Bluetooth User-Driven Cooperative Gallery Using Pull-based Technology

by

Hezreen binti Hassan

Dissertation submitted in partial fulfillment of
the requirements for the
Bachelor of Technology (Hons)
(Information Communication Technology)

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CERTIFICATION OF APPROVAL

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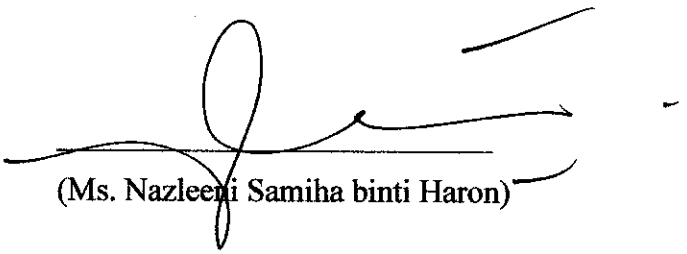
Approved by,



(Ms. Nazleeni Samiha binti Haron)

UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK
July 2006

CERTIFICATION OF ORIGINALITY

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

(HEZREEN BINTI HASSAN)

ABSTRACT

The Dissertation is part of the compulsory requirement upon completion of the Final Year Project (Part A) and also to fulfill the requirement of graduating in Bachelor of Technology (Hons) Information Communication and Technology (ICT). The topic chosen for the project is Bluetooth User-Driven Cooperative Gallery Using Pull-based Technology. The purpose of the report is to have an overview of the project. It will discuss and clarify all the findings and information which are relevant to the objectives of the project. Students will have the opportunity to exercise their writing skills and to clearly communicate their idea and suggestions. Advance in wireless technology are becoming more and more popular throughout the world. In a world of increasing mobility, there is a growing need for people to have timely access to information regardless of the location of the individuals or the information. Introduction will cover the background of the project under study, problem statement, and the objectives of the project. The objective is to implement Bluetooth as a suitable wireless transmission technology that is appropriate to be used for the Universiti Teknologi PETRONAS Gallery. Literature review is the analytical, critical and objective review of the written materials on the chosen topic. It contains all relevant theories, hypotheses, facts, and data which are relevant to the objective and findings of the project. Methodology will be discussing the identification of the procedure that will be using in the development of the project. This part will also discuss all the tools needed in developing the product in terms of hardware and software needed. Results and conclusion will discuss about the results from the questionnaires made to the students and the clarifications of the design and implementation phase. Lastly, the conclusion is to clarify whether the project has been a success, where all the objectives had been achieved or otherwise as well as the recommendation for future work.

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ABBREVIATIONS

API	Application Program Interface
SMS	Short Messaging Services
WAP	Wireless Application Protocol
MMS	Multimedia Messaging Service
GPRS	General Packet Radio Services
WTK	Wireless Tool Kit
PDA	Personal Digital Assistant
DVD	Digital Video Player
UTP	Universiti Teknology Petronas
ICT	Information, Communication and Technology

CHAPTER 1

INTRODUCTION

1.1. BACKGROUND OF STUDY

Currently, advances in wireless technology are becoming more and more popular throughout the world. In a world of increasing mobility, there is a growing need for people to have timely access to information regardless of the location of the individuals or the information. Right now, people are demanding technologies that are efficient and easy for them to use. An increasing number of applications are being written for mobile hosts which include laptop computers, mobile phones, personal digital assistant (PDA) and many more. The evolution of mobile devices as one of the essential technology has made it possible for these various mobile applications to be developed. Nowadays, new small and powerful devices are more and more widespread. They allow the users to access and manage multimedia files (image, audio, video, etc.) everywhere without loss of definition quality. New scenarios of use are being introduced. To better support users in their activities, the system that will be developed have to take into account the possible changes of context. The work stems from the growing interest in identifying effective design for the interaction of users with such small devices. Mobile phones have become the communication medium of choice. They have evolved into a multifaceted device capable of data services and multimedia applications in addition to their voice capabilities. Mobile phone communicative capabilities have been broadened significantly by the inclusion of technologies. It has the potential to be useful for more complex functionality than common voice and text usage.

To this purpose, the system considers the University Technology Petronas (UTP) Gallery visits where the users will be able to freely move about in the gallery area without a predefined path. In particular, an application was designed and developed for the UTP Gallery. The goal is to provide relevant information to the visitors of UTP Gallery regarding the exhibits displayed while being mobile around the gallery via their mobile phone using Bluetooth technology.

Bluetooth doesn't stand alone in technology options for wireless connectivity. 802.11 and HomeRF are two wireless standards that also address wireless connectivity. Table 1 shows the various wireless communication technology options and outlines the characteristics of each. 802.11 technology is very focused at wireless LAN extensions. Power ratings are not the main design goal. HomeRF is an initiative to communicate with other intelligent embedded devices in the home with the home PC. Bluetooth provides close to the same data rate with the added benefit of having a typical power consumption of 1mWatt. This means that Bluetooth power budget within a typical cell phone represents approximately 3% power load.

This makes Bluetooth a technically viable communications option for handheld wireless devices desiring to accommodate voice and data services. The summary of these wireless options can be seen below [1]:

Table 1: Technology characteristics of 802.11 Wireless LAN, HomeRF and Bluetooth

Technology Characteristics	
802.11 Wireless LAN	2 Mbps, 802.11b 11 Mbps >100 mWatt
HomeRF	Home networking, many devices, accommodates data & voice 1 or 2 Mbps 100 mWatt
Bluetooth	Variable data rate technology accommodating data & voice Variable bit rate to 720 Mbps 1 mWatt typical, up to 10 mWatt, ~50 mA @ 3 Volts

The novel contribution of this paper is the introduction and implementation of a Bluetooth User-driven Cooperative Gallery system, which is based on pull-based technology.

1.2. PROBLEM STATEMENT

1.2.1. Problem Identification

Normally in museum or galleries, visitors need to manually read all the information provided regarding exhibits exhibited in the area. This requires visitors to move around back and forth in order to get to each section or area. This situation somehow will cause dissatisfaction for the visitors to go back and forth around the exhibition area. But with the implementation of the system, it could provide instant easy access to information provided at the gallery. Users will be able to retrieve the information using Bluetooth technology just by using their mobile phone. This implementation is more user-friendly compared to the old traditional way.

There is also another option of implementing this system which is using push-based technology compared to pull-based technology. This is where the information exhibited will be sent to the visitors' mobile phone automatically without their request. However, there are issues related to the use of push-based technology. One of it is spamming issues where the Bluetooth service must be turned on at all time, and this makes them to be more vulnerable to spamming attacks from mobile devices. Users will receive unwanted information and this would irritate them. The server might attempt to push whatever information they have once it finds a mobile phone within its range. Most probably they will be sending unwanted content that can be annoying to the visitors and eventually forces them to stop using the system. Once exposed to spamming attack, it can lead to virus attacks as well. This is considered as a serious security risk as most of the Bluetooth phones user cannot recognize the kind of files they are downloading. Somehow they might be downloading viruses or other malware to their mobile phone.

These issues lead to the implementation of Bluetooth User-driven Cooperative Gallery using pull-based technology. User-driven is a way to provide a control of the system to users. The recipients will be provided with a list of information according to the exhibits and they may select the preferred one for them to view.

1.2.2. Significance of the project

We are living in a world where our business and personal lifestyles are changing ever faster and shaping our needs. In our business and personal lives we have learned to value services that allow us to be able to do our task in a more convenient and easier way. Our daily life sometimes requires quick decisions and efficient sharing of timely information. The significance of the user-driven cooperative gallery system is to help visitors of UTP Gallery to retrieve or gather information regarding the exhibits displayed using their mobile phones. This could assist them in getting around the gallery better as the information is in their hands. Visitors will be able to retrieve the list of information needed from the server using pull-based technology. With this feature, it is definitely more user-friendly compared to the traditional way of visiting a particular museum or gallery. Thus, with the ample information provided to the visitors of the gallery, it surely will give the visitors more satisfaction in touring around the UTP Gallery area. Furthermore, with the implementation of this Bluetooth User-driven Cooperative Gallery using pull-based technology, it can overcome the disadvantages of push-based implementation.

1.3. OBJECTIVES AND SCOPE OF STUDY

1.3.1. Objectives

1. To implement Bluetooth as a suitable wireless transmission technology that is appropriate to be used for the Universiti Teknologi PETRONAS Gallery.

2. To apply pull-based concept and a user-driven system in the implementation of this project.

1.3.2. Scope of Study

The degree of this study is by looking into how Bluetooth functions and how it operates with mobile devices. It includes the study of integration of Bluetooth technology and Bluetooth enabled devices like mobile phones with the project under development. This study will focus on Bluetooth pull-based technology in terms of its feasibility and effectiveness that is used to implement this project. For this project, it will be implemented in the Universiti Teknologi PETRONAS (UTP) Gallery. To ease the flow of the development of this project, the scope will be inside the UTP Gallery. This study focuses on using Bluetooth as a tool to provide information to the visitors using the user-driven concept. User-driven concept simply means giving flexibility to end users to select the preferred information from a list provided by the server.

1.3.3. Relevancy of the project

This project is definitely related to Information, Communication and Technology (ICT) area. The development of the product involves the use of networking skills and knowledge as it is related to the wireless technology under study which is Bluetooth. The implementation of Bluetooth User-Driven Cooperative Gallery using pull-based technology will be related to the networking skills. The accomplishment of developing this project related to the mobile communication using Bluetooth is definitely pertinent to the ICT course. Comprehensive knowledge need to be acquired in order to develop the application in the mobile phone itself. All the information and data that involve the skills of using the tools necessary will also be documented.

1.3.4. Feasibility of the project within the Scope and Time Frame

In developing the project thorough knowledge and comprehensive research need to be done in order to seek absolute information regarding the wireless technology. Student has been assigned two semesters to work on the research and development of the project. The research regarding to the project has been completed. On the other hand, in order to complete this project completely will require more time. The process of identifying the requirements to the project and the system workflow are done during the time frame that has been assigned. With comprehensive research on this project, the system was completed within the time frame allocated.

CHAPTER 2

LITERATURE REVIEW

2.1. WIRELESS TECHNOLOGY

2.1.1. Wireless Networks

The world is going wireless. It has becoming ubiquitous and increasingly relied upon. From airport lounges and hotel meeting room to café and restaurants across the globe, wireless LANs are being built for mobile professionals to stay connected to the Internet. The market for wireless communications has grown rapidly since the introduction of 802.11b wireless local area networking standards, which offer performance more nearly comparable to that of Ethernet [2]. Wireless networks are telephone or computer networks that use radio as their carrier or physical layer. There are three main applications of wireless technology that are in use today: wireless application protocol, wireless Internet connections and wireless networks.

There are many examples of wireless networks available these days. To name a few, there are Wireless Metropolitan Network (WMAN), Wireless Local Area Network (WLAN), Wireless Personal Area Network (WPAN), Cellular phone network, Global Standard for Mobile (GSM), Code Division Multiple Access (CDMA), General Packet Radio Services (GPRS) and Bluetooth. Initially, wireless is for use in locations that are difficult to wire. Such as building with asbestos, factory floor and temporary installations such as Desert Storm, disaster recovery sites and trade shows.

However, technologies and development of wireless network produces many applications of useful and beneficial products for the society.

Wireless networking refers to technology that enables two or more computers or devices to communicate using standard network protocols, but without network cabling. Any technology that does this could be called wireless networking which refers to wireless LANs.

2.1.2. Wireless Personal Area Network (WPAN)

A personal area network (PAN) is a computer network used for communication among computer devices (including mobile phones and PDA) close to one person. The reach of a PAN is typically a few meters. PANs can be used for communication among the personal devices themselves (intrapersonal communication), or for connecting to a higher level network and the Internet (an uplink). Personal area networks may be wired with computer buses such as USB and FireWire. A wireless personal area network (WPAN) can also be made possible with network technologies such as IrDA and Bluetooth. The WPAN is a new standard under development, which will be part of the IEEE 802.15 standard. The main objective of the WPAN is to replace wires between electronic and/or computing equipment in close proximity and provide connectivity to larger networks through a convenient transmission medium [3]. A WPAN is a personal area network for interconnecting devices centered around an individual person's workspace in which the connections are wireless.

Wireless communication systems are evolving to support communication needs for wide range of applications [4]. Traditionally wireless communication systems have been used in outdoor communication environment such as cellular mobile radio, microwave radio, etc. In last decade there has been significant growth in wireless local area networking mainly driven by the IEEE 802.11 standard. With the advancement of RF and semiconductor technologies researchers are now concentrating efforts in developing pico-networks where electronic devices within few meters to a maximum of 100 meters can communicate without requiring any fixed infrastructure [5].

2.1.3. Bluetooth

Bluetooth is an industrial specification for wireless personal area networks (PANs), also known as IEEE 802.15.1. Bluetooth provides a way to connect and exchange information between devices like personal digital assistants (PDAs), mobile phones, laptops, PCs, printers, digital cameras and video game consoles via a secure, globally unlicensed short-range radio frequency. It is a radio standard and communications protocol primarily designed for low power consumption, with a short range (power class dependent: 1 meter, 10 meters, 100 meters) based around low-cost transceiver microchips in each device. The figure below shows the Bluetooth logo.

Figure 1: Bluetooth logo

Bluetooth lets these devices communicate with each other when they are in range. The devices use a radio communications system, so they do not have to be in line of sight of each other, and can even be in other rooms, so long as the received transmission is powerful enough. As a result of different antenna designs, transmission path attenuations, and other variables, observed ranges are variable. It is the name given to a technology using short-range radio links, intended to replace the cables connecting portable or fixed electronic devices. Bluetooth is a specification for WPANs and known as IEEE 802.15.1. Bluetooth provides a way to connect and exchange information between electronic devices using a secure, low-cost, globally available, short-range radio frequency. Its key features are robustness, low complexity, low power, and low cost. The big advantages of Bluetooth are that it is wireless, inexpensive, and automatic.

There are other ways to avoid using wires, including infrared communication. Infrared communications are fairly reliable and don't cost very much to build into a device, but there are a couple of drawbacks. First, infrared is a line-of-sight technology. For example, remote controls work on infrared, and you have to point a remote control at the television or DVD player to make things happen. The second drawback is that infrared is almost always a one-to-one technology. One can send data between desktop computer and laptop using infrared signals, but not from your desktop to laptop and PDA at the same time. Bluetooth is intended to get around the problems that come with infrared systems.

Designed to operate in noisy frequency environments, the Bluetooth radio uses a fast acknowledgment and frequency-hopping scheme to make the link robust. Bluetooth devices operate at 2.4 GHz in globally available license-free ISM bands. (ISM stands for industrial, scientific, and medical.) The operating band is divided into 1 MHz-spaced channels, each signaling data at 1 Mbps.

After transmission of each packet, the communicating device retunes their radio to a different frequency, hopping from radio channel to radio channel. Thus, if the transmission of a packet is affected on one channel because of interference, the retransmission will always be on a different channel. If the devices are to change frequency after each transmission, they must all agree on a sequence of frequencies to use.

Bluetooth devices can operate in two different modes: master and slave. A piconet is a collection of slave devices operating together with one common master. Each Bluetooth device has a unique Bluetooth device address, and a Bluetooth clock. The slave device uses the master's device address and clock to calculate the frequency hop sequence. When the slave device connects to a master, it is told the master's device address and clock. This keeps all the slave devices in the piconet synchronized with the master. The master controls how the total available bandwidth is divided among the slaves by deciding when and how often to communicate with each slave. The number of time slots each device gets depends on its data transfer requirements. The system of dividing time slots among multiple devices is called time division multiplexing. The slaves in the piconet have only links with the master; there are no direct links between the slaves [6].

2.1.4. Bluetooth Protocol Stack

The Bluetooth protocol stack is defined as a series of layers, with each layer representing a different protocol. The Bluetooth profiles, described along with the stack in the Bluetooth specification, are essentially usage models to illustrate how applications should use the stack. The stack can be divided into two major sections, the first is the Bluetooth host, which is the upper section of the stack and is usually

implemented in software. In the case of a mobile phone, the Bluetooth host is integrated with the operating system of the phone. The lower layers are known as the Bluetooth controller. The figure below shows a typical Bluetooth stack [6].

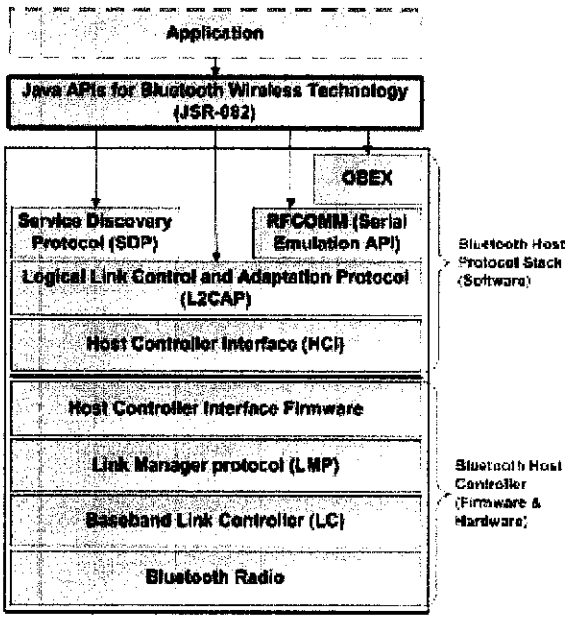

Figure 2: Bluetooth Stack

There are a few layers of the Bluetooth stack. Those layers are:

- *Radio*

  The Bluetooth radio layer is the lowest defined tier of the Bluetooth specification. It classifies the requirements of the Bluetooth transceiver device operating in the 2.4-GHz ISM band. It defines transmitter and receiver characteristics, including the ability of the receiver to measure its Received Signal Strength Indicator.

- *Baseband Link Controller (LC)*

  The Baseband tier is the physical layer of the stack. The protocol is implemented as a link controller, and together with the link layer it manages the physical radio frequency link between Bluetooth devices and enables connections. The two kinds of physical links are synchronous connection oriented (SCO) and asynchronous connectionless (ACL) are managed by the Baseband which involves handling packets and the paging and enquiring techniques of Bluetooth discovery.

- *Link Manager Protocol (LMP)*

  The Link Manager Protocol (LMP) carries out link setup and link configuration between Bluetooth devices, managing and agreeing the baseband packet sizes. Link managers communicate via the LMP using a number of PDU (Protocol Data Units), which are sent between devices to facilitate link management. It also responsible for managing security issues, such as authentication and encryption by generating, exchanging, and checking link and encryption keys [7].

- *Host Controller Interface (HCI)*

  The Host Controller Interface (HCI) provides a command interface to the radio,baseband controller and link manager, providing a single interface for accessing the baseband resources, the hardware status and control registers

- *Logical Link Control and Adaptation Protocol (L2CAP)*

  It is located in the data link layer and provides both connection-oriented and connectionless data services to upper layer protocols. It is responsible for multiplexing the various connections of the upper layer protocols.

This protocol allows higher level protocols to send and receive data packets of up to 64 kb.

- *RFCOMM*

  One of the most frequently used communication techniques in communication devices makes use of serial ports. This protocol is an emulation of RS232 serial ports over L2CAP. It facilitates a transport service for higher level services using a serial interface and is capable of supporting up to 60 simultaneous links, although most devices, especially mobile phones, have limited capabilities regarding the maximum number of connections. RFCOMM provides a communication mechanism for two Bluetooth enabled endpoints, making it feasible for this project.

- *Service Discovery Protocol (SDP)*

  This protocol provides a process for applications to query available services and attributes of services on other devices. The discovery of services is distinct from the discovery of devices in Bluetooth, and is a completely separate protocol. It is also distinct from the more traditional notion of service discovery in LAN networks as the set of services available are dynamic and change frequently when devices are active in the PAN.

- *Object Exchange Protocol*

  The Object Exchange protocol is a relatively new facility built over RFCOMM. It is a protocol for simple file transfers between mobile devices, often used for transferring objects such as electronic business cards. It was originally implemented over IrDA, but is now common on Bluetooth devices.

2.1.5. Technicalities of Bluetooth technology

Bluetooth wireless technology is an open specification for a low cost, low power, short range radio technology for ad hoc wireless communication of voice or data. Its estimation over the air communication range using radio waves is 10 meters. Due to the short range, the radios are low power and are suited to small, compacted devices with reduced battery power. Bluetooth networks are ad-hoc by nature, and are known as personal area networks (PAN).

Technicalities of the Bluetooth Technology include:

- *FHSS (Frequency Hopping Spread Spectrum)*

  The Bluetooth radio transmission uses a packet switching protocol FHSS. The hop frequency is 1600 hops per second. The frequency spectrum is divided into 79 hops of 1 MHz bandwidth each, so devices occupy 79MHz, but at any specific moment, only 1 MHz is occupied. Frequency hopping is used to reduce interference and enhance security. The frequency-hopping scheme is combined with fast ARQ (Automatic Repeat Request), CRC (Cyclic Redundancy Check) and FEC (Forward Error Correction). A binary radio frequency modulation and simple link layer protocols reduce the complexity and the costs of the radio chip. Bluetooth provides a nominal data rate of 1 Mbit/s [8].

- *ISM Band*

  A Bluetooth radio operates in the 2.4GHz license-free, globally available industrial, scientific and medical (ISM) band. This band is used for various other ISM devices e.g. WLAN, microwaves, but Bluetooth is

designed to withstand interference and remain almost unaffected when in contact with other devices in the same band.

2.2. PULL-BASED TECHONOLOGY

2.2.1. Definition of Pull-based technology

Pull-based approach enables the users to request for information from the server. It provides information to users based on their willingness and request. For example, one is using pull technology when he or she surf the World Wide Web, in order to seek out and download information to their computer.

2.2.2. Pull vs. push: the newspaper metaphor

In software engineering, the pull model and the push model designate two well-known approaches for exchanging data between two distant entities. The newspaper metaphor is a simple illustration of these models. For example, if a person wants to read your favorite newspaper everyday, he or she can either go and buy it every morning, or subscribe to it once and then receive it automatically at home. The former is an example of pull-based technology, and the latter of push-based technology.

2.2.2. Comparison of Pull-based and Push-based

The pull model is based on the request or response paradigm (called data polling, or simply polling, in the SNMP management framework) where the client sends a request to the server, then the server answers, either synchronously or asynchronously. This is functionally equivalent to the client "pulling" the data off the server. In this approach, the data transfer is always initiated by the client, i.e. the manager. Whereas, the push model, conversely, is based on publish, subscribe or distribute paradigm. As an example, in this model, agents first advertise what MIBs they support, and what SNMP notifications they can generate. The administrator then subscribes the manager (the NMS) to the data he or she is interested in, specifies how often the manager should receive this data, and disconnects. Later on, each agent individually takes the initiative to "push" data to the manager, either on a regular basis via a scheduler (e.g., for network monitoring) or asynchronously (e.g., to send SNMP notifications) [9] .The difference between push and pull technologies centers upon the side which is initiating the transaction. The transaction is either initiated on the user or client side (pull) or on the provider or server side (push).

2.2.3. Disadvantages of push-based technology

There are many disadvantages that related to the use of push-based technology. Spamming becomes an issue in a push-based system because of its nature of sending the information to the users without their request. One of the merits of pull-based system is that issue of spam is out of question since all the information received by the end users is welcome. Another issue is time limit is implemented in a push-based system. The issue with this implementation is the users must reply the permission

message within a specified time to receive the information provided. If they fail to do so then they may not receive the information at all.

Another issue is the high battery consumption when using a push-based system. When a mobile phone using Bluetooth communicates wirelessly, the data is transmitted at very specific frequencies. One person can talk on a mobile phone at a frequency of 2.0001 gigahertz, and someone else nearby can talk at 2.0002 gigahertz, and neither one will pick up the other's conversation. In order to make sure it is both listening for and sending information on exactly the right frequency at all times, the phone must maintain a very accurate and stable clock, which is generated by a special circuit called "phase-locked loop." This circuit consumes a dramatic portion of the battery usage on wireless devices. Thus, to reduce the battery consumption, it is advisable to use Bluetooth service only when needed [10].

2.3. USER-DRIVEN CONCEPT

User-driven is similar to user-centered. User-driven concept here means that for each process in the system will require user to initiate the initial process. For example in this project, user will initiate the first move in order to obtain information regarding the UTP Gallery. With the move made by the user and sending the signal to the server, this means that user initiates the process thus making it as a user-driven system.

User-driven concept simply means giving flexibility to end users to select the preferred information from a list provided from the server. It is a way to provide a control of the system to users. The recipients will be provided with a list of

information, and they may select the preferred one for them to view. The objective of this project is to implement a Bluetooth User-driven Cooperative Gallery using pull-based technology.

2.4. CONTEXT-AWARENESS

A context-aware system is one that can determine and react to the current physical and computing context of mobile users and devices, by altering the information presented to users or commands issued by and on behalf of those users. It focuses on mobile-computing where mobile people are also considered. Context-aware systems become accustomed according to location of use, neighbouring entities, accessible devices and changes of these attributes stated above. There are four categories of context-aware applications. Those four are represented as two orthogonal axes with two points each: fetching information vs. giving commands, and manual vs. automatic actions [11]. The four categories are proximate selection, automatic contextual reconfiguration, contextual information and commands and context-triggered actions.

2.4.1. Proximate selection

Proximate selection is the manual fetching of context-aware information about input or output devices, non-physical objects and services, or locations. User interface issues of how to emphasize information based on degree of proximity exist [11].

Proximate selection is a user interface technique where the located-objects that are nearby are emphasized or otherwise made easier to choose [12]. It involves entering two variables which are the "locus" and the "selection."

There are at least three kinds of located-objects that are interesting to select using proximate selection technique. The first is computer input and output devices that require co-location for use which includes printers, displays, speakers, facsimiles and video cameras. The second kind is the set of objects that you are already interacting with, and which need to be addressed by a software process. The third kind is the set of places one wants to find out about: restaurants, night clubs, gas stations, and stores, or more generically, exits and entrances.

Proximate selection interfaces must take into account the bandwidth requirements. Presenting information that changes, either due to the user moving or the contents of the dialog changing for instance like people moving will cause update to the network traffic. One approach is to view location information with more or less precision based on the situation [12]. User interfaces for proximate selection pose some challenges. Map imagery may provide a good user interface metaphor. Since proximate selection may occur on a mobile host, the user interface techniques developed must take into account device capabilities such as screen real-estate and communication bandwidth.

2.4.2. Automatic contextual reconfiguration

Automatic selection of information or altering components is based on context [11]. For example, a white-board application may bring up new or existing pages when a person enters a new room, or an OS may decide to spin down a disk when AC power is disconnected. Reconfiguration is the process of adding new components, removing

existing components or altering the connections between components. Typical components and connections are servers and their communication channels to clients. In the case of context-aware systems, the appealing aspect is how context of use might bring about different system configurations and what these adaptations are.

2.4.3. Contextual information and commands

Contextual information and commands queries on information or commands themselves may be altered by the context of the user. For instance, a migrate button could bring a user's X display to a whiteboard in that user's current room or a whiteboard may display information relevant to a user because it detected the proximity of that user. Its aim is to exploit the facts that people can often be predicted by their situation [13]. Queries on contextual information can produce different results according to the context in which they are issued. Similarly, context can parameterize "contextual commands".

Aside from displaying data files parameterized by the viewer's location, the location browser also runs programs. Contextual commands of this kind may take two forms. First, the appearance of the command itself might change depending on context of use. Second, a command may appear the same but produce parameterized results.
Contextual information and commands pose many challenges. Businesses and government agencies would find it profitable to export contextual information and commands in order to inexpensively engage large numbers of potential customers. However, people interacting with third parties need to ensure security and authenticity of the information. Also, personal customizations must somehow coordinate with those provided by third parties.

2.4.4. Context-triggered actions

These are IF-THEN style rules triggered by contextual information [11]. For example, a watchdog application will execute arbitrary UNIX shell commands based on rules such as "if coffee is made then play the rooster.au sound". A contextual reminder program raises reminders when a contextual rule is satisfied, like "the next time I see marvin" or "the next time I'm in the library".

Context-triggered actions are simple IF-THEN rules used to specify how context-aware systems should adapt. Information about context-of-use in a condition clause triggers consequent commands; something like living in a rule-based expert system. The category of context-aware software is similar to contextual information and commands, except that context-triggered action commands are invoked automatically according to previously specified rules.

The problems of building context-triggered actions include how to balance the requirement of timely execution with the need for predictable behavior, when systems transition between a numbers of states it may not be desirable to have all the intermediary actions triggered, but delaying too long will make the system seem sluggish. Two problems to be addressed are the expressiveness of the predicate language, and the accuracy and timeliness of the underlying context information.

CHAPTER 3

METHODOLOGY

3.1. PROCEDURE IDENTIFICATION

Since "Bluetooth User-driven Cooperative Gallery system" project may require change of requirements from time to time during the development due to constraints encountered, there is a need to support process iteration where parts of the processes are repeated as system requirements evolve. For the development of this project, Iterative Development will be used. Developing systems through incremental release requires first providing essential operating functions, then providing system users with improved and more capable versions of a system at regular intervals [14]. In this section, discussion will be about the planning, analysis, design and implementation phase.

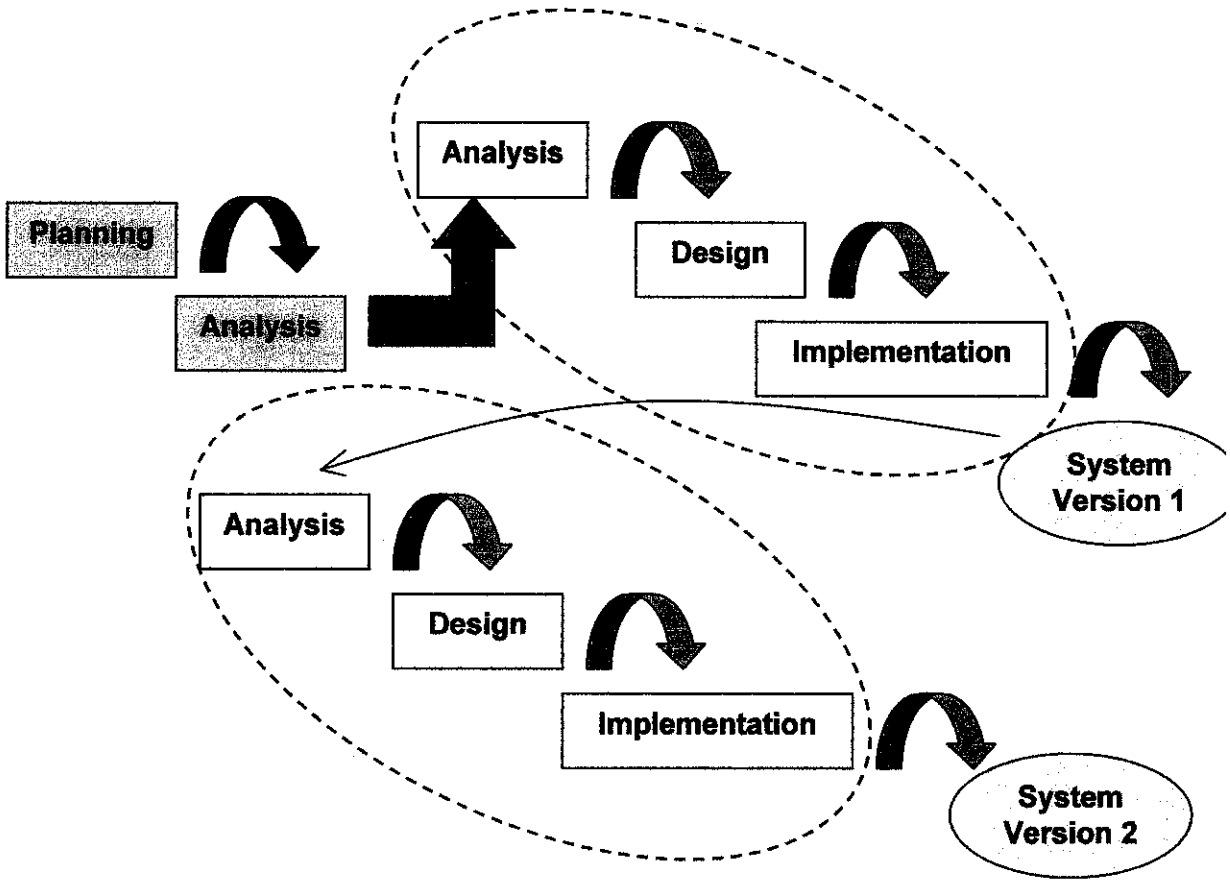

Figure 3: Iterative Development

Figure above shows the Iterative Development methodology. The iterative methodology breaks the overall system into a series of versions that are developed sequentially. The analysis phase identifies the overall concept; information gathering and information analysis then categorizes the requirement into a series of versions. The most important and fundamental requirements are bundled into the first version of the system. The analysis phase then leads into design and implementation, but only with the set of requirements identified for version 1.

The fundamental idea behind iterative enhancement is to develop a software system incrementally, allowing developer to take advantage of what was being learned during the development earlier, incremental, deliverable versions of the system. Key steps in the process were to start with a simple implementation of a subset of the software requirements and iteratively enhance the evolving sequence of versions until the full system is implemented. At each iteration phase, design modifications are made and new functional capabilities are added.

3.1.1. Planning phase

Planning phase includes planning the development of the project such as its scope, feasibility and time frame. A project schedule was planned with the supervisor as a guideline to project commission. This is to ensure the project commission such as weekly report, progress report and final draft report meets deadlines. In addition, planning also includes describing the major area of research, determining the scope of studies, problem statement and the proposed solution towards the problem. Literature review, journals and thesis have been reviewed for further supporting of the research. This phase was done during the first semester of Final Year Project (Part A).

3.1.2. Analysis phase

The activities that has been done for the analysis phase is information gathering and information analysis. The analysis phase was also being done during the first semester of Final Year Project (Part A).

3.1.2.1. Information gathering

For information gathering, there are three phases involved which are requirement elicitation and analysis, requirement specification and requirement validation. Requirement elicitation and analysis is the process of deriving the system requirements through observation of existing research projects, task analysis and many more. Requirement specification is the activity of translating the information gathered during the analysis into a set of requirements document. The last phase, which is requirement validation, is the activity to check the requirements for realism, consistency and completeness.

In gathering the information, technique applied is by using Questionnaire. A questionnaire is a type of statistical survey handed out in paper form usually to a specific demographic to gather information in order to provider better service or goods. The survey findings can then help to maintain business decisions towards improvement of services.

In developing questionnaires, there are several important steps that need to be considered. They include the following:

- *Establishing the goal*

  The goals of the project determine whom you will survey and what you will ask them. If the goals are unclear, the results will probably be unclear. For this project, the goal of the questionnaire is to examine and evaluate the acceptance of the implementation of a new technology called "Bluetooth User-driven Cooperative Gallery using pull-based technology" in UTP Gallery area.

- *Determining the sample*

  Determine the target population from which the sample will be taken. This could be the patient, administrators, employees, etc. In the case of this project, the target audience is the visitors of the UTP Gallery as the sample.

- *Choosing surveying methodology*

  Traditionally, surveys are done by passing around the questionnaires to the target audience and this lead to the loss of a lot of papers because some of them have the probability of getting lost in the midst of the survey. With the advent of computers and the Internet, there are two rapidly growing methods for surveying and they are E-mail and Web-based surveys. Each of these methods has advantages and disadvantages. For the research of this project, method chosen of the surveying is through Web-based surveys where questions were created online and then the target audiences are notified, the link of the survey are emailed to all the samples' email addresses. The results of the responses can be accesses online.

The advantages of using Web-based survey are:

- Extremely fast because a questionnaire posted online can gather a lot of responses within a short period of time, so this saves more time.
- Low cost of preparing the questionnaire in terms of papers and ink for printing.

However, there are also drawbacks applying Web-based survey:

- No control over who responded to the surveys
- People may respond multiple times to bias the results

However, a correctly designed survey is an excellent tool for collecting and evaluating data and will definitely produce positive responds and results that will benefits the implementation of this system to UTP Gallery.

- *Creating the questionnaire*

  When creating questions, it is essential to consider the wordings of the questions and also the format on how the responses will be should be considered. There are three main response formats multiple choice, numeric open-end and text open-end.

- *Analyzing data*

  In all instances data can either be entered direct or imported from other packages such as Excel, provided the instructions for the receiving package are adhered to.

Upon gathering information on evaluating the implementation of Bluetooth User-driven Cooperative Gallery using pull-based technology, questionnaires have been developed in order to observe the implementation of the technology to the UTP Gallery area. The target audience for this survey would be the students of University Technology Petronas itself. The number of target audience is allocated to 20 students. The purpose of the survey being made is to determine the acceptance and effects of implementation Bluetooth User-driven Cooperative Gallery to the UTP Gallery area. The details are elucidated below:

Purpose	: The purpose of this survey is to examine and evaluate the acceptance of the implementation of "Bluetooth User-driven Cooperative Gallery using pull-based technology" in UTP Gallery area.
Target audience	: Students of Universiti Teknologi Petronas who are enrolled in Information Communication Technology (ICT) and Business Information System (BIS)
Number of target audience	: 20 students
Number of questions	: 10

3.1.2.1. Information analysis

After all of the information are gathered through the questionnaires, the data are then collected to be analyzed. The steps taken were:

- *Monitor response rate*

  From the date the survey is administered to the due date, the response rate were monitored regularly monitor the response rate regularly. This will be important if there are plans for follow-up.

- *Review and edit survey returns*

  It is also important to review and edit survey returns before compiling the data. Respondents do not always mark their intended responses unambiguously. To ensure the most accurate data possible, review each return, clarifying ambiguous responses and correcting those that are inaccurate.

- *Compiling the response data*

  There is a wide variety of spreadsheet, database, and statistical software available for the purpose of compiling the data. It will be important to have an experienced data entry operator to ensure that this job is done as accurately as possible.

- *Analyze response*

  One of the first substantive sets of questions in analyzing survey results revolves around who responded and how representative they are of the larger population under study.

- *Generate and display findings*

  Once data provided by respondents has been entered and processed, findings can be generated and displayed in ways that facilitate interpretation. To communicate overall results of a survey, a frequently chosen display method is to add summary data about responses to the survey form itself. Charts and diagrams illustrating findings may also be helpful for analytical as well as presentation purposes.

- *Draw conclusions*

  Once survey findings are generated and displayed, conclusions can be drawn. The conclusions about all the survey findings involve interpreting what they mean for the issues in question and making practical recommendations about how to address those issues.

3.1.3. Design phase

At the design phase, layout of the project and the architecture of the system will be defined. Design phase of the project was done during the second semester of completing the Final Year Project (Part B). The proposed system design is in a master-slave configuration. A master contains the available information and it will send them to the slave upon request. More than one slave can connect or interact with the master at the same time for requesting the information about the UTP Gallery. The approach that is used for this system is pull-based. This means that the visitors of the UTP Gallery will have the ability to request for the information according to their preferences.

3.1.4. Implementation phase

Based on the design phase, the proposed system architecture will be implemented. The client (slave) will connect to the server (master) in order to request for the information. Pull-based concept is used whereby the visitors will retrieve the information from the server. From this, the system flow of the proposed system will be defined in order to identify the main components and operation sequence of the system. This section will be discussed further in Chapter 4: Results and Discussions.

3.2. TOOLS

3.2.1. Software

- Java Wireless Toolkit by Sun Microsystems with Java API Bluetooth Wireless Technology (JAWBT)

3.2.2. Hardware

- Mobile phone with Bluetooth compatibility
- Laptop with Bluetooth compatibility

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1. ANALYSIS PHASE

For the responses gathered from the questionnaire, the data collected are then interpreted into charts and graphs for better understanding. There are 20 students who are required to answer the questionnaire and all of the 20 students responded. Below is the elucidation of each of the 10 questions provided in the questionnaire.

4.1.1. Results

Question 1 : Gender

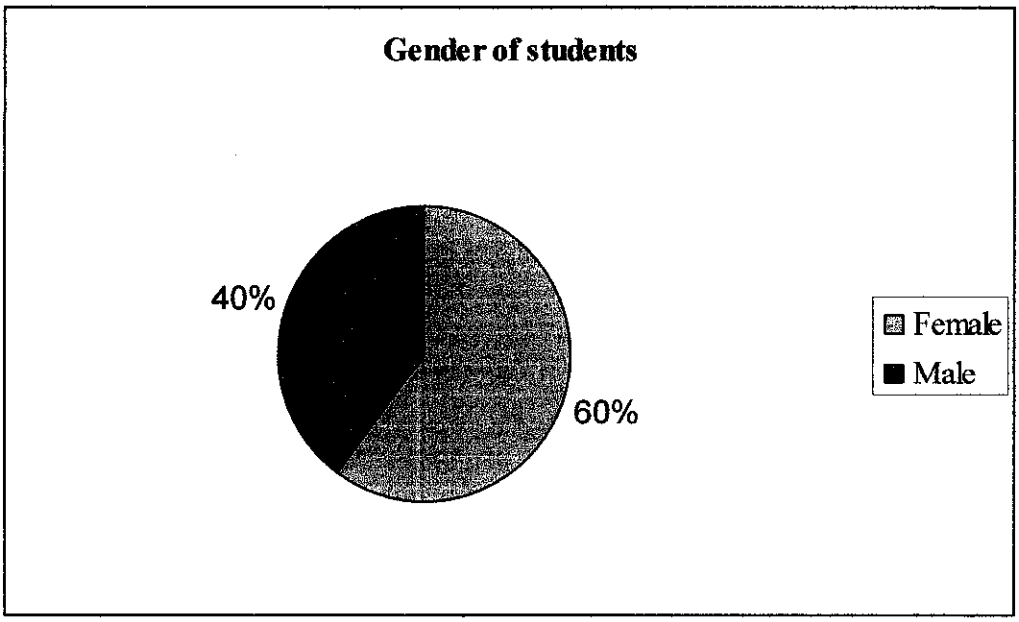

Figure 4: Gender of students

Most of the students who answered the questionnaires are female students

Question 2 : Which programme are you enrolled in?

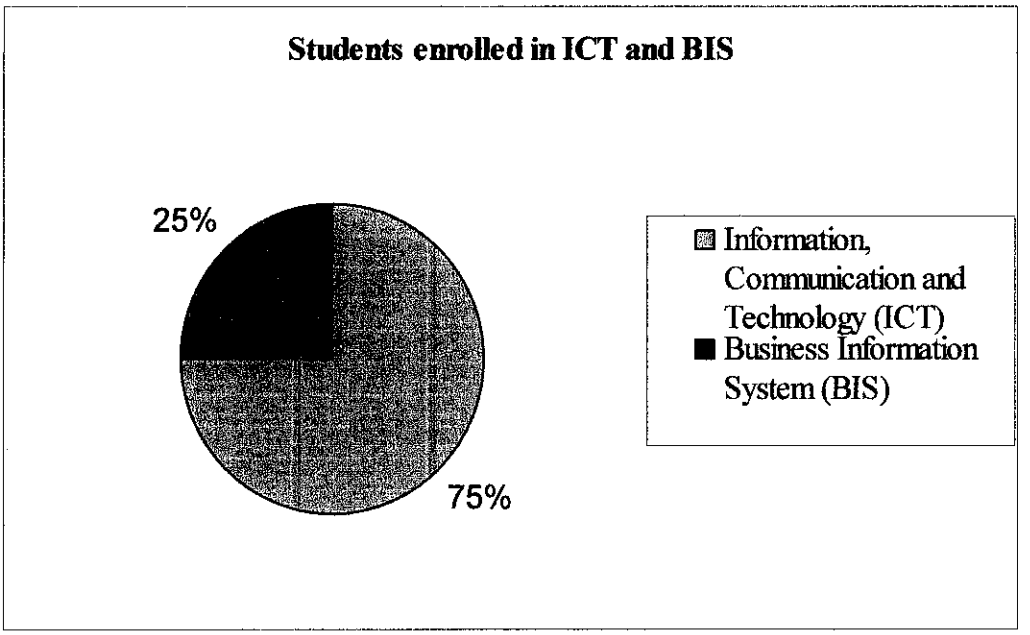

Figure 5: Percentage of Students Enrolled in ICT and BIS

Based on the pie chart above, 15 out of 20 students who answered the questions are students enlisted in Information Communication Technology (ICT) programme. This is because ICT students are more familiar with the technical knowledge of the system implemented.

Question 3 : Do you own any Bluetooth enabled phone?

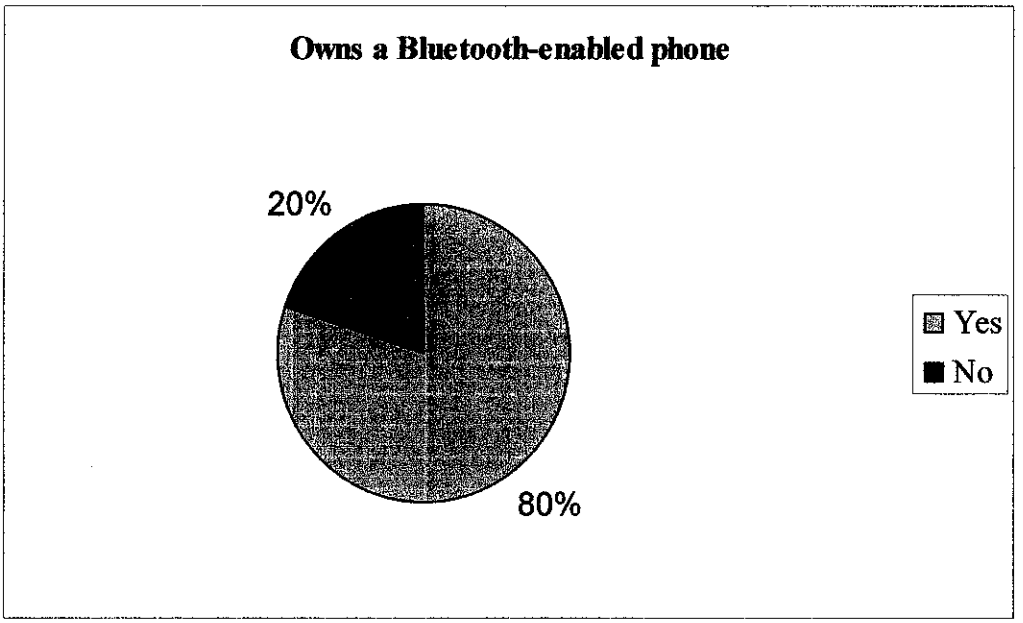

Figure 6: Percentage of students who owns a Bluetooth-enabled phone

According to the pie chart, 16 out of 20 students own a Bluetooth-enabled phone. This shows that most of the students are updated with the latest technology being introduced. With this, they will have ample knowledge and much easier for them to use the Bluetooth User-Driven Cooperative Gallery system.

Question 4 : How often do you use Bluetooth?

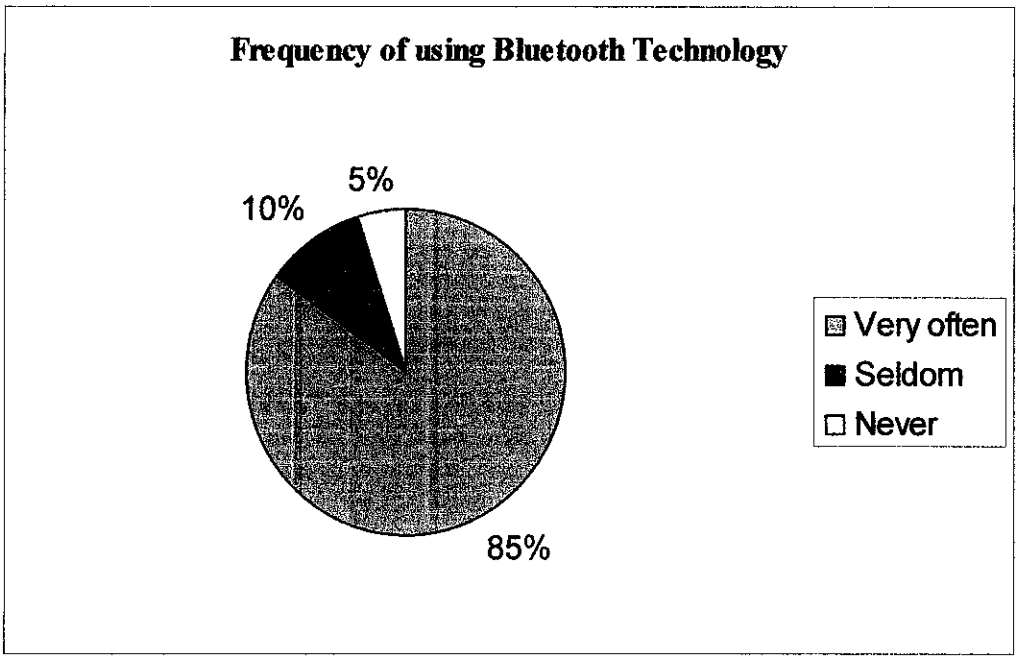

Figure 7: Percentage of students with their frequency of using the Bluetooth Technology

Based on the pie chart above, 17 students claimed that they often use the Bluetooth technology in their mobile phone. This is considered a high number of percentage as it will definitely effect their interest in using the new system. This shows that Bluetooth has many advantages such as its easiness, user-friendly and most importantly is that the cost is free compared to using MMS or GPRS.

Question 5 : How do you rate the Bluetooth technology?

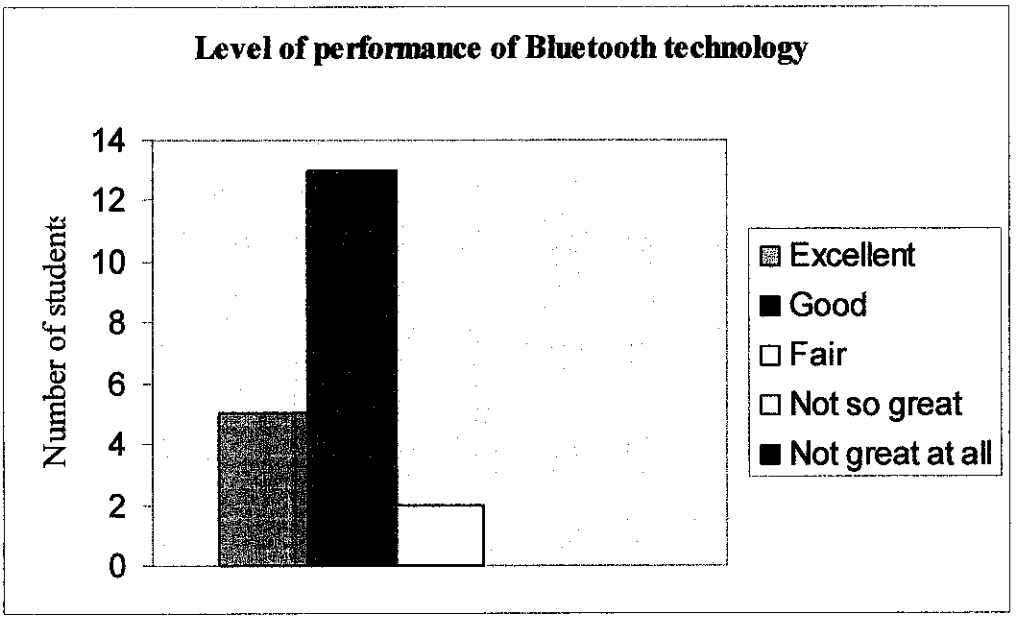

Figure 8: Level of performance of Bluetooth technology

According to the bar chart above, 13 students rate excellent for the level of performance of the Bluetooth technology. While only 2 students claimed that the technology is not great at all. This shows that the performance of Bluetooth gives high impact on the usage of the technology since users nowadays opt for technology that gives more satisfaction to them and also one that provides better performance.

Question 6 : Have you been to the University Technology Petronas Gallery?

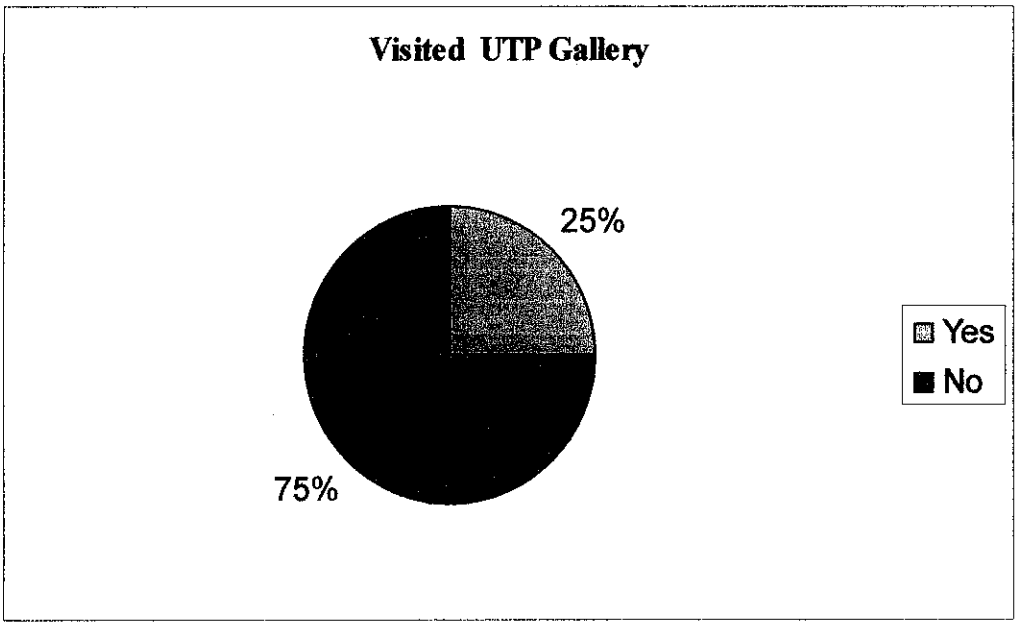

Figure 9: Percentage of students that visited the UTP Gallery

Based on the pie chart above, only 5 students responded that they have been to the University Technology Petronas Gallery. This shows a very small amount of number of visitors. With this respond, a new approach needs to be implemented to the gallery in order to promote more visitors to visit the gallery.

Question 7 : How do you find the presentation of the information there?

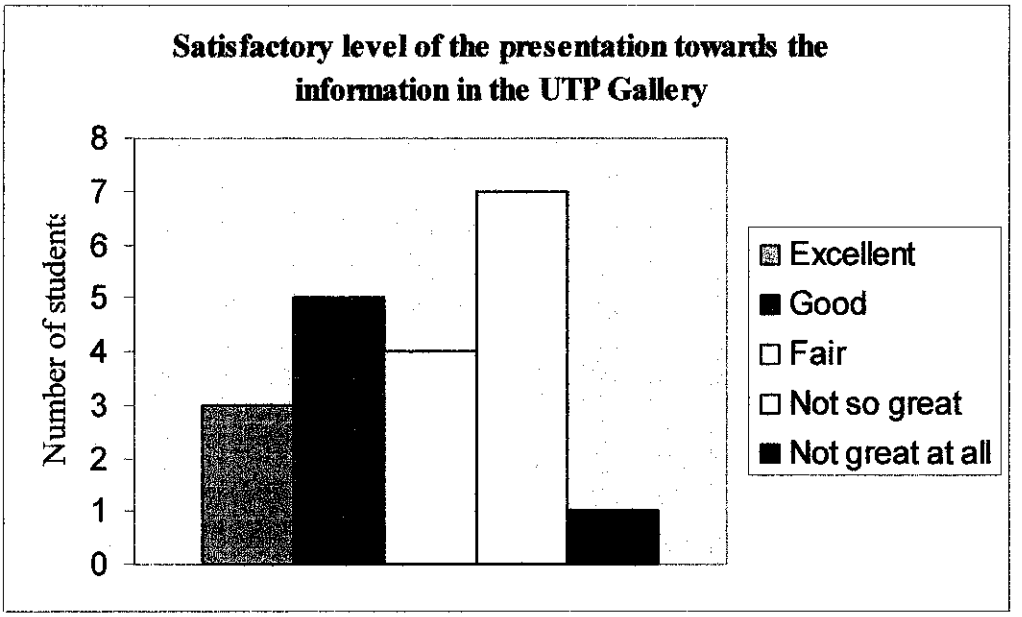

Figure 10: Satisfactory level of the presentation towards the information in the UTP Gallery

From the bar chart above, the highest number of students (7 students) responded that the information was "not so great" while one 3 students responded that the information was "excellent". This may be the reason that leads to a small number of visitors visited the UTP Gallery. Thus, the information presented in the gallery need to be more user-friendly to be viewed by the visitors in order to attract more visitors.

Question 8 : Do you think the University Technology Petronas Gallery need to propose a new approach of presenting the current information in the gallery?

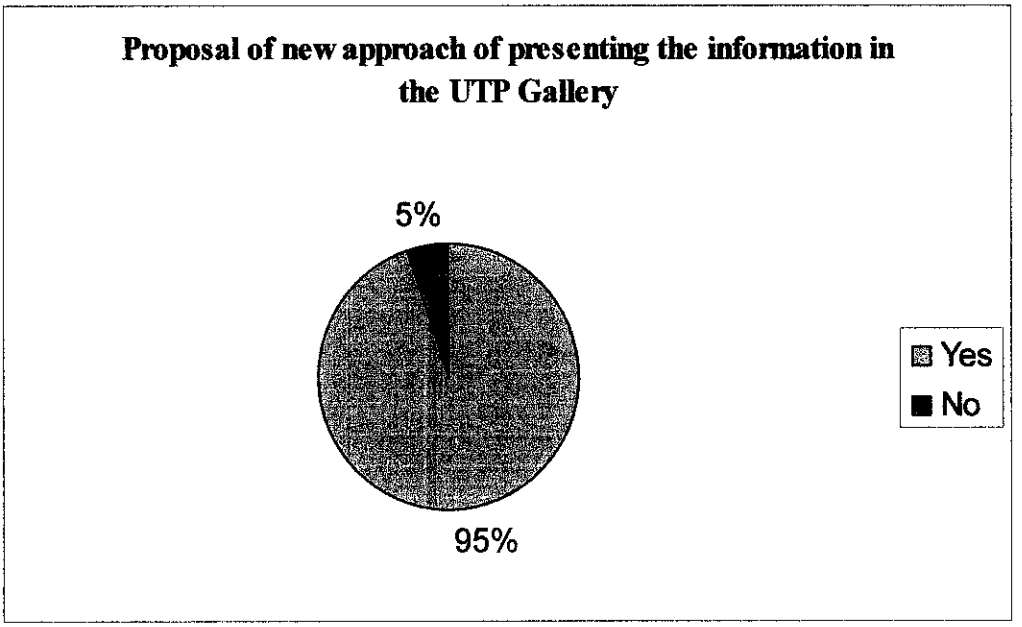

Figure 11: Percentage of the proposal of the new approach of presenting the information in the UTP Gallery is agreed by the students

From the responds from the questionnaires, 1 out of 20 students do not want a new approach being implemented to the UTP Gallery while 19 others are eager for a new approach of venturing to the Gallery. Since the UTP Gallery is using the conventional way of presenting its exhibits and its information, this question arises to question the students whether they would want a new approach in venturing inside the gallery. This shows a positive respond towards the new system to be implemented.

Question 9 : Are you interested with a new technology that enables you to obtain information regarding the University Technology Petronas Gallery using your Bluetooth enabled mobile phone?

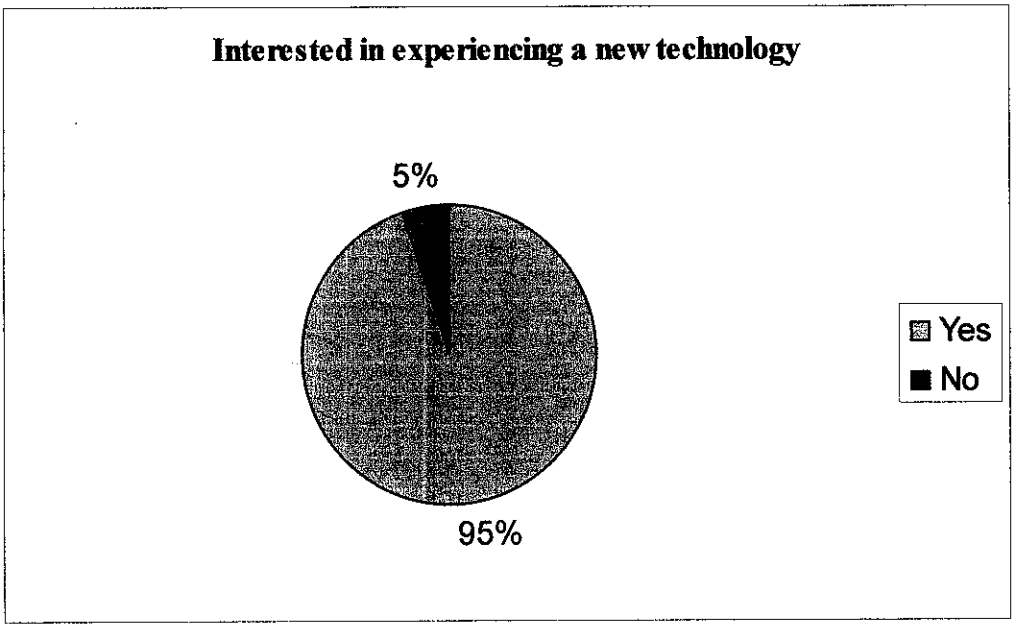

Figure 12: Percentage of students interested in experiencing a new technology

Based on the pie chart in Figure 13, 19 out of the 20 students who answered the questionnaire is interested in experiencing a new technology to venture around the UTP Gallery using their Bluetooth enabled mobile phones. However, only 1 of them is not interested. One or the reason was due to the fact that they do not own a Bluetooth enabled mobile phone.

Question 10 : Will the implementation of the new system helps to promote more visitors to visit the University Technology Petronas Gallery?

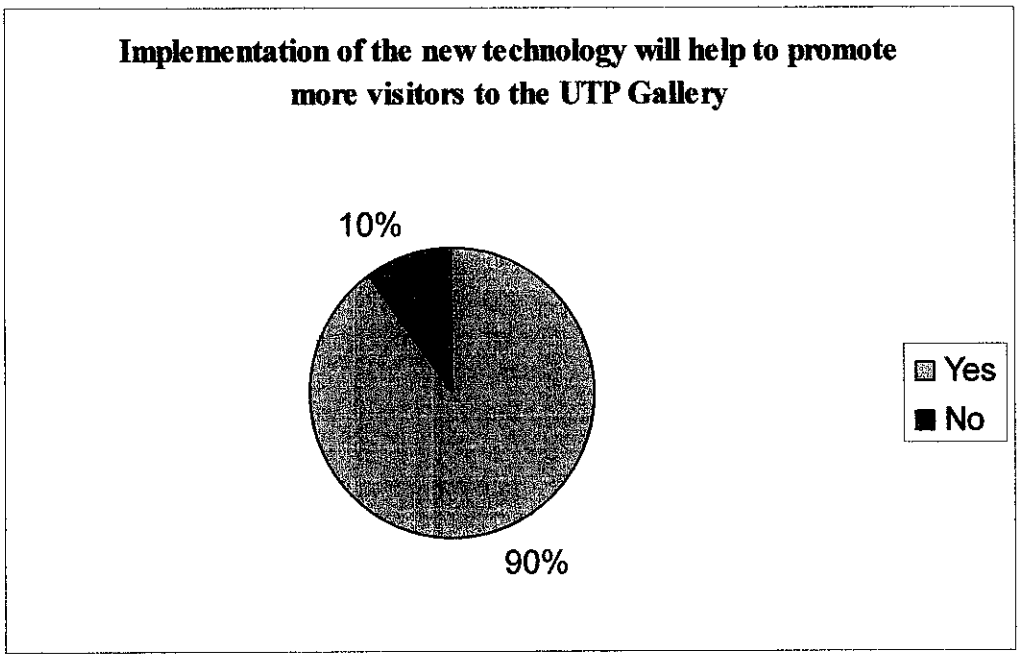

Figure 13: Percentage of students who wanted new technology implementation in order to promote visitors to the UTP Gallery

As for the reason of promoting UTP Gallery to be visited by many more students, 18 students agree that with the new technological advancement in mobility around the Gallery could certainly increase the amount of visitors to the Gallery. While the other 2 students disagree that this new advancement could affect the amount of visitors to the UTP Gallery.

4.1.2. Discussion

As a conclusion, what can be derived from the information gathering technique is that most of the students are familiar with Bluetooth since it is a technology that has been widely used nowadays. Other than that, positive responses from the students on the new way communicating with each other will make the project become successful. This would give a better chance for the UTP Gallery to improve their services and definitely will attract more visitors to visit the gallery.

4.2. DESIGN PHASE

The proposed system design is in a master-slave configuration. A master contains the available information and it will send them to the slave upon request. The approach that is used for this system is pull-based. This means that the visitors of the UTP Gallery will have the ability to request for the information according to their preferences.

4.2.1. Results

At the design phase, layout of the project and the architecture of the system were defined. The system architecture is shown in Figure 15.

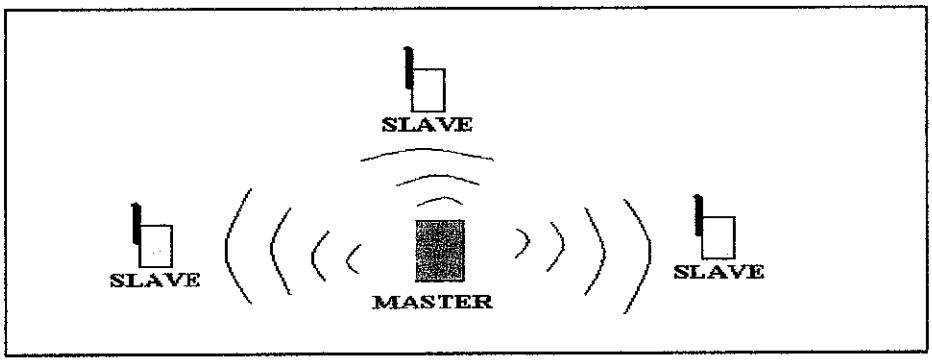

Figure 14: System architecture

4.2.2. Discussion

The proposed system architecture is implemented in a master-slave configuration. A master contains the available information and it sends them to the slave (user's mobile phone) when requested. Initially a laptop has been used as a master, but for making it easier to mobile from one place to another to perform testing, the authors set up its configuration in another mobile phone, but it still serves the same purpose as a master. More than one slave may connect or interact with the master at the same time for requesting the information regarding the UTP Gallery.

4.3. IMPLEMENTATION PHASE

4.3.1. Results

The implementation phase discussed about the system description of the Bluetooth User-driven Cooperative Gallery system. The main components and operation sequence of the proposed system are illustrated in Figure 16:

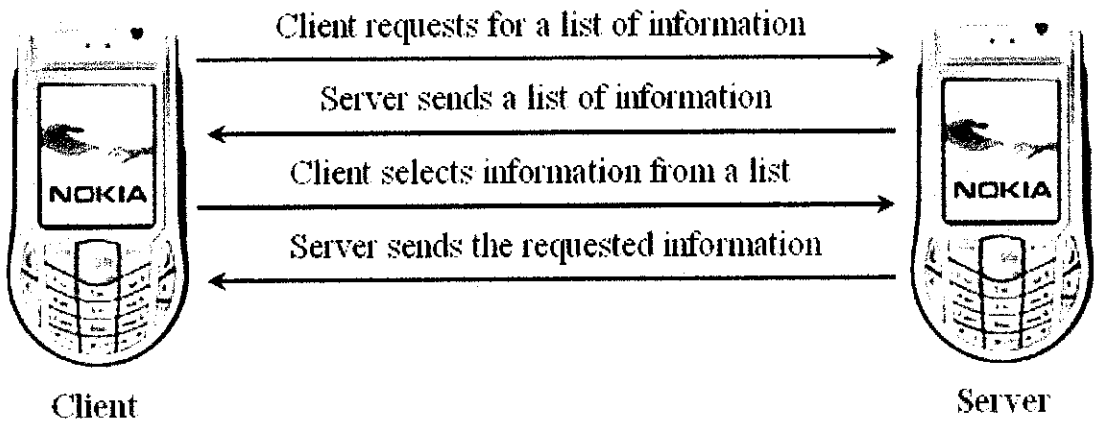

Figure 15: System flow

4.3.2. Discussion

The approach implemented in this system is pull-based. Pull-based means the user has the ability to request for the intended information. Both the server and client can be any mobile phones, as long as it has Bluetooth service and can install java application. To use this system, user need to download the java application into the mobile phone, install it and it is ready to use. In this study, the application is stored inside a laptop. It is transferred to the mobile phones using infrared or Bluetooth connection (whichever applicable.) Below is the system flow for the proposed project:

1. Client scans for available server within range.
2. Once found, client can start requesting list of available information regarding the UTP Gallery from the server.
3. Server will send the list to the requesting client.
4. Client can select type of information the desire from the list that they found interesting to view.
5. Server sends client the requested desired information.

4.3.3. Snapshots of the system

Below shows the snapshots of this project and how the system flows.

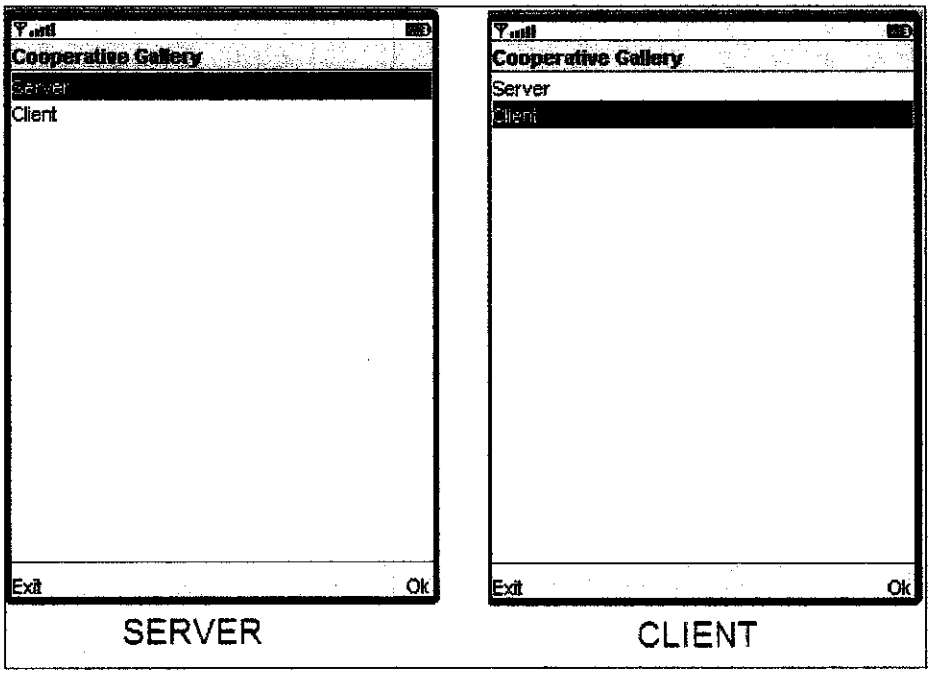

Figure 16: Start-up screen of the application

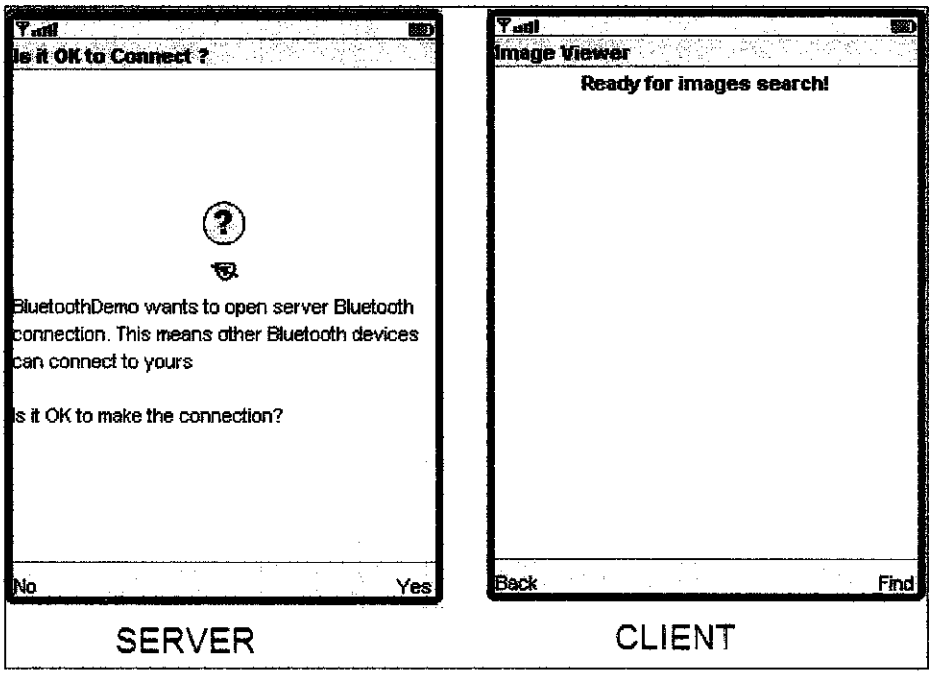

Figure 17: Connection to Bluetooth by server

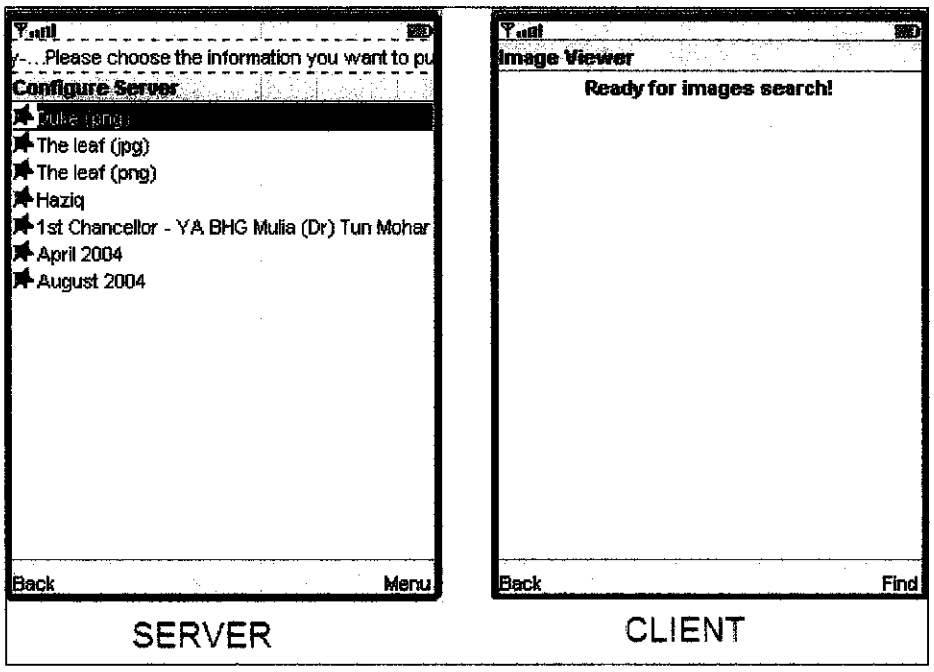

Figure 18: List of information at server-side

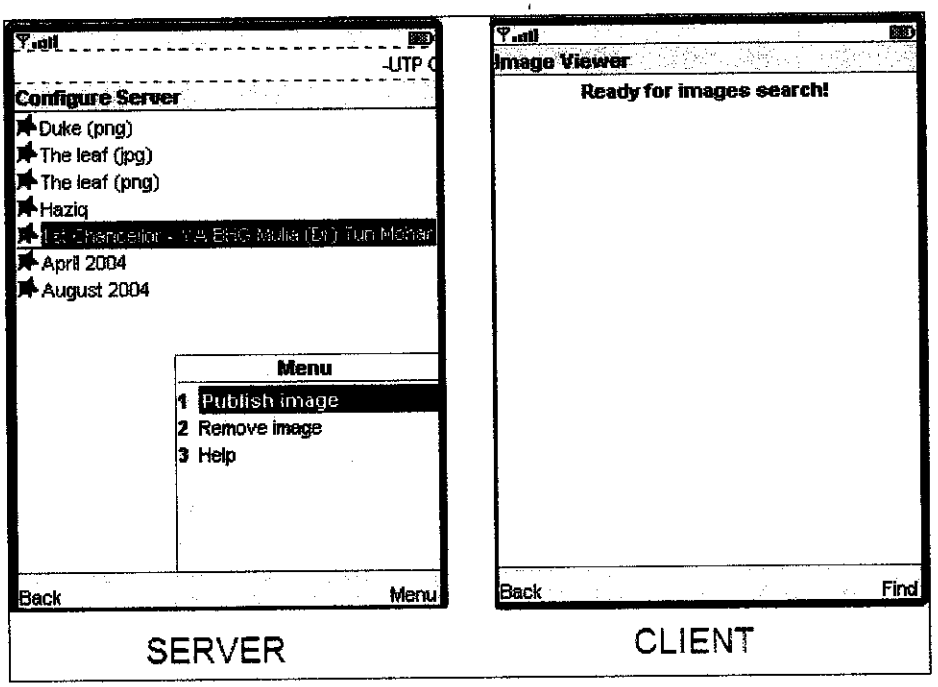

Figure 19: Select information to publish to client

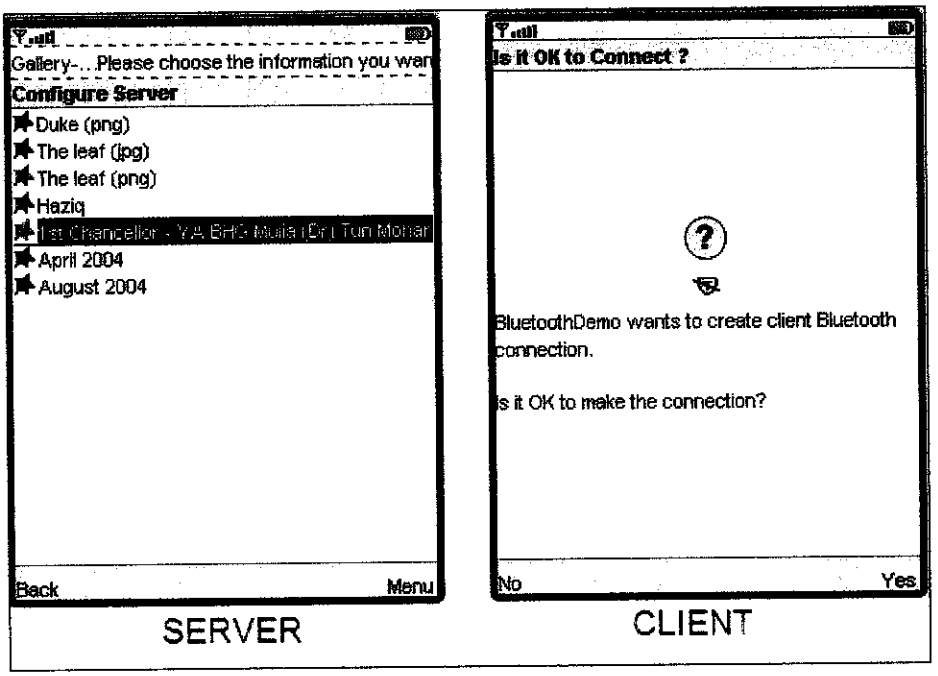

Figure 20: Connection to Bluetooth by client

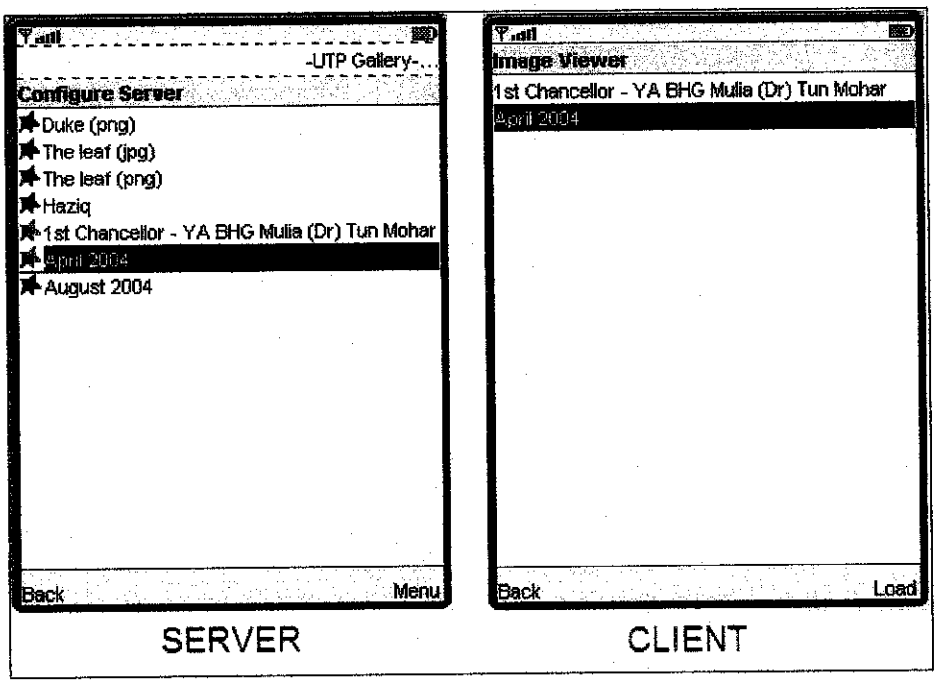

Figure 21: List of information at client-side

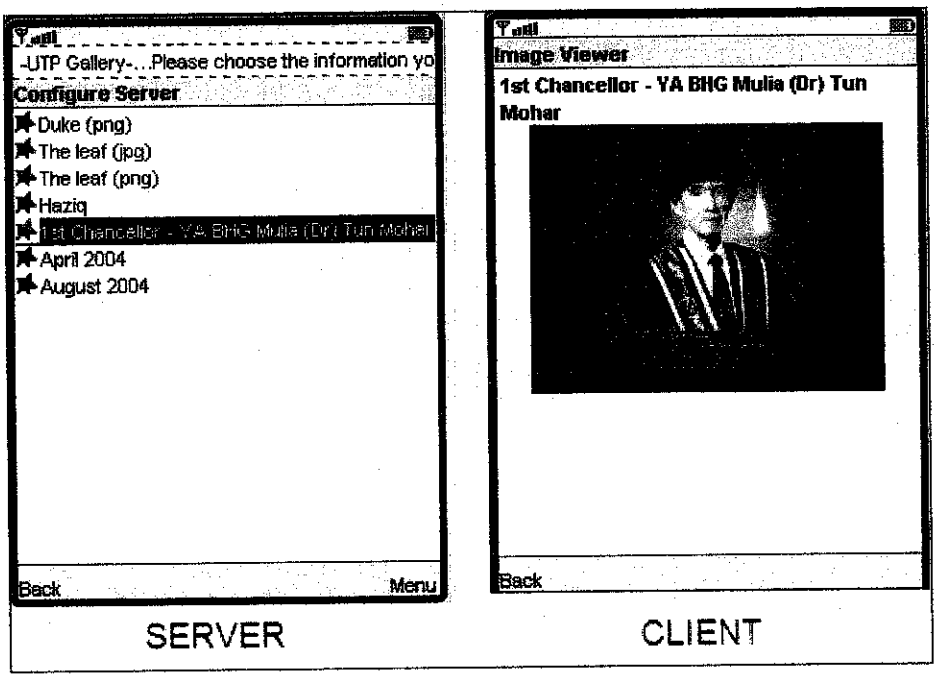

Figure 22: Selected information displayed at client-side

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

This study introduced a system for providing mobile information to mobile phones using Bluetooth pull-based technology for the UTP Gallery. It presented a thorough quantitative and qualitative evaluation of the system. This section will conclude the study and provide some recommendation for future work.

5.1. CONCLUSION

Advances in wireless technology are becoming more and more popular throughout the world. In a world of increasing mobility, there is a growing need for people to have timely access to information regardless of the location of the individuals or the information. Right now, people are demanding technologies that are efficient and easy for them to use. Mobile phones have become the communication medium of choice. Mobile phone communicative capabilities have been broadened significantly by the inclusion of technologies.

The first objective of this project is to implement Bluetooth as a suitable wireless transmission technology which is appropriate to be used for the Universiti Teknologi PETRONAS Gallery. To this purpose, the system considers the Universiti Technology Petronas (UTP) Gallery visits where the users will be able to freely move about in the gallery area without a predefined path. In particular, an application was designed and developed for the UTP Gallery. The goal is to provide relevant information to the visitors of UTP Gallery regarding the exhibits displayed while being mobile around the gallery via their mobile phone using Bluetooth technology.

The second objective is to apply pull-based concept and a user-driven system in the implementation of this project. Based on the description of the system development, it is clear that the system implemented is using user-driven and pull-based approach whereby the user retrieves the information from the master only upon request. With this implementation, the spamming issues that arise in push-based technology were eliminated since the users initiate all the requests for information. Thus, it can be concluded that the project fulfill all its objectives.

5.2. RECOMMENDATION FOR FUTURE WORK

For this system, Bluetooth searching system needs to be more reliable [3]. To achieve this, the Bluetooth sensor needs to be more accurate. This would make the searching of the Bluetooth-enabled devices more reliable. At the same time, more server could be set up to accommodate more user at one go as Bluetooth Piconet only allow maximum of seven user connect at a time. The server could be placed at each section in the gallery area that will publish only information related to the particular area of the gallery.

In addition, instead of only using pull-based approach for the implementation of this project, push-based approach may also be implemented at the same time. This is to balance all the weaknesses and strength related to both approach. From this, a better system can be implemented using both approaches which will definitely gives more impact on the improvement of promoting the UTP Gallery to University Technology PETRONAS community as well as the society.

Due to time limitations and hardware challenges encountered during implementation, some areas of the application were not examined fully. The user context is obtained and stored during execution but it is not used to its full potential. The application could be extended to use a rule based system to make decisions based on the context knowledge available. This would allow more intelligent selections. Filtering of messages could be carried out based on user's context such as age and the availability. Nodes could also be eliminated from certain functions due to some contextual information known about them [15].

The use of authentication and encryption in Bluetooth was not explored and could add safety precautions to avoid unauthorized users. The signing of MIDlets to create trusted applications was not undertaken either. A MIDlet is a Java program for embedded devices, more specifically the J2ME virtual machine. The implementation of these security features could prevent bogus applications or users affecting the handset.

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APPENDIX

Final Year Project using Bluetooth Technology Survey

This survey is to obtain feedback from respondents regarding my Final Year Project which would be the implementation of a system using Bluetooth Technology.

---

ler

Male

Female

---

ch programme are you enrolled in?

Information & Communication Technology (ICT)

Business Information Systems (BIS)

ou own any Bluetooth enabled phone?

Yes

No

often do you use Bluetooth?

Very Often

Seldom

Never

do you rate the Bluetooth technology?

Excellent

Good

Fair

Not so great

Not great at all

: you been to the Universiti Teknologi Petronas's Gallery?

Yes

No

do you find the presentation of information here?

Excellent

Good

Fair

Not so great

Not great at all

ou think the Universiti Teknologi Petronas need to propose a new approach of presenting the current ir
ry?

Yes

No

---

you interested with a new technology that enables you to obtain the information regarding the Universi
's Gallery using your Bluetooth enabled mobile phone?

Yes

No

---

ll the implementation of the new system helps to promote more visitors to visit the Universiti Teknolog

Yes

No

Submit

Click Here to Conduct Your Own Survey