applications in Python; Python can also be used to prototype components until their design can be "hardened" in a Java implementation. To support this type of development, a Python implementation written in Java exists, which allows calling Python code from Java and vice versa.

2.7.3 C++ vs Python

Almost everything said for Java also applies for C++, just more so: where Python code is typically 3-5 times shorter than equivalent Java code, it is often 5-10 times shorter than equivalent C++ code. Anecdotal evidence suggests that one Python programmer can finish in two months what two C++ programmers can't complete in

University of Malaya

a year. Python shines as a glue language, used to combine components written in C++.

2.7.4 Benchmark Comparison

Benchmark is a program or set of program used to evaluate computer or application performance based on execution time. Below is benchmark comparison between Python, Java and C++.

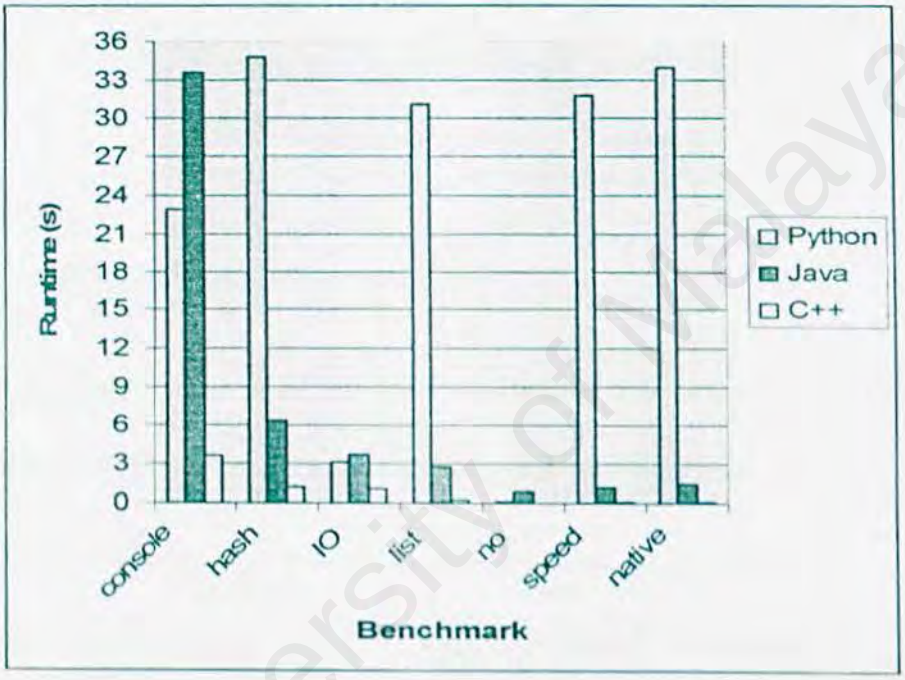

Figure 2.4: Benchmark comparison between Python, Java and C++

University of Malaya

Below is result table for benchmark test.

	Python	Java	C++
Console	22.93	33.58	3.6
Hash	34.84	6.35	1.23
Io	33.16	3.68	1.04
List	31.05	2.71	0.19
No	0.12	0.86	0.04
Speed	31.81	1.18	0.18
Native	33.97	1.4	0.09
Total Sum	187.88	49.76	6.36

Table 2.6: Benchmark result table

2.7.5 Conclusion of Java, Python and C++

Conclusion of Java, Python and C++ are stated below. The conclusion describes on development, execution speed, libraries and portability of those language.

	Python	**Java**	**C++**
Development	Fast and easy. Very simple to hack things up in. Dynamic typing etc can often result in finding bugs at runtime that would have been found earlier in a statically typed language.	Fair. Longwinded syntax makes it slow going, but helps produce solid code. Enforced exception handling, bounds checking and toString help make debugging easy.	Good to write in. Templates work well, and the STL is generally good. Debugging can quite difficult.
Execution speed	Slow	Good (modulo VM startup). Swing performance is still	Superb.

University of Malaya

		slow, but it is also very capable. A little thought (or experience) is important in order to get the best speed.	
Libraries	Good default libraries. A number of solid free 3rd party non-standard libraries (ie wxPython).	Superb standard libraries, very broad and useful.	Limited standard libraries, but lots of 3rd party libraries.
Portability	Very Good	Very good	Fair

Table 2.7: General comparison between Python, Java and C++

2.8 TCP/IP

TCP/IP is a set of protocol suite, defines how all transmission are exchanged across the Internet.

In 1969, Advanced Research Project Agency (ARPA) established a packet-switching network of computer linked by point-to-point leased lines called Advanced Research Project Agency Network (ARPANET). The conventions developed by ARPA to specify how individual computer could communicate across that network became TCP/IP.

University of Malaya

2.8.1 TCP/IP Layers

There is no official TCP/IP protocol model. However, TCP/IP can be organized into five relatively independent layers, which are the following:

- Application layer
- Transport layer
- Internet layer
- Network Access layer
- Physical layer

The physical layer covers the physical interface between a data transmission device (eg., workstation, computer) and a transmission medium or network. This layer is concerned with specifying the characteristics of the transmission medium, the nature of the signals, the data rate, and related matters.

The network access layer is concerned with the exchanged of data between an end system and the network to which it is attached. The sending computer must provide the network with the address of the destination computer, so that the network may route the data to the appropriate destination. The sending computer may wish to invoke certain services, such as priority, that might provided by network. The specific software used at this layer depends on the type of network to be used.

The Internet layer is concerned with the procedures needed to allow data to traverse multiple interconnected networks when there are two devices are attached to different networks. The Internet protocol (IP) is used at this layer. This protocol is implements not only in the end systems but also in routers.

University of Malaya

The transport layer assures that all packets arrive at the destination application and they arrive in the same order when they were sent. The transmission control protocol (TCP) is the most commonly used protocol to provide this functionality. Application layer contains the logic needed to support the various user applications. A separate module is needed for different application.

2.8.2 Operation of TCP/IP

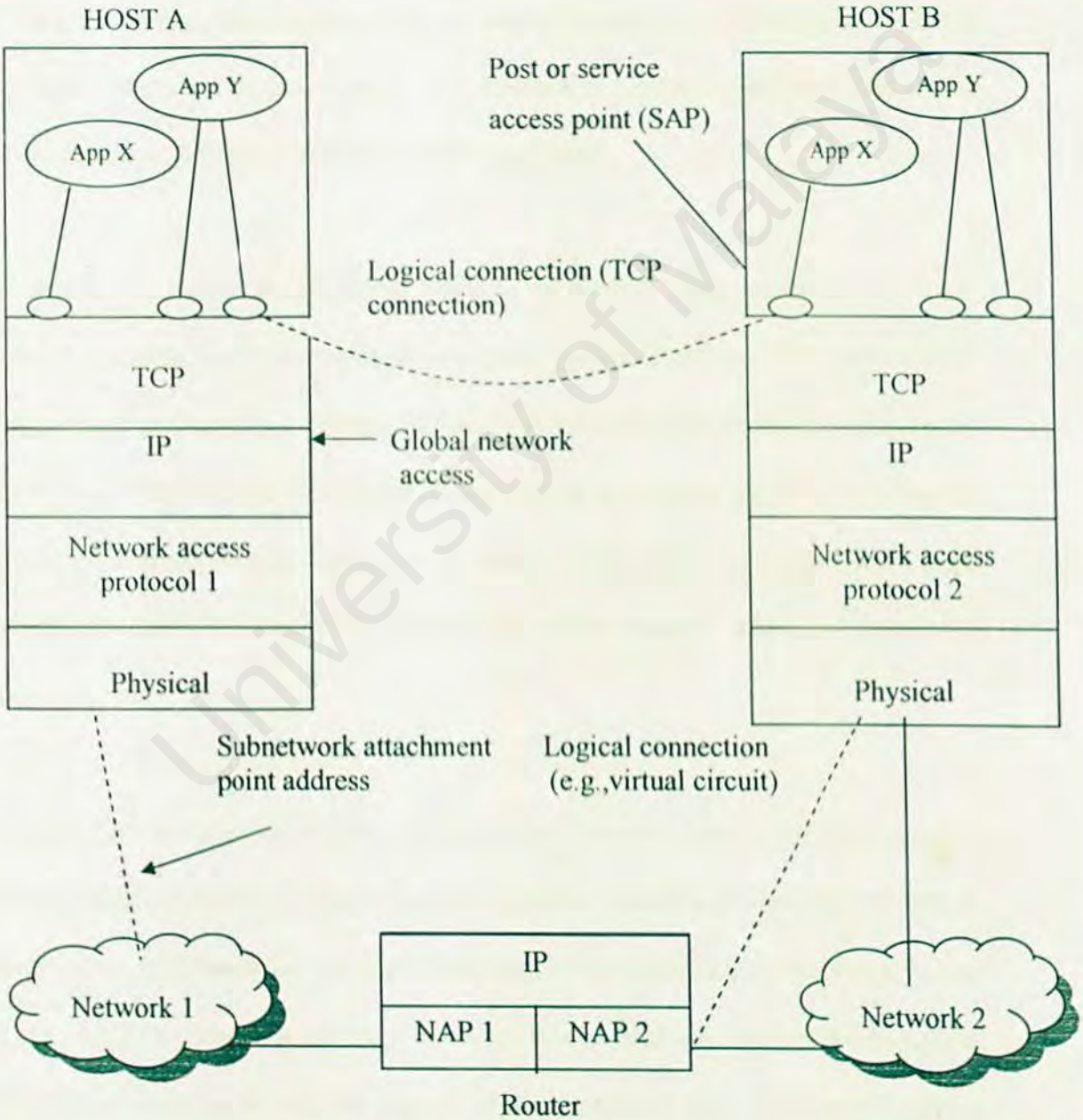

Figure 2.5: TCP/IP concepts

University of Malaya

Figure 2.5 indicates how these protocols are configured for communications. To make clear that the total communications facility may consist of multiple networks, the constituent networks are usually referred to as subnetworks. Some sort of networks access protocol, such as the Ethernet logic, is used to connect a computer to a subnetwork. This protocol enables the host to send data across the subnetwork to another host or, in the case of a host on another subnetwork, to a router. IP is implemented in all the end systems and the routers. It acts as a relay to move a block of data from one host, through one or more routers, to another host. TCP is implemented only in the end systems; it keep track of the block of data to assure that all are delivered reliably to the appropriate application.

For successful communication, every entity in the overall system must have a unique address. Actually, two levels of addressing are needed. Each host on a subnetwork must have a unique global internet address; this allow the data to be delivered to the proper host. This address is used by IP for routing and delivering. Each application within a host must have an address that is unique within the host; this allow the host-to-host protocol (TCP) to deliver data to the proper process. The latter address is known as ports.

A simple operation is traced here. Suppose that a process, associated with port 1 at host A, wishes to send a message to another process, associated with port 2 at host B. The process at A hands the message down to TCP with instruction to send it to host B, port 12. TCP hands the message down to IP with instruction to send it to host B. Note that IP need not be told the identify of the destination port. All it needs to know is that the data are intended for host B. Next, IP hands the message down to network

University of Malaya

access layer (e.g., Ethernet logic) with instruction to send it to router X (the first hop on the way B).

To control this operation, control information as well as user data must be transmitted, as suggested in figure 2.6.The sending process generates a block of data and passes this to TCP. TCP may break this block into smaller pieces to make more manageable. To each of these pieces, TCP appends control information known as the TCP header, forming a TCP segment. The control information is used to be the peer TCP protocol entity at host B. Items included in the header are destination port, sequence number and checksum.

Next, TCP hands each segment over to IP, with instruction to transmit it to host B. These segment must be transmitted across one or more subnetworks and relayed through one or more intermediate routers. This operation, too, requires the use of control information. Thus IP appends a header of control information to each segment to form an IP diagram.

Finally, each IP datagram is represented to the network access layer for transmission across the first subnetwork in its journey to the destination. The network access layer appends its own header, creating a packet frame. The packet is transmitted across the subnetwork to router X. The packet header contains the information (e.g. destination subnetwork address, facilities request) that the subnetwork needs to transfer the data across the subnetwork.

University of Malaya

At router X, the packet header is stripped off and the IP header examined. On the basis of the destination address information in the IP header, the IP module in the router direct the datagram out across subnetwork 2 to host B. To do this, the datagram is again augmented with a network access header.

When the data are received at B, the reverse process occurs. At each layer, the corresponding header is removed, and the reminder is passed on to the next higher layer, until the original user are delivered to the destination process.

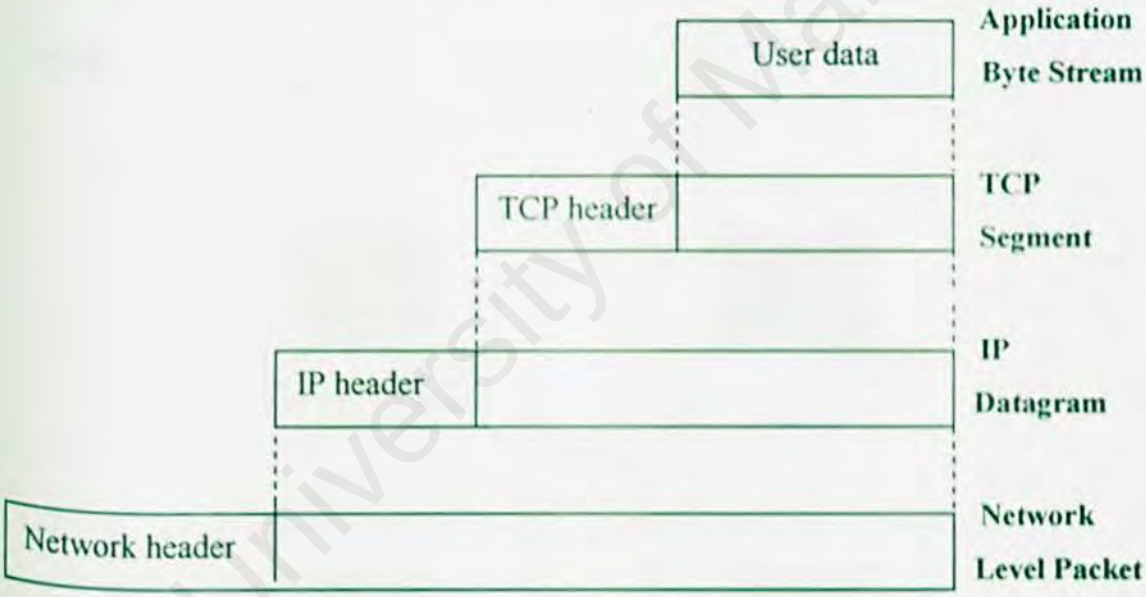

Figure 2.6: Protocol Data Units in the TCP/IP Architecture

University of Malaya

2.9 Computer Configuration

To accomplish this project, there are two computers needed, PC A and PC B. PC A consists user interface and simulation control while another PC with virtual home model. There are several configuration could be used in order to connect these two PCs.

2.9.1 Peer-To-Peer

If just only need to share a printer or an Internet connection, a client-server network (literature review 2.9.2 Client-Server) may be overkill. Sometimes, a simpler peer-to-peer network may fulfill the needs. The diagram below show a simple peer-to-peer network:

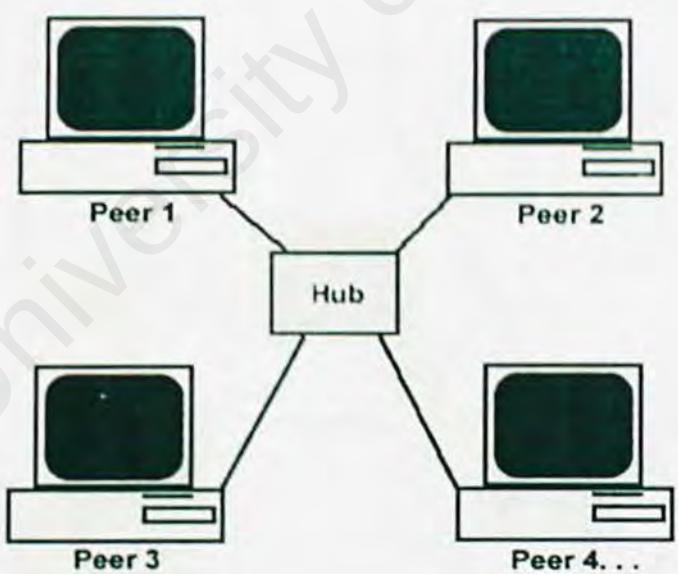

Figure 2.7: Simple peer-to-peer network.

In a peer-to-peer network there are no dedicated servers or hierarchy among the computers. All of the computers on the network handle security and administration for themselves. The users must make the decisions about who gets access to what.

University of Malaya

Beyond that there are more similarities than differences. All of the computers must have network cards. It also uses the same cables, the same hubs, and the same protocols such as the client-server model. The only difference is that there isn't a server.

2.9.2 Client-Server

In an environment with more than 10-15 computers, a peer-to-peer network begins to become more trouble than it is worth. The computers start to slow down and can never find the file which is looking for, and security is non-existent. The server is "dedicated" because it is optimized to quickly serve requests from the clients. The diagram below shows a simple client-server network:

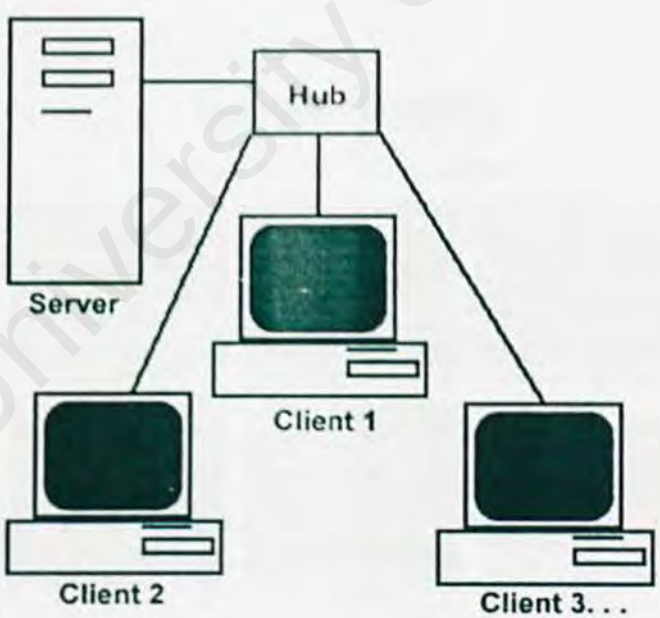

Figure 2.8: Simple client-server network

What is a server?

A server, like any computer, consists of two parts, the hardware and the software. A server is simply a computer that is running software that enables it to serve specific

University of Malaya

requests from clients. For example, a file server becomes a central storage place for a single network and client will request from server if they need a data. A server main benefit is optimization, which the server hardware is designed to quickly serve requests from clients. Any normal desktop computer could act as a server, but typically it needs something much more robust.

2.10 Research on Existing System

Several researches are done on existing system. Smart Home demos can be found in the net which user can view visual effect by clicking at the button. This demo is a web based demo which input and output is coming from the same computer but Smart Home Simulation is also emphasis on physical connection which involving two machine to communicate with each other. Figure below shows example of the demo.

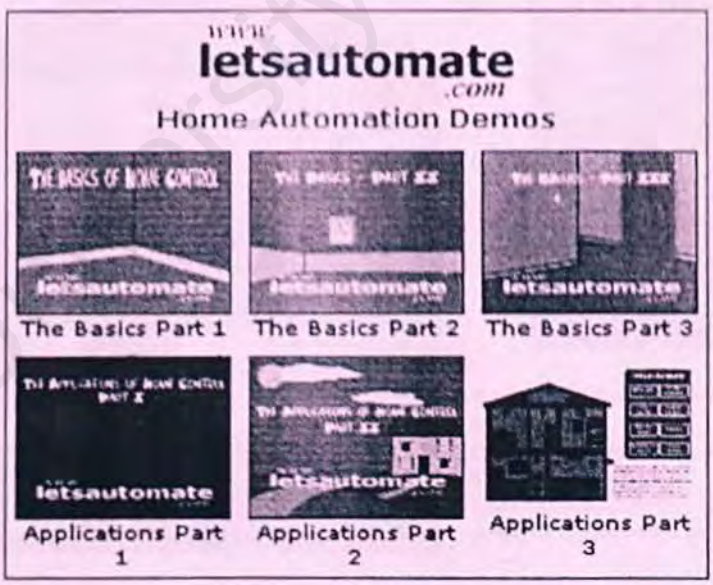

Figure 2.9: Smart Home demo

University of Malaya

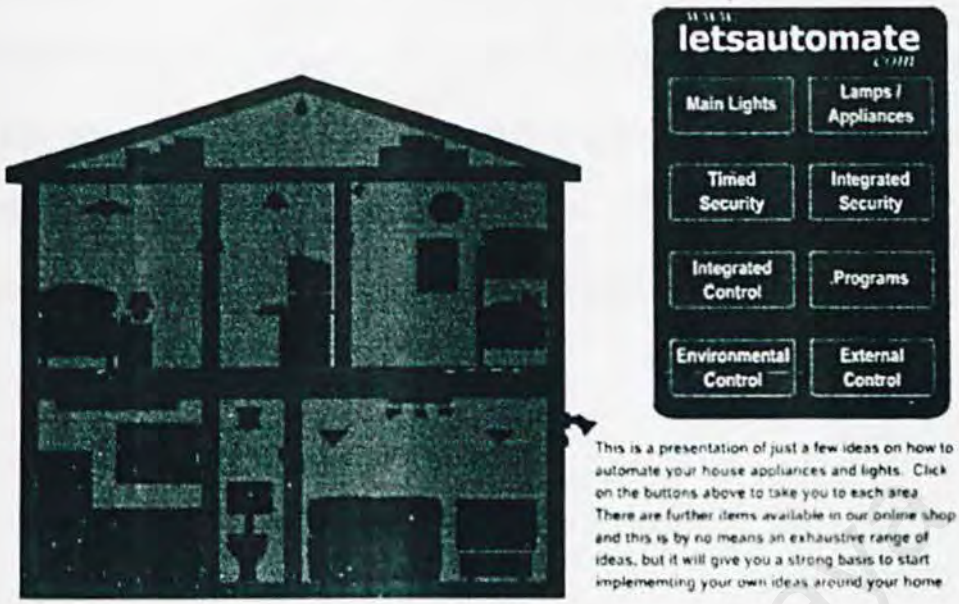

Figure 2.10: Visual of dark house

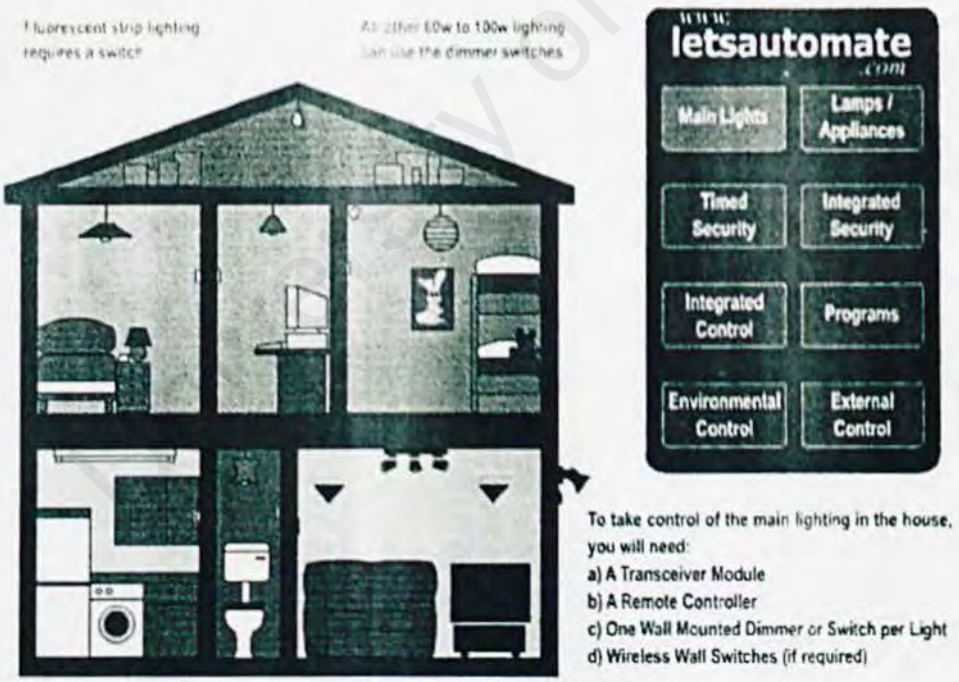

Figure 2.11: Visual change after user key in an input

2.11 Conclusion

Based on the review that had been done, chapter 2 had stated project concept clearer. Various platforms, tools and configuration are discussed and fact finding techniques are explained. Chapter 3 will discuss the system methodology and advantages/disadvantages of existing system development model.

University of Malaya

CHAPTER 3: METHODOLOGY

3.1 Introduction

According to FOLDOC, Free On-Line Dictionary of Computing, *methodology* is an organized, documented set of procedures and guidelines for one or more phases of the software life cycle, such as analysis or design. Whereas, Rumbaugh et al defined that a software engineering methodology is a process for the organized production of software, using a collection of predefined techniques and national conversations. A methodology is usually presented as a series of steps, with techniques and notation associated with each step.

Process model is very important during the software development process or software life cycle. It can form a common understanding of the activities, resources and constraints involved in software development. When a process model is created, it helps to find the inconstancies, redundancies and omissions in the process. As the problems are noted and corrected, the process becomes more effective and focused on building the final system.

People have developed software systems for decades. In the development process, several different models for system development have been used. For instance, Waterfall Model, V Model, Prototyping Model, Spiral Model and Transformation Model. These models provide guidance on the order in which a project should carry out its major tasks.

University of Malaya

The methodology or process model using for Smart Home Simulation is "V Model". It is very similar to waterfall model except the flow is in V shapes and it's allow developer to verify system design by refer to programming code easily.

3.2 System Development Model

Many process models are described in the software engineering literature. Some are prescriptions for the way software development should progress, and others are descriptions of the way software development is done actually. In theory, the kinds of models should be similar or the same, but in practice, they are not. Building a process model and discussing its sub processes help the developer team understand the gap between what should be and what is.

3.2.1 Waterfall Model

Waterfall model is a software life cycle model, described by W.W. Royce in 1970, in which development is supposed to proceed linearly through phases of requirement analysis, design, implementation, testing (validation), integration and maintenance. The phases are depicted as cascading from one to another, which means one development stage should be completed before the next stage.

Advantages of Waterfall Model

- It is very straightforward and simple. Its simplicity makes it easy to explain to customers who are not familiar with system development.
- It present a very high-level view of what goes on during development process, and it suggests to developers the sequence of events they should expect to encounter.

University of Malaya

- It has clear defined milestones. This is very useful in helping developers lay out what they need to do next.
- It also delivers structured documents at each defined milestones, which makes the process visible. No phase is completed until the documents are done.
- It has lots of reviews and evaluations, thus, some sort of output will gained after each step.

Disadvantages of Waterfall Model

- There have little insight into the operation of the system such as how each activity transforms one artifact to another. Thus, it provides no guidance to developers on how to handle changes to activities that are likely to occur during development.
- Requirements must be fixed before the system is designed – requirements evolution makes the development method unstable.
- Design and code work often turn turns up requirements inconsistencies, missing system components, and unexpected developers needs.
- System performance cannot be tested until the system is almost coded, under capacity may be difficult to correct. Problems are not discovered until system testing.
- It does not reflect the way code is really developed.
- Real projects rarely flow in a sequential process. A working revision of the system is not seen until late in the project's life.
- Failed to treat software as problem-solving process due to it was derived from the hardware world.

University of Malaya

3.2.2 Prototype Model

A prototype is partially developed product that enables customers and developers to examine some aspect of the proposed system and decide if it is suitable for the finished products. Prototyping is such a sub process to develop a prototype. The objectives of this model are:

- To establish user interface
- To reduce communication problems and avoid misunderstanding.
- To explore potential designs.
- To evaluate performance.

Advantages of Prototype Model

- To explore user needs.

  It is difficult to imagine system from the specification, prototyping model allows all part of a system to be constructed quickly to understand or clarify needs. It also reduces misunderstanding and identifies missing functions and problems. Prototype forms the basis for a written specification.

- To explore design.

  In this model, design requires repeated investigation to increase a common understanding of what is needed and what is proposed.

- To help in risk management.

  This model collect information (at a cost) and reduces uncertainties in development, it also reduces chances of user rejection.

Disadvantages of Prototype Model

- Time consuming. It is a waste of time if requirements are already clear.
- Can be a high percentage of total cost.
- Needs experienced people to test it.

University of Malaya

3.2.3 V Model

The V model is a variation of the waterfall model that demonstrates how the testing activities are related to analysis and design .As shown in Figure 3.1, coding forms the point of the V, with analysis and design on the left, and testing and maintenance on the right. Unit and integration testing addresses the correctness of programs. The V model also be used to verify the program design. During testing stage, unit and integration testing should ensure that every aspect of the program design have been implemented correctly in the code. Similarly, system testing should verify the system design, making sure that all system design aspects are correctly implemented. Acceptance testing should validate requirement in order to meet all requirements analysis that has been done before.

The model's linkage of the left side with the right side of the V implies that if problem are found during verification and validation, then the left side of the V can be re-executed to fix and improve the requirements, design and code before the testing steps of the right side are re-enacted. As a result I have chosen this process model for Smart Home Simulation project. This model allow the developer to correct any problem in testing stages compared to waterfall model whereas focus of waterfall is often documents and artifacts, the focus of the V model is activity and correctness. Otherwise the V model has several advantages as shown below:

- More explicit some of the iteration and rework than are hidden in the waterfall depiction.
- Easy to understand the project planning. How it planned, how it reworked and how it finished.

University of Malaya

- Can fix any problem or improve the design and requirements even not in development stage.

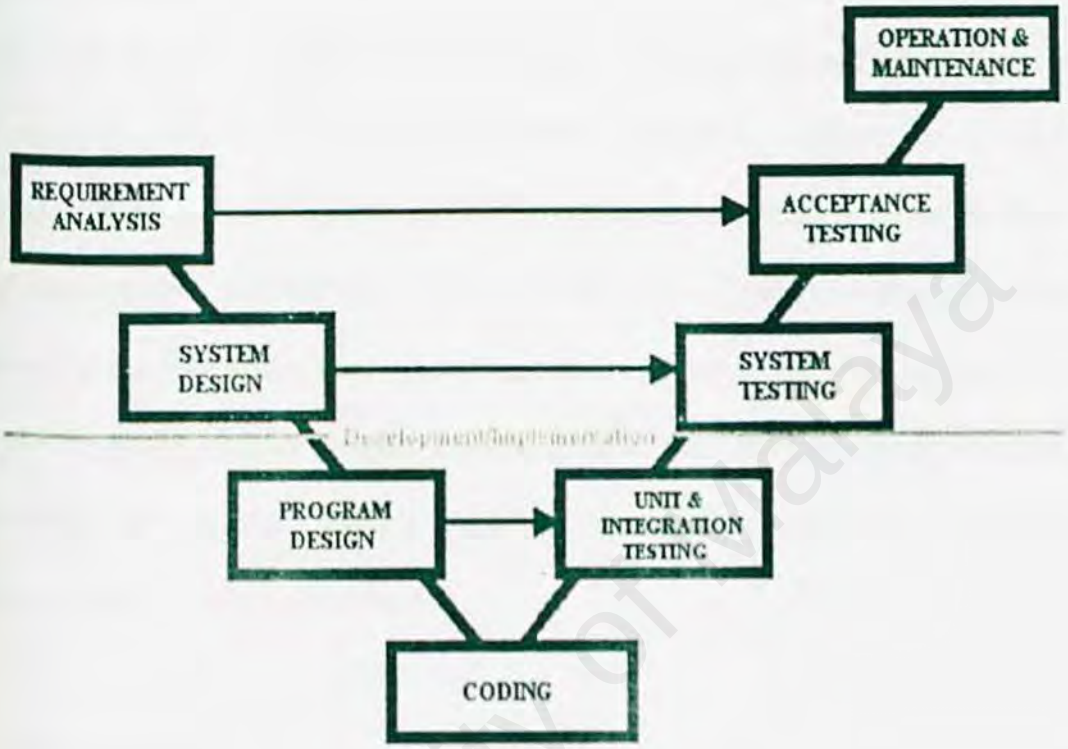

Figure 3.1: The V model

In this model, the fundamental development activities are:

1) Requirement Analysis

This is the first stage of the V model. It defines functional capabilities, performance, design constraints and system interfaces. Various researches are conducted to understand the technologies and issue concerning the system to be developed. Then, the results are analyzed. Goals, constraints, and scope are established based on

University of Malaya

results. Later, the requirements of the system are defined by developers. Finally, a System Requirement Document (SRD) is produced.

2) System design

Design is the structure, interface relations, sizing, key algorithms and assumptions of each program component. Once the requirements are defined, a system design has to be created. The system design process partitions the requirements to either hardware or software systems. Besides that, various diagrams such as data flow diagram, entity relationship diagram and process flow diagram are drawn to logically represent the system. It establishes an overall system architecture. System design involves representing the software system appearances and functions from the user's perspective. The user then reviews it.

3) Program design

The previous phases was approved, the overall system design is used to generate the design of the individual program involved.

4) Coding

Coding is complete, verified set of program components. The programmer will write the programs based on the approved program design.

5) Unit and integration testing

The assigned system design has more than one program. The testing involves making sure that each unit satisfied its specification. When the program has been written, they are tested as individual pieces of code, which called unit testing. Once the

University of Malaya

pieces work as desired, the system was build by adding one piece to next until the entire system is operational, which called integration testing. Integration is a properly function software product composed of the software components. In V model approach if any problem or any improvements are needed, developer are allowed to re-execute the early stages to produce perfect system.

6) System testing

This stage involves a test of the whole system to make sure that the functions and interactions specified initially have been implemented properly and satisfy the specifications. Validation ensures that system has implemented all of the requirements, so that each system function can be tracked back to a particular requirement. Besides, verification ensures that each function works correctly. That is, validation makes sure that the developer is building the right product, and verification checks the quality of the implementation. Similarly, any corrections and improvements allow in this stage.

7) Acceptance testing

This stage tests whether the complete system accepted by the customer or not. This stage also addresses the requirements meet and it conducted by the customer rather than developer.

3.3 Conclusion

During this requirement analysis phase, the V model is chosen as the best methodology based on the iteration and rework. This approach was used because if any problem occurred during implementation phase, developer may correct and fix

University of Malaya

the problem and re-do the implementation phase. The iteration is not limited until the problem fixed. This model consists of seven phases: requirement analysis, system design, program design, coding, unit and integration testing, system testing and operation and maintenance. System design of this project will be explained in the next chapter.

University of Malaya

CHAPTER 4: SYSTEM ANALYSIS

4.1 Introduction

A requirement is a feature of system or a description of something that the system is capable of doing in order to fulfill the system's purpose. It describes not only the flow of the information to and from the system but also the constraints on the system's performance.

Requirement elicitation is an especially critical part of the process. It explains the requirement definition of the system. Requirement definition is a complete listing of everything the customer expects the proposed system to do. It represents an understanding between customer and developer of what customer needs or wants, and it usually written jointly with developer. On the other hand, the requirement specification restates the requirement definition in technical terms appropriate for the development of a system design. It is written by requirement analysts.

The requirements for Smart Home Simulation project cover four main categories, which are:

- Functional requirements
- Non-functional requirements
- Software requirements
- Hardware requirements

University of Malaya

4.2 Functional Requirement

Functional requirement explains what the system will do. It describes an interaction between the system and its environment. Furthermore, functional requirement describes how the system should behave given certain stimuli; functional requirement are the system expected by users. In order to deploy the functional requirement there are three major modules that have been recognized as the most important functional requirements for this system: User interface, virtual home module and simulation control.

4.2.1 User Interface

This module consist interface for user to control the virtual home. Its also be as an input point for this system. Several buttons will be designed to indicate home area such as living hall, bedroom or kitchen. Each button will provide option to user either to switch-on or switch-off home appliance in the area. In this module there are eight functional buttons to represent home area.

University of Malaya

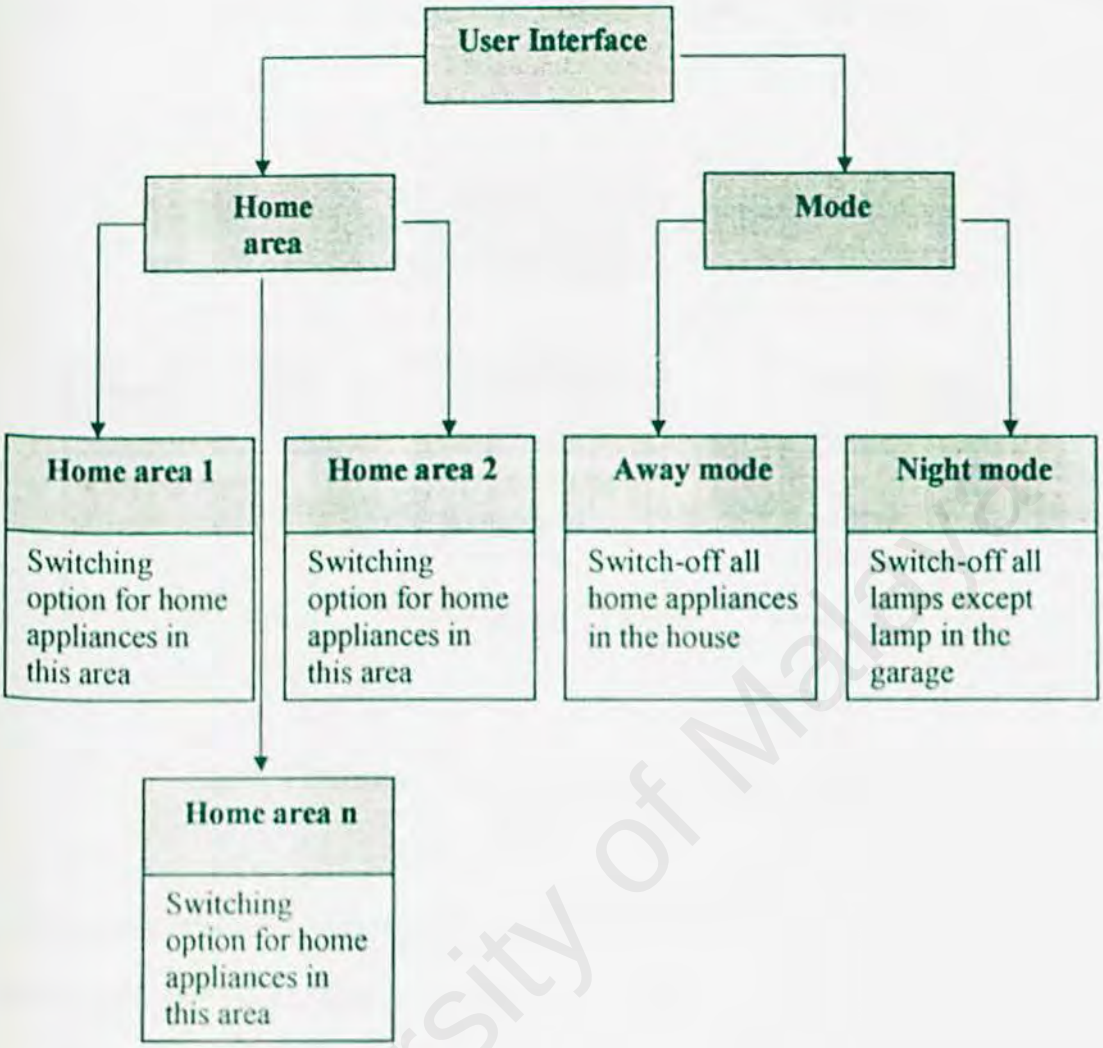

Figure 4.1: Conceptual diagram for user interface module

4.2.2 Virtual home module

Virtual home module is an output point for this system. It contain home in virtual. Graphical picture such as living room, bedroom or kitchen will be designed in this module. User can see effect from this module as an output for their input from user interface module. Effect at this module represented by several different colour for different home appliance. Since there are eight buttons in user interface module there

University of Malaya

are eight home areas will be designed in this module to represent living hall, dining hall, kitchen, bathroom, master bedroom, bedroom1, bedroom 2 and garage.

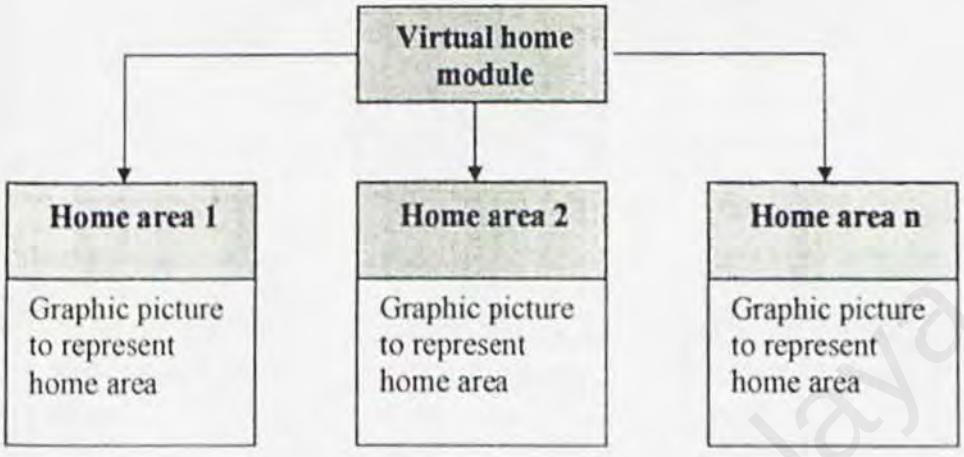

Figure 4.2: Conceptual diagram for virtual home module

User interface module will communicate with virtual home module via network. Conceptual diagram for both module are stated below.

University of Malaya

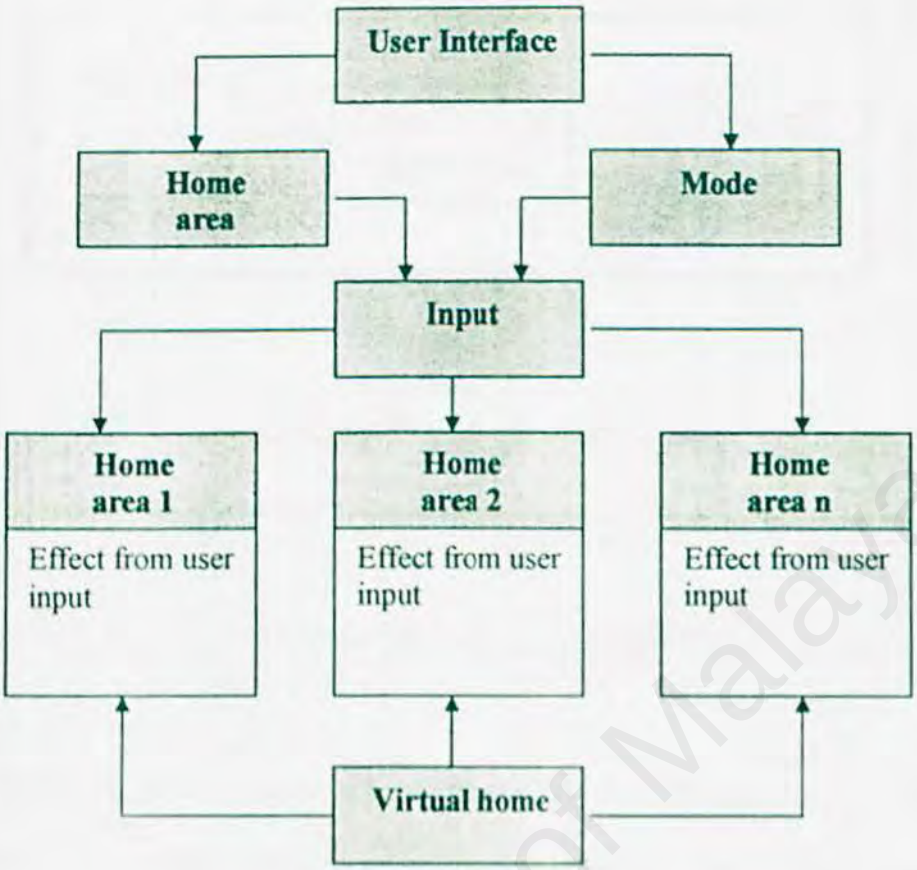

Figure 4.3: Conceptual diagram for user interface and virtual home module

4.2.3 Simulation control

Simulation control is vital module for this system. Without this module, user interface module and virtual home module cannot be interacts with each other. Simulation control will be installed in the same machine with user interface. User only can view the user interface and virtual home module as shown as figure 3.4 below:

University of Malaya

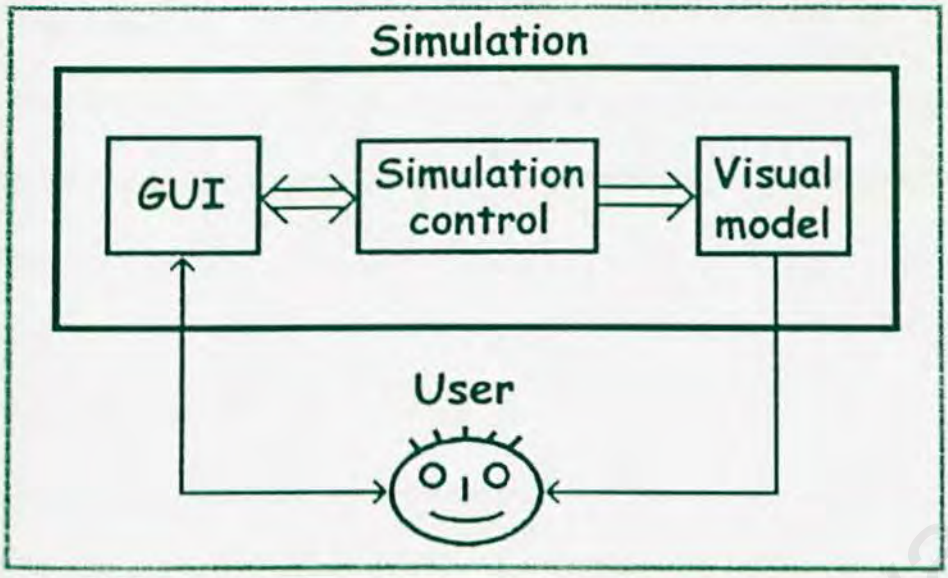

Figure 4.4: Basic communication diagram for Smart Home simulation

This simulation control will control a signal sent by user through the network from user interface. Its involve sending a signal by establishing a socket. Socket needs to be established for both machine that consist a user interface module and virtual home module.

The transmission between these two sockets will communicate over TCP protocol. Once these two sockets have been connected, it can be used to send signal either in one or both directions.

4.3 Non-Functional Requirement

Non-Functional Requirement describes the modules that will not have on the system in order to operate and produce the required result.

University of Malaya

4.3.1 User Interface

A user interface for the simulation system must as same as a real world application. A same interface helps user to operate and understanding real Smart Home efficiency.

4.3.2 User friendliness

A user-friendly interface should have a good flow of navigation. It can help user to control the simulation system easily. Friendly interface also can make user familiar with it. Besides that, it should apply the graphical features approach for better visual effect to the user.

4.3.3 Reliability

Smart Home Simulation should be reliable in processing the input. The system should generate user-friendly feedback to the user for response to their input.

4.3.4 Expandability

Smart Home Simulation should be expandable or modified if there any addition or modification features in real world Smart Home application.

4.4 Software Requirement

After several literature researches done in Chapter 2, some system development tools have been selected based on their features and capabilities. Below is the chosen software to develop the system.

University of Malaya

4.4.1 Platform

Microsoft Windows 2000 has been chosen. It is the second latest version of Microsoft evolving operating system beside Window XP. The benefits of this platform are listed below:

- **Multitasking**

  User could run multiple applications simultaneously on the same system. Number of applications supported would depend on memory in the system.

- **Memory support**

  Windows 2000 provides support for up to 64 GB of memory.

- **Symmetric Multiprocessing (SMP) Scalability**

  It is a technology that allows an operating system to use multiple processors (up to 32 processors) simultaneously to improve performance by reducing transaction time.

- **Plug and Play**

  It is easy to install plug and play device without performing complicated setup process.

- **User-friendly environment**

  Windows 2000 provides user friendly interface and most people are familiar with the interface.

- **Ease of installation**

  Windows 2000 provides user interface during installation. The interface will guide user with step-by-step installation method.

- **Availability of technical support**

  Technical support is availability to user if any error occurred.

University of Malaya

- **Dominant position in software market**

  Microsoft is a big name in producing operating system and it is adapted world wide.

4.4.2 User Interface and Virtual Home Module Tools

To develop these two models, decision has been made to use Visual Basic as a main tool. From literature review in Chapter 2, Delphi and PowerBuilder has a better advantage against Visual Basic but to develop these two models, Visual Basic is good enough and sufficient for this system. The other reason for choosing this tool is stated below:

- Easy to learn. Almost not using a complicated code.
- Visual Basic provides a user friendly interface itself.
- Allow programmer to develop interactive interface.
- Drag and drop method will provides user a simple and easy way in coding stage.
- Visual Basic is a Microsoft's product and it will goes well with Windows 2000, the platform that had been chosen.

4.4.3 Simulation Control Tools

Developing the simulation control need to consider about several things. Transmission over TCP protocol needs to establish between two sockets. Those sockets must be programmed before it can communicate. Programming language such as C++, Python or Java can be used to program the sockets. In Chapter 2, advantages and disadvantages of those programming language had been stated.

University of Malaya

Finally, Java language has been chosen as a programming language to program the sockets. The reasons are it is simple, platform independent, object-oriented, distributed, architecture-neutral, portable, multithreaded and dynamic. In addition, it has strong support of networking such as TCP and UDP sockets. Java network applications only have fewer lines of codes and each line can be explained without much difficulty. Besides, it also has exception mechanisms for robust handling of common problems that occur during I/O and networking operations.

4.5 Hardware Requirement

After discussing software requirement in above section, this section will emphasis on hardware requirement which it is very important too. This simulation system need two machines which is PC A and PC B. Hardware requirement is different on these two machines, which server machine, PC A need high requirement than client machine, PC B. Below are hardware require diagram for this system:

Figure 4.5: Hardware require for this system

User interface module and simulation control will be installed in PC A which PC A is a server while virtual home module installed in PC B, a client machine. Table below shows minimum hardware require for each PC.

University of Malaya

⌦ **PC A**

Component	Descriptions
Microprocessor	Pentium II 266 MHz or above
RAM	At least 128 MB
Storage	At least 2 GB
Input devices	Mouse, Keyboard
Network interface card	10/100 Mbps

Table 4.1: Requirement of PC A (server machine)

⌦ **PC B**

Component	Descriptions
Microprocessor	Pentium II 166 MHz or above
RAM	At least 64 MB
Storage	At least 1 GB
Network interface card	10/100 Mbps

Table 4.2: Requirement of PC B (client machine)

4.6 Conclusion

The system requirements for this system have been stated out. Functional requirements, non-functional requirements, software requirements and hardware requirements have been discuss in this chapter. Tools chosen for developing the system also stated in this Chapter, in software requirement section. Next chapter will explain about system design.

University of Malaya

CHAPTER 5: SYSTEM DESIGN

5.1 Introduction

System design is a process to convert the conceptual ideas from requirement specification in system analysis into more technical specification.

A design specification displays both the physical and logical design of the system. Physical design is the Smart Home Simulation architecture design. For the logical design, specifications are on the system functionality design, user interface design and virtual home design.

5.2 Overview of Smart Home Simulation Architecture

The Smart Home Simulation using two-tier architecture. Application components for Smart Home Simulation are distributed between the server and client. The server contains user interface and simulation control. The server also is responsible to process a signal from user interface before send it to client.

The PC clients are responsible to show an output from server. This PC contains virtual home module and only responsible to received signal sent by server.

University of Malaya

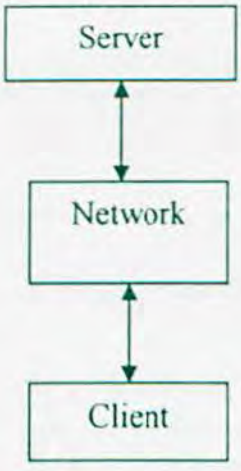

Figure 5.1: Two-tier architecture

5.3 System Functionality Design

System functionality design is based on the system requirements stated in Chapter 4, system analysis. In other words, system functionality design sketches out the system requirements in the form of structure chart and data flow diagram.

5.3.1 System Structure Chart

The system structure chart is used to depict high-level abstraction of a specified system. By using structure chart, the interactions between the independent sub-modules are described. A typical system structure chart includes in the Smart Home Simulation are shown below. Each of these modules is further divided into several sub-modules.

University of Malaya

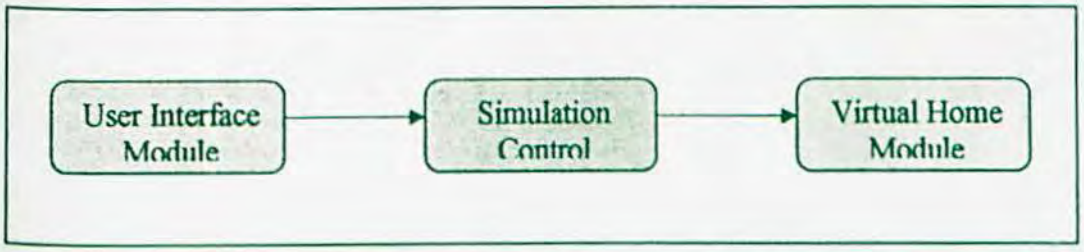

Figure 5.2: Structure chart for Smart Home Simulation.

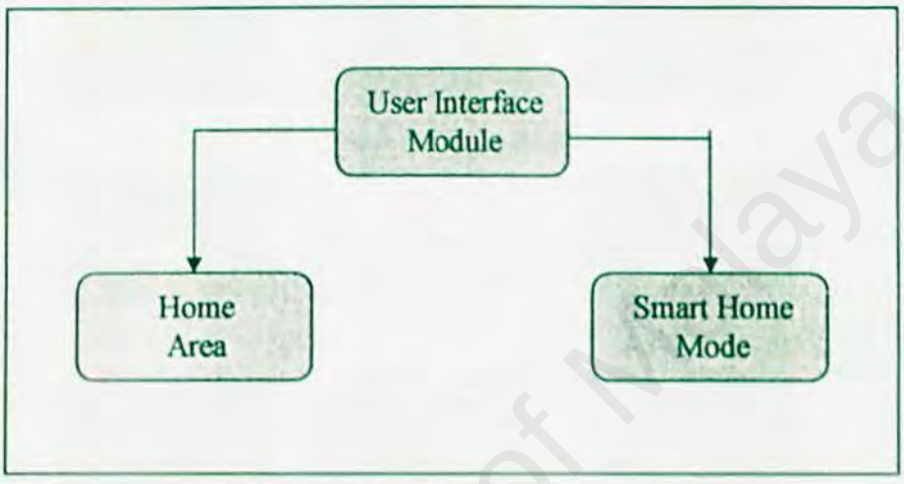

Figure 5.3: Structure chart for user interface module

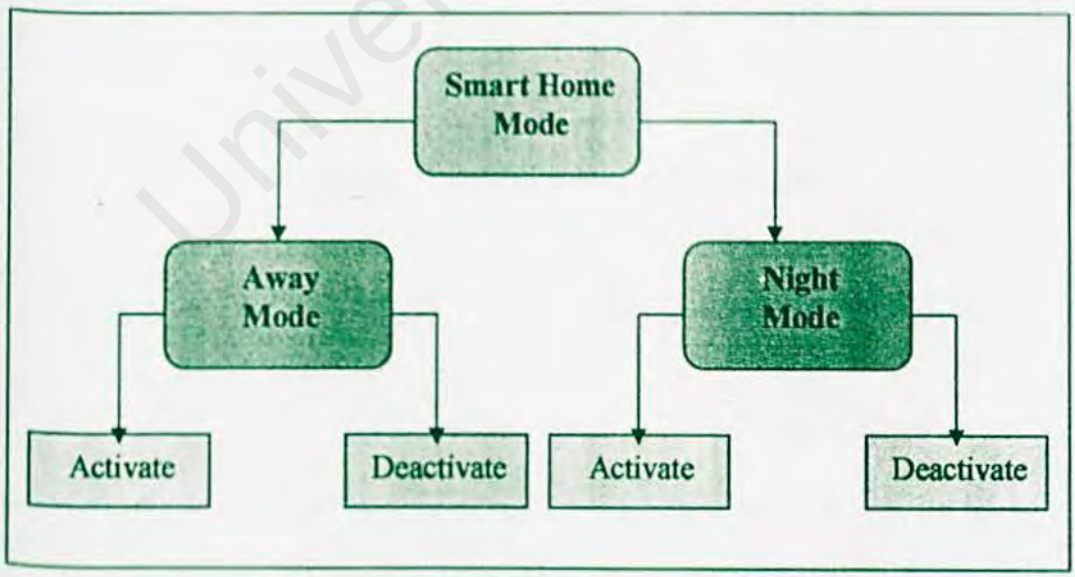

Figure 5.4: Structure chart for Smart Home mode

University of Malaya

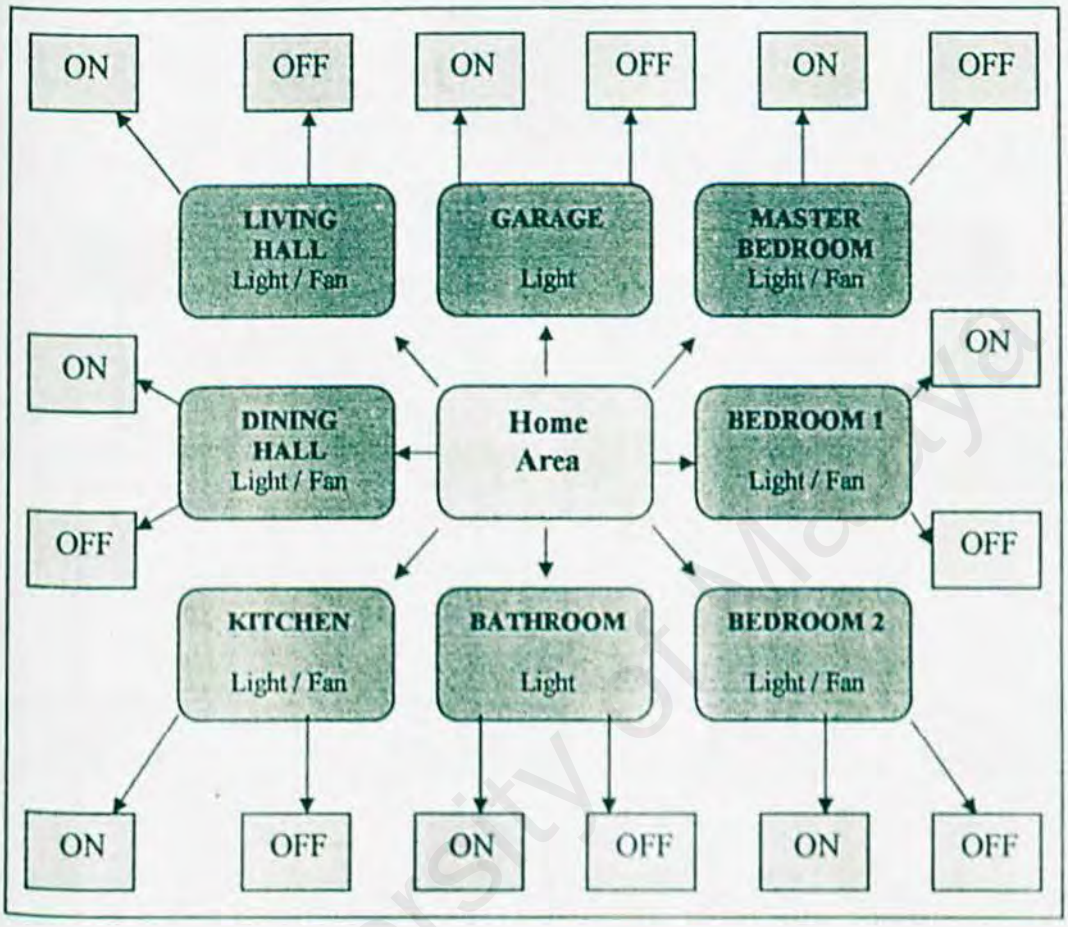

Figure 5.5: Structure chart for Home area

University of Malaya

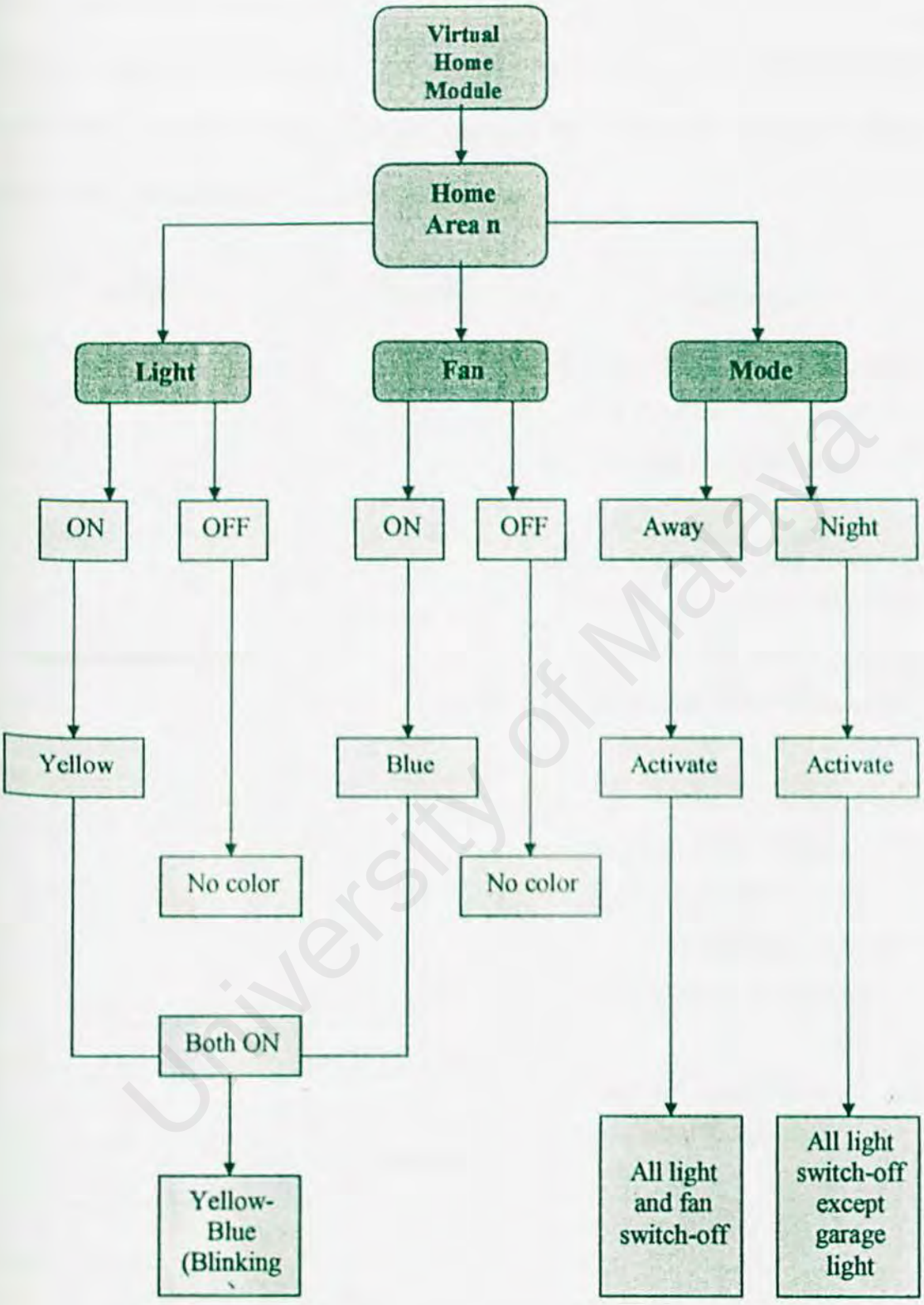

Figure 5.6: Structure chart for virtual home module

University of Malaya

5.3.2 Data Flow Diagram (DFD)

Data flow diagram is the various graphical models that show the boundaries of the system and information used within the system. DFD depicts the broadest possible overview of system inputs, processes and outputs.

Symbol	Meaning	Description
	Entity	⇨ Any object in the real world, e.g. Student. ⇨ Labeled with a name
	Flow of data	⇨ Movement of data from one point to another, with the head of the arrow pointing toward the data's destination.
	Process	⇨ Top section is labeled with a unique number indicating its level within the diagram. ⇨ Lower section contains description of the process
	Data store	⇨ Labeled with identifier and data store description

Table 5.1: Four basic symbols in DFD

University of Malaya

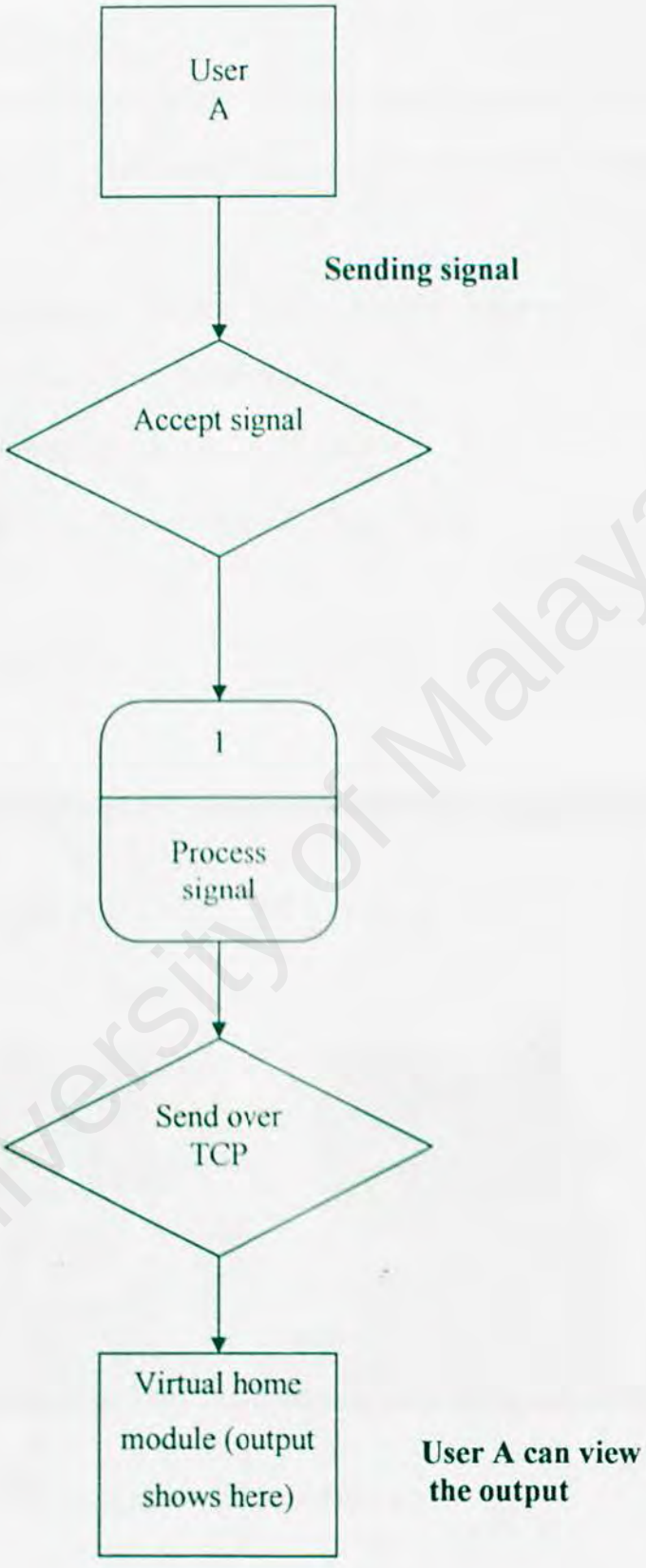

Figure 5.7: Data flow diagram for Smart Home Simulation

University of Malaya

5.4 User Interface Design

User interface is an important component for this simulation system. Therefore, the user interfaces of Smart Home Simulation are design based on several considerations as stated below:

- Creates the user interface that easy to use. This is to make sure that the first time user can handle well the simulation.
- Provide the standard and consistent look interface
- Design the interface as same as real world Smart Home.

Below is draft of interface design:

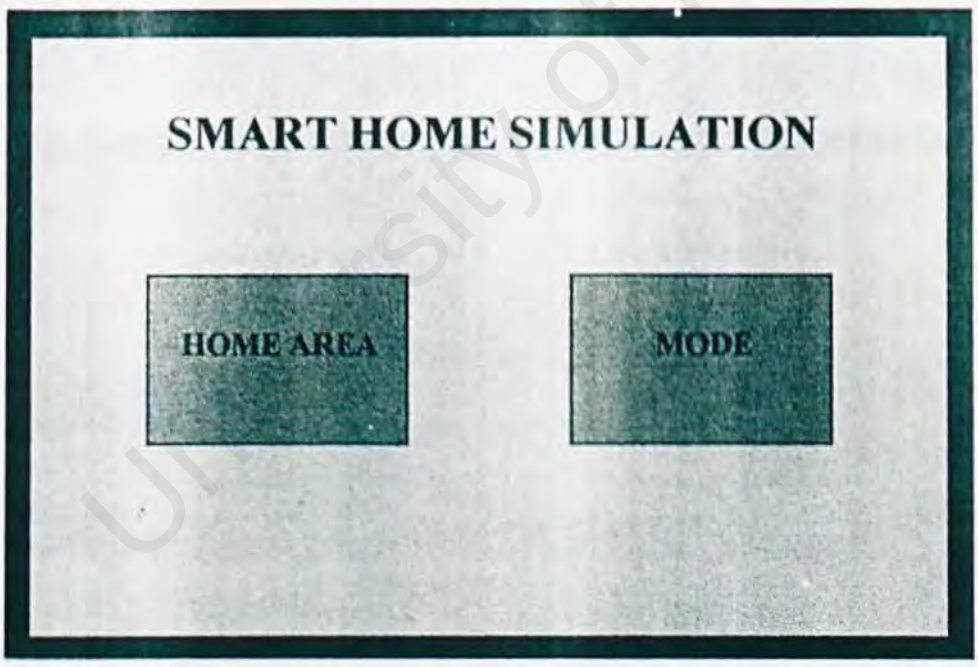

Figure 5.8: Interface of main page

University of Malaya

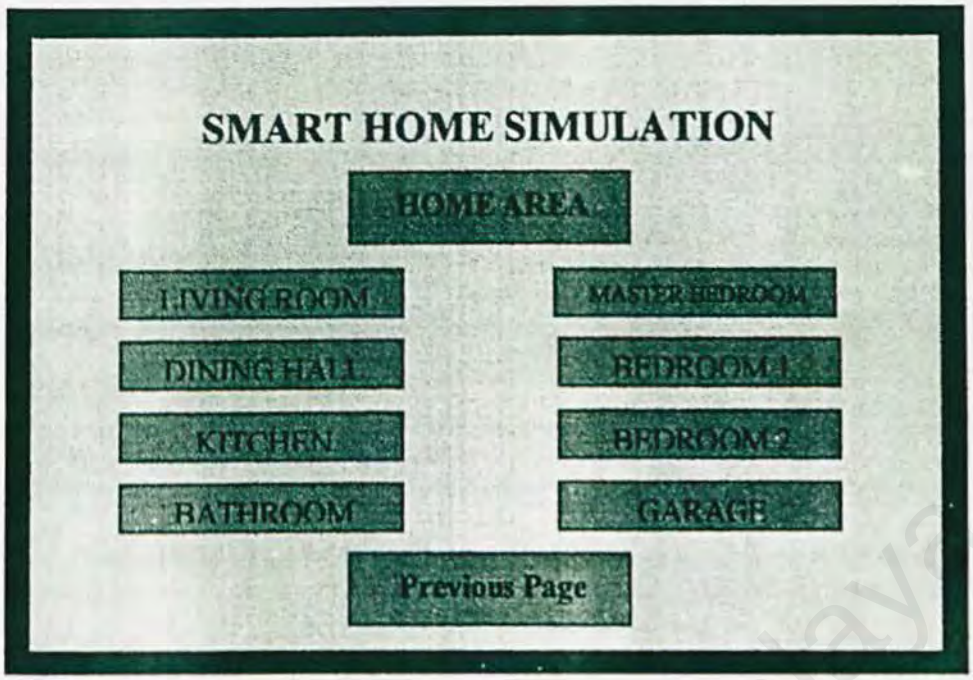

Figure 5.9: Interface of Home Area option 1

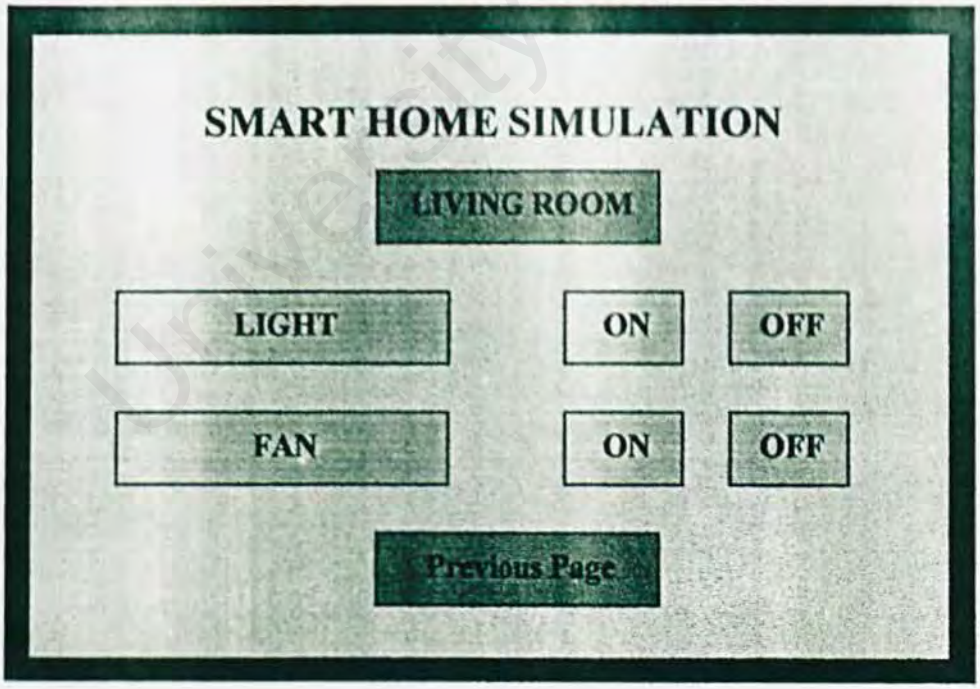

Figure 5.10: Interface of Home Area option 2

University of Malaya

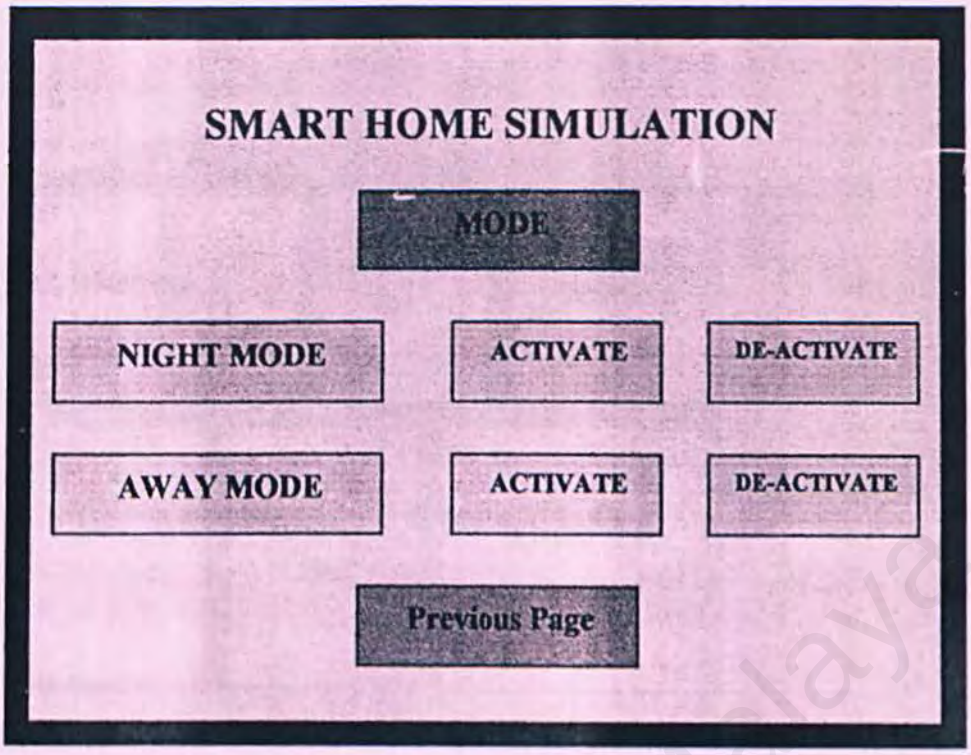

Figure 5.11: Interface of Mode option

5.5 Virtual Home Design

Virtual home module will show output to user. Figure below shows draft of virtual home design.

University of Malaya

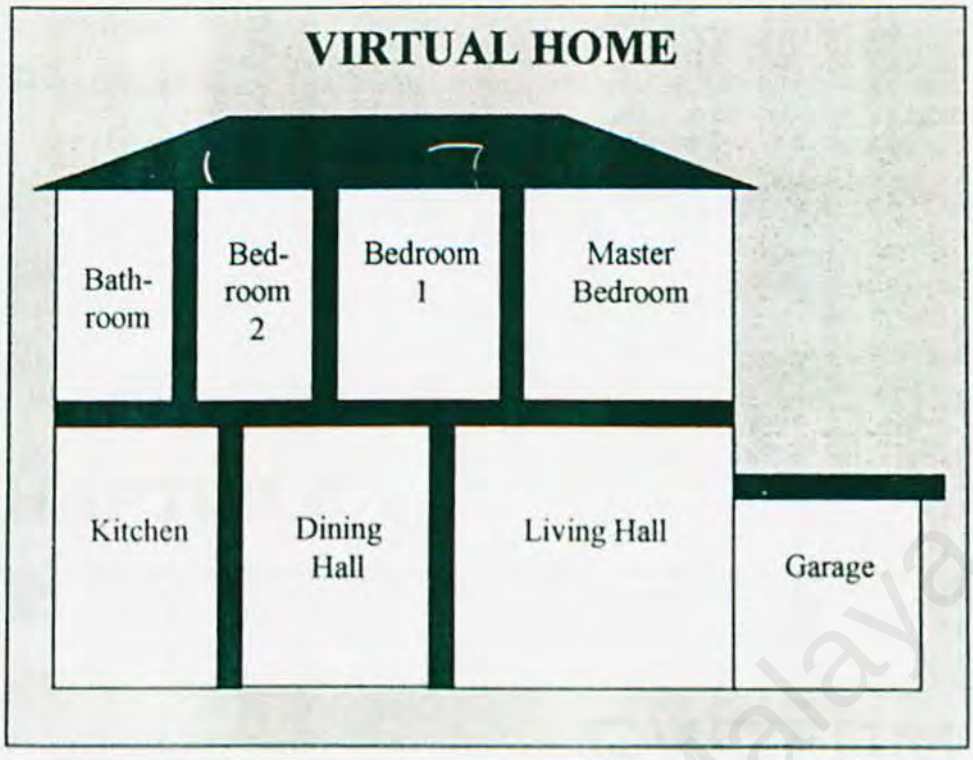

Figure 5.12: Virtual home interface

5.6 Conclusion

This chapter is mainly about the design of the proposed system. Some specific guidelines to design this system are discussed. The system design provides a guideline to system developers in implementing a system. Thus, a good system design is an important key to a successful system.

University of Malaya

CHAPTER 6: SYSTEM IMPLEMENTATION

6.1 Introduction

In this stage, the design model of Smart Home Simulation is converted into a workable product. In the requirements analysis and system design stages, the blueprint of the system is analyzed and developed, however the product is slightly different from the blueprint and several modifications has been done.

System Implementation considered about several aspects. Those are

- Development Environment
- System Development

6.2 Development Environment

Development environment is important in building a correct and efficient product. Using the suitable hardware and software will not only help to speed up the system development but also determine the success of the project. Development environment considered hardware and software tools had been used during development stage.

6.2.1 Hardware Used

The hardware to develop the system is listed below:

- AMD Athlon 1.7 GHz processor
- 7.0 GB hard disk
- 128 MB memory
- Other standard desktop PC component

University of Malaya

6.2.2 Software Tools Used

There are a lot of software tools available in the market that can be used to do the development, designing tasks and report writing. The software used to accomplish the system is depicted as table below:

Software	Purpose	Description
Microsoft Windows 98	System requirement	Operating System
Internet Explorer 5	System development	Browser for viewing web pages developed
Microsoft Visual Basic 6.0	System development	Developing and Coding.
Adobe Photoshop 7	Edit pictures	Image design and editing tool
Microsoft Word 2000	Writing	Writing manual for user purpose.

Table 6.1: Summary of software used

6.2.3 Platform Development

Smart Home Simulation is a Client-Server application. In order to accomplish this system, two PC are needed and it is connected each other either via single cable or LAN. The platform development including setting up two PC and get both PC IP address for coding purpose.

University of Malaya

6.3 System Development

The implementation of the system involves several steps. Those are:

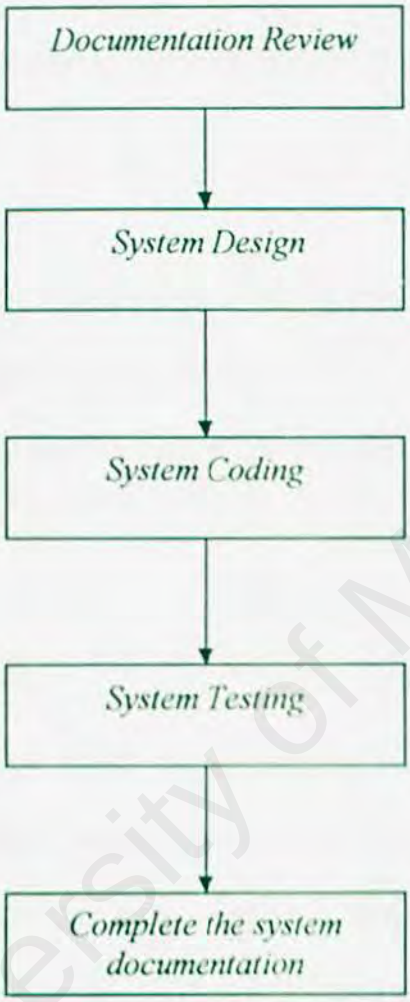

Figure 6.1: 5 steps of system implementation

⇒ **Documentation Review**

Documentation review was been prepared during the previous phase. The documentation consists of system requirement and process flow. This documentation will give a better understanding of the work that needs to be done during the coding phase. Review the documentation is also a guide to develop the system as well.

University of Malaya

⇒ **System Design**

System design step, emphasize on designing User Interface and Virtual Home Module. To create a friendly interface, research has been done in this step. Several experts and programmers have been referred to gain information and tips.

⇒ **System Coding**

System coding is the phase of writing the program instruction that implement the system design. Design specification must be translated into the machine-readable format. If design is performed in details manner, coding can be accomplished mechanically.

⇒ **System Testing**

System testing is the phase which the program is been tested. The testing is needed to ensure it functions correctly to produce information that user relying on. Demonstration product has been produced during testing phase. Several correspondents had been demonstrated to get feedbacks and comments.

⇒ **Complete the system documentation**

Completing the system is essential for the successful operation and understanding of the system. This documentation includes the system's user manual that may be needed by most of the user.

University of Malaya

6.3.1 Interface Coding

Developing User Interface using Visual Basic is quit easy. Most of tools are provided. Most of coding used in User Interface is for pages navigation and the rest is for Winsock function. Below is sample of coding use in User Interface during developing the system.

To show page while hiding previous page.

```
Private Sub Image_Kitchen_Click()
        Unload Me
        frmKitchen.Show
End Sub
```

Code above also had been used at "previous" button as well.

This system is using a background to make it more attractive. To avoid user from clicking at the background page that would make functioning page disappear these coding is using for background page.

```
Private Sub Form_Load()
        frmBackground.Show
        frmBackground.Enabled = False
        Me.Show vbModal
End Sub
```

University of Malaya

For Exit button those coding will end the system.

```
Private Sub cmdExit_Click()
    End
End Sub
```

Every time user clicking on 'ON' /'OFF' function or activate/de-activate function, appropriate string will send through stream established by Winsock. These string represent input or command from User Interface. Those were coding for sending the string.

```
Private Sub cmdG_LOn_Click()
    If (tcpClient.State <> sckClosed) Then
    tcpClient.SendData = "GL21"
    End If
End Sub
```

Besides sending string, User Interface module can receive string from Virtual Home as well. Event simulation is available at Virtual Home Module and message box will appear each time user click on the simulation button. Below is coding to convert received string into message box.

```
Private Sub tcpClient_DataArrival(ByVal bytesTotal As Long)
    Dim str As String
    Call tcpClient.GetData(str)
    If str = "fire" Then MsgBox ("FIRE DETECTED")
    If str = "intruder" Then MsgBox ("INTRUDER!")
End Sub
```

University of Malaya

This system provides flexibility for user to change IP address and port address. Text box for both addresses is available at Connection Setting frame. Those coding will enable user to key in appropriate addresses.

```
Private Sub txtIPAddress_Change()
        If (tcpClient.State <> sckClosed) Then tcpClient.Close
        tcpClient.RemoteHost = txtIPAddress.Text
End Sub

Private Sub txtPortAddress_Change()
        If (tcpClient.State <> sckClosed) Then tcpClient.Close
        tcpClient.RemotePort = txtPortAddress.Text
End Sub
```

Declaration for both addresses; IP address and port address must been write first before writing coding above. Below is a coding for declaration of both addresses.

```
Private Sub Form_Load()
        txtIPAddress.Text = "127.0.0.1"
        txtPortAddress.Text = "1001"

        tcpClient.RemoteHost = txtIPAddress.Text
        tcpClient.RemotePort = txtPortAddress.Text
End Sub
```

"127.0.0.1" and "1001" shown above is a default value if user not enter any new IP address or port address.

University of Malaya

6.3.2 Virtual Home Coding

Coding at Virtual Home Module emphasize on how to manage data arrival from client application (User Interface). Every string received is a command to generate output. For example if string "G21" received, that means light at garage must be turning on. Currently light icon at garage image is invisible. After string arrived, those coding will compared the string and make it visible.

```
Private Sub tcpServer_DataArrival(ByVal bytesTotal As Long)

Dim str As String
Call tcpServer.GetData(str)

    If str = "G21" Then ImageLGarage.Visible = True
End Sub
```

To invisible the light icon (turning off the light) it still the same as to visible the icon (turning on the light). String compared coding had been used.

```
If str = "G20" Then ImageLGarage.Visible = False
```

Every icon in Virtual Home Module has specific name and specific string representing.

Virtual Home Module has function to show Local IP. User just has to run this server application to get IP address. IP address gained from this application can be use at client application in order to establish the connection. Below is a coding to get local IP address.

University of Malaya

```
Private Sub Form_Load()
        txtLocalIP.Text = tcpServer.LocalIP
        Call tcpServer.Listen
End Sub
```

Call tcpServer.Listen is a coding to instruct server application to listen to client application. The coding is located at form load because every time server application form is loaded, server application will listen to client application automatically.

Besides receiving string, this module also can send string to User Interface Module. Clicking on event simulation will send appropriate string to User Interface and message box will appear. Those are coding for sending string from server application.

```
Private Sub ImageFire_Click()
        Call tcpServer.SendData("fire")
End Sub

Private Sub ImageKey_Click()
        Call tcpServer.SendData("intruder")
End Sub
```

6.3.3 Winsock Coding

Winsock coding is a socket coding provided by Visual Basic. In Literature Review chapter, I had stated to use Java for socket programming. During development stage I had found it was easier to code socket using this tool. After discussion with several friends whom was a programmer in Klang Valley, I decide to use Winsock instead of Java.

University of Malaya

Below is stated some Winsock coding and its description.

```
Private Sub cmdConnect_Click()
    If (tcpClient.State <> sckClosed) Then tcpClient.Close
    tcpClient.Connect
End Sub
```

Description: Socket will connect if there is a server application currently in 'LISTEN' state.

```
Private Sub cmdTerminate_Click()
    tcpClient.Close
End Sub
```

Description: Socket will disconnected.

```
Private Sub tcpServer_ConnectionRequest(ByVal requestID As Long)
    If tcpServer.State <> sckClosed Then
    tcpServer.Close
    tcpServer.Listen
    End If

    tcpServer.Accept(requestID)
End Sub
```

Description: This coding is situated at server application side. It will close any socket currently open and start to listen to any client request. If server had found request from client which match with server address, it will accept the client request

University of Malaya

and start to establish the connection. Once these two applications has connected, both side can send and received data from each other.

6.4 Conclusion

This chapter is discussing about system implementation stage which is a crucial stage in system development. Development environment, platform and system have been stated clearly in this chapter. Next chapter will discussing about testing stage.

University of Malaya

CHAPTER 7: SYSTEM TESTING

7.1 Introduction

System testing is the process of testing process and approach used to test the system. It is a critical phase which is to make sure the system is fulfills the user requirements. In this phase, a systematically test procedure is need to make sure the system is tested thoroughly and completely. A few steps of test procedure have to go through to complete the system testing; there are unit testing, integration testing, sub-system testing, overall system testing and acceptance testing as shown in the figure below.

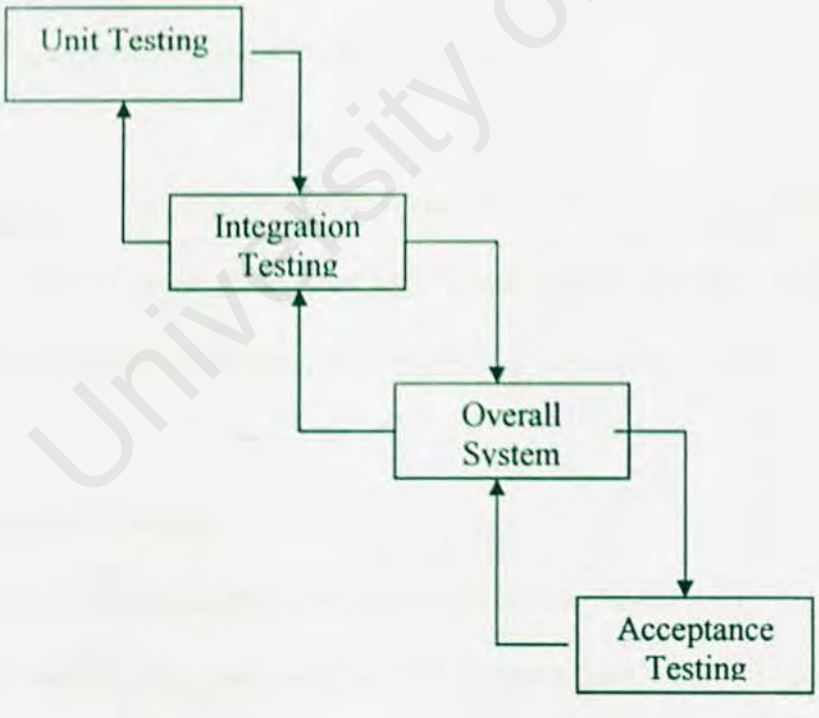

Figure 7.1: System Testing Process

University of Malaya

7.2 Unit Testing

Unit testing stressed on the components' function that linked the modules in this system. Unit testing is done after every module to ensure the correctness and to find any error or problems in the module. Every module needs to be tested in every aspect such as error handling and logic flow interface.

For Smart Home Simulation project, every function is tested separately. There are two units of components in Smart Home Simulation has been tested, User Interface and Virtual Home. In User Interface testing, every page links were checked to ensure all pages navigation is correct. Virtual Home must show all action from User Interface. All icons showed in Virtual Home has been tested and checked to make sure the right icon appear when user key in an input.

From this stage, demonstration module has been produced to get feedback from respondents. Several respondents had been demonstrated and they have to fill up feedback form to gain their comments in order to improve this system.

7.3 Integration Testing

When collections of components have been unit tested, the next step is ensuring that the interface among the components are defined and handled properly. The integration testing is the process that verifying the system components works together as described in the system and program design specifications.

Figure 7.2 illustrates the integration of the components in Smart Home Simulation.

University of Malaya

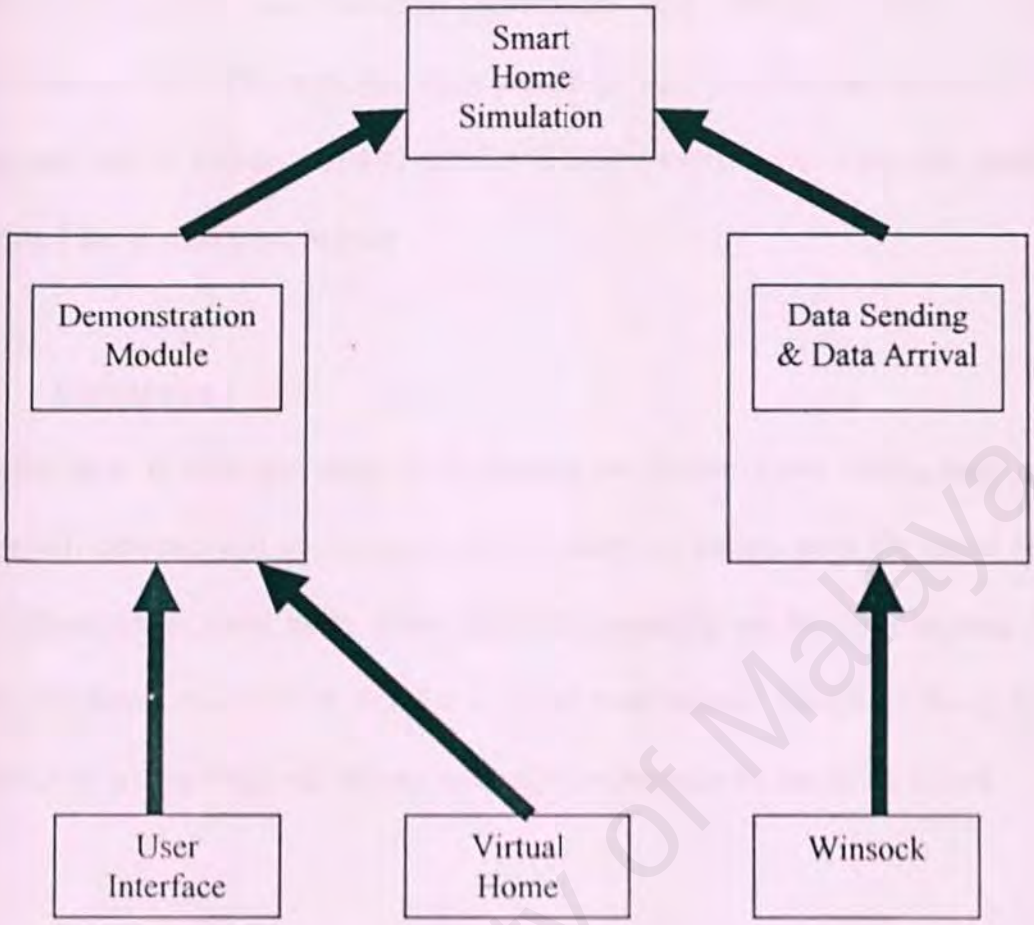

Figure 7.2: The integration of the components in Smart Home Simulation.

7.4 Overall System Testing.

Then, next testing is the Overall System Testing. This testing is used to ensure that all the components or modules of the system are functioning properly.

7.5 Acceptance Testing.

This stage is an important part in the system testing. It is been done by the user of the system. It is commences when the system is ready to use. User involvement in this stage is to make sure the system meets their understanding of requirement, which may be different from the developer.

University of Malaya

Acceptance testing also includes performance and efficiency testing. System performance and efficiency has been tested in real environment. Each PC was assigned with IP address and port number to ensure every signal from User Interface received the destination correctly.

7.6 Conclusion

Testing stage is very vital stage in developing the system. From testing stage every error will detected and improvement can be done. In testing stage for Smart Home Simulation, there were many errors detected especially on Winsock coding. That make me learns how hard to develop a system individually. Hopefully Smart Home Simulation testing stage will be my invaluable experience for me in the future.

University of Malaya

CHAPTER 8: DISCUSSION

Smart Home Simulation project has achieved almost aims and objectives stated in introduction of the report. Due to the project boundaries, there are some limitations in this system and future enhancement can be made to produce a perfect version of Smart Home Simulation.

8.1 Objectives Achieved

Smart Home Simulation project achieved its objectives after it has been developed. They are:

- Developed a dynamic and interactive system successfully.
- A professional interface and meets users' requirements.
- Replaced real world Smart Home with simulator.
- Developed a virtual guidance to user for understanding Smart Home.

8.2 System Strength

Below is stated Smart Home Simulation strength

8.2.1 User Friendly

The graphic user interface of the system is easy to use for the user. Simple and easily understandable standard control objects such as buttons, text box and tips are available in the system. These predictable user interfaces will enable potential user to shorten the learning curve of using the system.

University of Malaya

8.2.2 Transparency

The system is transparent to the user. One does not have to posses' knowledge how the system connected, how the system structured and etc. For example, users don't need to know how to send data. All they need to do is 'click' and see the result.

8.2.3 Simple Operation Maintenance

This system can run at any PC as long as users enter the right IP address. User can obtain server PC IP address by running server application.

8.3 System Limitation

Below is stated this system limitation.

8.3.1 Graphic User Interface

The graphic user interface available in the system, can still be enhance more multimedia technologies in order to attract users to the system.

8.3.2 Lack of Features

To build powerful simulation, more features must be attached. This system should not limit to switch on or switch off home appliances, it should have controller function such as speed up fan, controlling air condition temperature and etc. More features will give user more information.

8.4 Problem Encounter and Solution

Below here is a list of encountered problems and its solution. Some solution may come easily but there were those that required an alternative solution.

University of Malaya

8.4.1 Problem in development tools

In order to develop a good simulation, one must possess a good knowledge and experience about development tools. And I lack of this aspect which burden me most of time in system development. Furthermore this is my first time developing system using Visual Basic tool.

SOLUTION: I have overcome this problem with learning and understanding source code from Internet. I also used the method of trial and error to gain more understanding of this tool. Beside that, I always refer to friend who posses a good knowledge and had experience in developing system.

8.4.2 Problem in Winsock coding.

After developing User Interface Module and Virtual Home Module, I started to develop third module of this system; Winsock. During doing the coding I had found some pages cannot recognize Winsock I had declared before.

SOLUTION: To overcome this problem I have to change whole User Interface Module. I had re-designed this module and finally I found it can function well after several modifications.

8.5 Recommendation and Future Enhancement

Those are enhancement can be made to improve this simulation.

8.5.1 Enhance Function and Scope

As stated before, Smart Home Simulation only focused on several home appliances and several function. In future or next version of Smart Home Simulation more function can be added such as more home appliances, controller function and timer

University of Malaya

function. By added this function and scope, this simulation could be more realistic and attractive.

8.5.2 System Security

Smart Home Simulation could be more smarts if there's a security function to access the system. In real world Smart Home only authorize user can log in to the system to avoid third party from access user house. In the future Smart Home Simulation should have security function such as requesting login name and password.

8.5.3 Hardware Involves

To produce a really powerful simulation, hardware involving should consider as an important aspect. From my opinion, to develop a powerful simulation a team of development should be formed. The team should be a combination of Computer Science student and Electrical Engineering student. Computer Science student will take responsible to develop system, interface and physical connection while Electrical Engineering student build up a circuit needed. I believe this combination will produce not just a simulation. It is more than that. It will produce what we can call it 'MINI SMART HOME'.

8.6 Experience and Knowledge Gained

Throughout the duration of system development, a lot of invaluable experiences have been obtained. The most important is the experience of developing a system. The systematic approach has been used and practically applied in developing the Smart Home Simulation. The systematic approach is embodied in System Development Life Cycle (SDLC) as what I have learned theoretically in my course.

University of Malaya

Developing Smart Home Simulation is indeed challenging and exciting experience. I have personally experienced the power of using Visual Basic 6.0 software especially during Winsock coding.

During the system implementation phase, I had through my hard time especially during testing stage. I have to re-develop several things to encounter an error detected in testing stage.

Apart from that, I found my programming skills have advanced a big step forward after I completed the project. I also have learnt the way of writing source code in a better way. Besides that, I have gained invaluable experience in developing the system.

8.7 Summary

All in all, this project has achieved and fulfilled the objectives and requirements determined during the system analysis. Smart Home Simulation not only a simulation system it also provide information and knowledge about Smart Home.

The Smart Home Simulation can be claimed as a pioneer to promote new invention and technology in Malaysia. Most of Malaysian citizens are not realize about this technology existence. This system will act as a guide for people to gain Smart Home information in fast and easy way.

From academic wise, this paper taught me how to be a part of development team. This project needed me to follow the software engineering methods, rule,

University of Malaya

documentations and tools in order to build good system. I have to use all the theory that I have learned before. And by doing so, it make me have better understanding on those theories.

Hopefully, this project will guide me to face the real working environment in the future.

University of Malaya

REFERENCES

1. **Stallings, William. and Van Slyke, Richard.** *Data and Computer Communication:* Prentice- Hall, Inc., 3rd Ed., 2000.
2. **Coulouris, George. Dollimore, Jean. and Kindberg, Tim.** *Distributed System Concepts and Design:* Addition-Wesley Publisher Limited, 3rd Ed, 2001.
3. **Whitten, Jeffrey L., Bentley, Lonnie D. and Dittman, Kevin C.** *System Analysis and Design Methods*: Irwin/McGraw-Hill, 5th Ed., 2000.
4. **Pfleeger, Shari Lawrence**. *Software Engineering: Theory and Practice.* U.S.A.: Prentice-Hall, Inc., 2nd Ed., 2001.
5. **Deitel & Deitel**. *Java How to Program.* Prentice- Hall, Inc., 2nd Ed., 1998.
6. **Deitel & Deitel**. *Visual Basic 6 How to Program.* Prentice- Hall, Inc., 2nd Ed., 1998.
7. **Shelly, Gary B., Cashman, Thomas J., Repede, John F., and Mick, Michael L.,** *Visual Basic 6: Complete Concepts and Techniques*: International Thompson Publishing company, Custom Ed., 1999.
8. **Deitel & Deitel**. *C++ How to Program.* Prentice- Hall, Inc., 2nd Ed., 1998.
9. http://isp.tm.net.my
10. http://www.clipsal .com.au
11. http://www.pesbdot.com
12. http://www.misterhouse.net
13. http://www.letsautomate.com
14. http://www.i-home.com.my
15. http://www.sybase.com

University of Malaya

16. http://community.borland.com

17. http://www.java.sun.com

18. http://www.devx.com

19. http://www.python.org

20. http://www.cprogramming.com

21. http://www.techsoup.org

22. http://www.what is.com

University of Malaya