

**Vehicle Parking Space Locator with Surveillance System  
(V-Locator)**

by  
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Final Dissertation submitted in partial fulfillment  
of the requirement for the  
Bachelor of Technology (Hons)  
(Information Communication Technology)

JANUARY 2007

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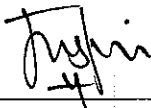
# CERTIFICATION OF APPROVAL

## Vehicle Parking Space Locator with Surveillance System

by  
Nurdyana bt Leham

An Final Dissertation submitted to the  
Information Technology/Information System Department  
Universiti Teknologi PETRONAS  
in partial fulfillment of the requirement for the  
BACHELOR OF TECHNOLOGY (Hons)  
(INFORMATION COMMUNICATION TECHNOLOGY)

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## CERTIFICATION OF ORIGINALITY

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



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NURDYANA BT LEHAM

## ABSTRACT

Vehicle Parking Space Locator with Surveillance System is developed to help drivers to locate available parking space in a parking area using their mobile devices via Bluetooth application. The system will provide information about the location of the parking space as well as the image of the parking area. The objective of the service is to enhance the existing parking system, to provide better service for drivers in searching of available parking space, and to utilize the Bluetooth application in mobile devices as the medium of the services. The service also looks forward in reducing the traffic congestion, high CO<sub>2</sub> emission, and the drivers' precious time which are derived from parking surveys activities. The methodology is based on the Rapid Application Development (RAD) model, which is the enhancement of waterfall model, since it is the most appropriate model to be used for fast project development and delivery if high quality system at low cost of investment. The service is hope would benefits mobile users and drivers in lowering thier fuel consumption, saving cost of services, and reducing user's time for parking surveys. The system will be integrating Visual Basic.NET with Matlab 7.0 tools. When a client/mobile user requests for available parking space information from the system via Bluetooth application, the system would respond to the request by providing the image of the current parking lot as well as the exact locations information. The parking area would be captured using Visual Basic.NET and the captured images would be processed using Matlab Image Processing Toolbox.

## **ACKNOWLEDGEMENT**

An absolute most is my expression of gratitude to God Almighty for His blessing and mercy that have given me the strength and have guided me through the challenges during my Final Year Project completion.

My utmost gratitude goes to my supervisor, Mr Justin Dinesh Devaraj for his guidance, suggestions and advice that help me a lot in development of this project. Thank you for your patience and trust on me towards completing this project.

I would like to express my deepest appreciation to my parents, Mr Leham b Md Som and Mrs Zainon bt Zakaria for their endless support, concerns, and encouragement. As they keep motivating me to do my best in anything I do, especially in completing my Final Year Project successfully. Special thanks and recognition goes to my friend, Azam b Hassan for his motivation, and contribution throughout my Final Year Project.

Last but not least, I would like to thank to UTP lecturers for positive outlook, advice, and constructive criticism during the project development, to my friends for being there for me, and not forgetting anyone who has contribute directly and indirectly in completing my Final Year Project.

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# **CHAPTER 1**

## **INTRODUCTION**

### **1. 1 Background of Study**

Parking activities constitute a wide area that can affect overall mobility of vehicle drivers as all vehicle trips require a parking space at destination. Parking surveys activities can be very frustrating, time-consuming and daunting task to drivers. Related problems derive from the driver's need of convenient parking space, especially in areas of scarce parking supply, where drivers' search for parking space may account up to 30% of urban traffic flows and correspondingly high proportion of CO<sub>2</sub> emissions.

The Vehicle Parking Space Locator System focused on developing a service to locate available parking space in a particular parking area by using mobile devices such as handphone, via Bluetooth wireless technology. The service can be accessed by drivers as long as the Bluetooth connection in their handphone is enabled. When a request is sent to the system via Bluetooth, the system would respond to the request by sending the information about the location of available parking space with the images of parking lot to mobile user. The image of parking lot will be captured periodically and will be processed using Matlab software tools. The system should also be able to monitor the activities going on in the parking area and save the video of the monitoring service.

### **1.2 Problem Statement**

#### **1.2.1 The inefficiency of image processing using RGB in VB.NET**

The existing system done by previous FYP uses Visual Basic.NET functions to get the RGB value from the captured image and compare the image manually by using pixel value of the image, which is quite tedious.

### **1.2.2 The high cost of applying WAP service**

The former Final Year Project is developed using WAP. Problem with the system using WAP service is that it needs collaboration with service providers (e.g. MAXIS, CELCOM) and subsequently requires mobile user/drivers of the parking space locator system, to pay for the service.

### **1.2.3 Time-consuming during search of parking space in parking area.**

Drivers may to have a complete tour of parking area in just to find a parking space, which can take for hours especially during weekends and holidays depending on the area. Studies have found that average time to find a parking space range between five to fifteen minutes depend on the environment (peak hours, prime hours or off hours).[10] Drivers and passengers would prefer to spend more time at destination rather than searching for parking space.

Related problems derived from the searching of parking space activities especially in areas of scarce supply may results up to 30% of urban traffic congestions and correspondingly high proportion of CO<sub>2</sub> emission.

### **1.2.4 The cost for having a parking space locator services available is high**

Currents available parking offers are also source of problems since parking facilities and parking space locator services are costly and some of it are limited to certain registered members. Looking at the high living cost and environmental cost, the services can not benefits drivers much.

### **1.3 Objectives of the Project**

#### **1.3.1 To enhance the available system by using Matlab software.**

Every image captured will be processed and compared automatically using Matlab Image Processing Toolbox and functions rather than process them manually using RGB functions in VB.NET. The results will be transferred to the main system, which will be built using Visual Basic.NET. The integration of Visual Basic.NET and Matlab is important to have better image processing method and better results.

#### **1.3.2 To use Bluetooth technology as a transmission medium instead of WAP**

Since WAP need collaboration with service providers which results to high service cost for clients, Bluetooth wireless technology provides better alternative solution for mobile user/drivers. By utilizing Bluetooth, V-PSLS can provide low cost service with equal or better output. . Bluetooth technology is applied in the system because of its availability in most of the mobile devices nowadays and its potential in moving and synchronizing information in a localized setting. Bluetooth technology is a radio-based and very inexpensive. It devices can communicate at ranges of up to 100 meters and do not need to be in direct sight of each other, that is suitable for the system to be accessed.

#### **1.3.3 To reduce time and hassle in searching for parking space.**

The purpose of the system is to reduce time needed in searching of parking space in parking area especially in urban area where traffic congestion is high and subsequently reducing the air pollution and drivers stress problems.

#### **1.3.4 To propose a better parking space locator solution for mobile users**

The system is proposed to introduce diversified parking space locator services for mobile users to make drivers' search for parking space more accessible, comfortable and time-saving. The system is hope be able to provide user with affordable service and better image presentation in the mobile devices.

#### **1.4 Scope of Study**

The scope of study of this project starts with integrating the Matlab and Visual Basic.NET. How the captured image will be processed and be programmed using Matlab tools and functions is studied. Then study is extended to how Bluetooth connection between mobile devices and PC is setup. The understanding of Bluetooth wireless technology application and devices needed for this system will be learned as well as it significance to this system. The study of Bluetooth personal area network range, device installations, and how to mobile devices can retrieve information from the PC.

The system can be use in any parking area such as shopping mall, university area, company, housing area and sports center. This project will apply the system onto real hanphones for testing. Mobile users within the system's Bluetooth area should be able to detect the service and request for information, and then view the image of parking area with location of available parking space. The expected user for the system testing and system validation will be focus more on Universiti Teknologi PETRONAS (UTP) students due to the scarce supply of parking space.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 Parking Space Optimization Service**

According to Hodel-Widmer and Cong (2004)

E-Parking provides a database-centered Web application solution based on our proposed conceptual model CIA (Channel, Integration, Application) for Web applications. The WAP, WEB and Bluetooth communication channels enable drivers to obtain early information on available parking space, make a reservation, access the reserved place and pay for the service booked. In reaching this goal, the innovative solutions seek to benefit all social segments, to optimize existing parking resources, and to contribute to achieving a more sustainable urban transport, reducing congestion and pollution. (p. 1).

PSOS is accessed both by drivers through Web, SMS or WAP technology and by parking space providers through Web Services to the central database. Bluetooth technology then enables the driver to be recognized at the entry and exit points of the parking lot and triggers the secure m-payment procedure which debits his credit card or phone bill. (p. 3)

The parking space provider offers parking space available for reservation. This information is registered in the PSOS database. Users are able to access the PSOS via Internet or WAP for obtaining parking information or for making a reservation request. The reservation request is registered in the PSOS database. The PSOS sends the booking information and access code to the end user subject to the acceptance of the reservation request by the Parking Space Provider. The car enters and exits the parking facilities using Bluetooth to open the barrier.

Once the car exits the car park electronic payments is made and the whole operation is registered in the PSOS. (p. 4)

Basically this system can be accessed both by drivers through WEB and WAP technology and by parking space providers through a specific interface to the central database. Bluetooth technology then enables the driver to be recognized at the entry and exit points of the parking lot. The system aims at supporting different business models in which payment flows can be either handled through the PSOS platform or at parking provider level. The combination of these technologies makes the system quite efficient but yet expensive.

## **2.2 Parking System Technologies**

Smith and Roth (2003) talks about how advanced Car Park techniques are being implemented using the SMS services available on cellular phones. It describes how useful these advanced car parking systems are in providing drivers with information about the structure of the car park system and the spaces available for them to park their cars.

The availability of the vacant parking spaces is calculated by means of sensors installed in the parking areas, which count the number of cars that enter and exit from the parking space. Also, the number of parking tickets issued at the ticket counter can be used to calculate the vacant spaces. All this information from the sensors and the ticket counters is used to update a central database which stores all the information about the areas of the parking space which is vacant or occupied. Smith and Roth (2003) also compares the parking techniques used at various airports in the United States. Among these, the notable ones are Houston International airport and the Baltimore airport at Massachusetts. The parking spaces at Houston international airport have wires embedded at the entry, exits and the various levels of the parking lots. These wires act as sensors and record the entry and exit of the card to update the central database. At the Baltimore airport, there are ultrasonic sensors at the top of each parking space which sense the availability or unavailability of each space. These sensors update the central database. Information from this

central database is used to display information at the “way-find” signs at the end of each row of the parking area and advise the drivers whether parking space is available or unavailable in that particular row.

These advanced car park systems also provide advanced, electronic payment options for the customers. The idea behind these electronic payment options is to prevent the customers from having to wait in long queues to buy a ticket. In this article, cite examples of mobile parking or “m-parking” facilities that are being used in Vienna (Austria) and Melbourne (Australia). Under the m-parking technology, customers initially register their mobile number, the license plate number of the car and their credit card number with the car park authorities, to create virtual parking ticket account. This completes the initial, one-time registration process. Whenever the customer needs to park, they would send an SMS text message to the number provided by the car park authorities. The SMS message would consist of the license plate number of the car, the location code of the parking area where they want to park and the time duration (in minutes) for which the customer wants to park. In return, the customer would then receive a text message from the car park message centre, with the confirmation and the expiry time of their electronic parking ticket. The customer would be sent a reminder SMS, 10 minutes before the parking time expires. The bill for the parking ticket would come up on the customer’s mobile bill.

### **2.3 Location Dependent Parking Service through Bluetooth**

The system proposed by Suryanarayana, Mariappan and Narayanasamy(2005) allows the mobile client to search for parking space, reserves the space and enters the parking space through Bluetooth enabled devices. Location Dependent Parking Services has three main features; Search Vehicle Park Information, Parking Slot Information Retrieval and Parking Slot Reservation. This system is implemented using Microsoft Visual Studio.NET with TomCat web server. User has to logon to the Location Dependent Service (LDS) system through their mobile device and search for nearby parking space by choosing the location where the user wants to park OR searching the nearby parking area with respect to their current location.

Then, user has to choose one from the given list. The Location Dependent Service Management (LDSM) will provide the roadmap to reach the parking area and the number of available slots, space, cost, and other information related to the service provider according to the users current location. On selecting the parking space, the system would store the vehicle information in service provider's database. On selection of the parking space, the system would get the vehicle details and inform the Location Dependent Service Management (LDSM). The Location Dependent Service Management (LDSM) will take all the vehicular information and store it in the service provider's database. On confirming the reservation of the slot, an "Authentication code" would be generate and send to the mobile user as well as to the Bluetooth enabled car park system. On reaching the parking slot Bluetooth-enabled device in the parking slot can interact with the Bluetooth-enabled mobile and exchange the authentication details. If the user could not reach and park the vehicle with in expiry time limit the parking system will issue a warning message through user mobile device and the reservation would get cancelled automatically after the timeout period.

#### **2.4. Bluetooth Wireless Technology**

The articles from BlueTomowrow.com and Bluetooth.com described from the basic information of Bluetooth to the details architecture of Bluetooth. This site also provides the articles and review about the Bluetooth devices as well as Bluetooth softwares and modules such as BlueTools.NET SDK which can integrate with .NET framework applications. These sites provide comprehensive guide on Bluetooth and its advantages.

Based on Tech Publication PTE LTD (2001), Bluetooth technology is a short-range wireless technology that allows communication between devices. Bluetooth wireless technology specification is globally available free-of-charge to our member companies. Bluetooth technology operates in the 2.4 GHz, one of the unlicensed industrial, scientific, medical (ISM) radio bands. As such, there is no cost



for the use of Bluetooth technology. While you must subscribe to a cellular provider to use GSM or CDMA, with Bluetooth technology there is no cost associated with the use beyond the cost of the mobile device. A fundamental Bluetooth wireless technology strength is the ability to simultaneously handle both data and voice transmissions that enables users to enjoy variety of innovative solutions such as a hands-free headset for voice calls, printing and fax capabilities, and synchronizing PDA, laptop, and mobile phone applications to name a few.

Bluetooth have secure connection. With adaptive frequency hopping (AFH), the signal “hops” and thus limits interference from other signals. Further, Bluetooth technology has built-in security such as 128bit encryption and PIN code authentication. When Bluetooth products identify themselves, they use the PIN code the first time they connect. Once connected, always securely connected.

The Bluetooth core system consists of an RF transceiver, baseband, and protocol stack. The system offers services that enable the connection of devices and the exchange of a variety of data classes between these devices. Bluetooth enabled electronic devices connect and communicate wirelessly through short-range, ad hoc networks known as piconets. Each device can simultaneously communicate with up to seven other devices within a single piconet. Each device can also belong to several piconets simultaneously. Piconets are established dynamically and automatically as Bluetooth enabled devices enter and leave radio proximity.

The operating range depends on the device class. Class 3 radios have a range of up to 1 meter or 3 feet, while Class 2 radios, which most commonly found in mobile devices, have a range of 10 meters or 30 feet, and Class 1 radios, which is used primarily in industrial use cases, have a range of 100 meters or 300 feet.

The most commonly used radio is Class 2 and uses 2.5 mW of power. Class 3 uses 1 mW (0 dBm) of power and Class 1 use up to 100mW of power. Bluetooth technology is designed to have very low power consumption. This is reinforced in the specification by allowing radios to be powered down when inactive. The data

rate for Bluetooth is 1 Mbps for Version 1.2 and up to 3 Mbps supported for Version 2.0 + EDR

From above information, Bluetooth is the best solution to be use in this project as it provides easy-to-setup installation, inexpensive and wide range of operation. Bluetooth technology has a big potential that it can be use in many areas of human daily activities as many devices has been developed utilizing Bluetooth technology.

## **2.5 Developing Bluetooth Application in GIS**

There are articles that provide step by step instruction on how to configure user computer or PDA for Bluetooth communication and demonstrate how to build a Bluetooth server application and a Bluetooth client application. For example, according to the article display in National Instrument website, describe about LabVIEW application.

LabVIEW 7.1 and later include Bluetooth VIs with which LabVIEW developers can build custom Bluetooth applications. This application note demonstrates how to build a LabVIEW application to communicate with Bluetooth-enabled devices. Refer to the Bluetooth Web sites at [www.microsoft.com](http://www.microsoft.com) and [www.bluetooth.com](http://www.bluetooth.com) (linked below) for more information about Bluetooth technology

Creating Bluetooth server and client applications in LabVIEW is similar to creating server and client applications for TCP communication. A Bluetooth server uses the Service Discovery Protocol (SDP) to broadcast the availability of the services contained and listens for inbound connections. A client creates an outbound RFCOMM connection to a server. Once the client and server connect to each other, they exchange data until the client or server terminates the connection or until the connection is lost. There is no inherent security built into the Bluetooth protocol, although many devices include

settings that require clients to log in before accessing Bluetooth services (p 1).

## **2.6 Mobile Internet Enabled Sensors Using Mobile Phones**

According to Rebolj and Menzal (2003)

The Internet Protocol (IP) provides standardized means of communication. Utilizing IP for communication has numerous advantages over developing proprietary protocols, e.g., compatibility, flexibility and ease of maintenance. However, traditional TCP/IP implementation requires extensive CPU and memory resources. For mobile applications we strive for small, light devices with low power consumption, thus long battery life. To meet this requirement a special TCP/IP stack lwIP (Dunkels 2002) has been used. It is a TCP/IP stack implementation optimized to reduce memory and CPU resources. For the connection to the mobile phone, Bluetooth was used. The Bluetooth standard defines a set of profiles for communication. To support commercially available Bluetooth devices such as the Compaq iPAQ or cell phones like Ericsson P800, a minimized Bluetooth stack, lwBT (Öhult, 2003) has been implemented on our EIS device. The stack extends lwIP with Bluetooth LAN access capabilities such as the LAN Access Point (LAP) and Dial-up Networking (DUN) profiles. The EIS device acts as a Bluetooth device providing a TCP/IP interface for data transport, configuration and maintenance. This concept allows user interaction through standardized WWW browser technology from any device supporting the Bluetooth LAN Access Profile. The EIS provides platform independent client software for data presentation. The client software (e.g. applets) is distributed from the EIS device by HTTP. The applet is run under the client browser, enforcing security. Sensor data can then be transferred over IP and displayed on the client device for on-line monitoring. (p.4)

## **2.7 Integrating Matlab and Visual Basic .NET**

The integration between MATLAB and Visual Basic .NET is possible with the Image Acquisition Toolbox and Image Processing Toolbox in MATLAB software. There are certain projects and research based on the integration between MATLAB and Visual Basic .NET application have been done. For example, in developing the Wireless Channel Simulator, the wireless channel was built up with a mathematical model, and simulated by a MATLAB-based program. The simulation program and interface program of this wireless channel simulator are programmed in MATLAB and Visual Basic (VB) respectively [12]. The interface of the program was created with Visual Basic and calls the "COM" object of the dynamic link library (DLL) file provided by the MATLAB program.

### **2.7.1 MATLAB Builder for .NET and MATLAB COM Integration**

Matlab Builder for .NET [16] is an extension to the Matlab Compiler so that programmers can access them from any CLS-compliant language such as C#, VB.NET, and C++. It converts Matlab functions to .NET methods that encapsulate the Matlab code. This tool allows user to generate a COM component that incorporates an event source. COM stands for Component Object Model, which is a software architecture developed by Microsoft to build component-based applications. These event components are accessible through Visual Basic, C++ or any language that supports COM objects.

MATLAB functions can be created in the m-files and these m-files can be converted to an executable code from Visual Basic by using Matlab COM integration. - "The *Component Object Model (COM)* provides a framework for integrating reusable, binary software components into an application. Because components are implemented with compiled code, the source code can be written in any of the many programming languages that support COM. Upgrades to applications are simplified, as components can simply be swapped without the need to recompile the entire application. In addition, a component's location is transparent to the application, so components can be relocated to a separate process or even a remote system without having to modify the application." [13].

Matlab Support Documentation [14] provides the example for running the M-File from Visual Basic.NET after creating the COM objects and how to view methods from the Visual Basic.NET client.

### **2.7.2 The difficulties of the integration**

However, most of the examples and previous people works regarding the integration between MATLAB and Visual Basic are commonly done by using Visual Basic 6, C# or C++. The integration with Visual Basic.NET is still in a new field that not much programs had been created using Visual Basic.NET since MATLAB Builder for .NET is still new. Thus, the idea of developing this project using Visual Basic.NET 2003 and using MATLAB Builder for .NET is quite a challenge especially for beginner programmers.

## **CHAPTER 3**

### **METHODOLOGY**

#### **3.1 Methodology Identification**

The suitable system development methodology for the system is Rapid Application Development (RAD) methodology. This methodology is compressing the analysis, design, build, and test phases into a series of short, iterative development cycles that has a number of distinct advantages over the traditional sequential development model (Waterfall methodology) [11]. The objective of choosing this model is objective is to build fast system development and delivery of a high quality system at a relatively low investment cost. It can reduce project risk by breaking a project into smaller segments and providing more ease-of-change during the development process. While this system emphasis is on fulfilling the business need, while technological or engineering excellence is of lesser importance, RAD is most suitable choice. The project control involves prioritizing development and defining delivery deadlines or “timeboxes”. If the project starts to slip, emphasis is on reducing requirements to fit the timebox, not in increasing the deadline. Standard systems analysis and design techniques can also be fitted into this framework. The RAD methodology is most appropriate to be adopted in a small to medium scale and of short duration, where the project scope is focused, such that the business objectives are well defined and narrow like in V-PSLS.

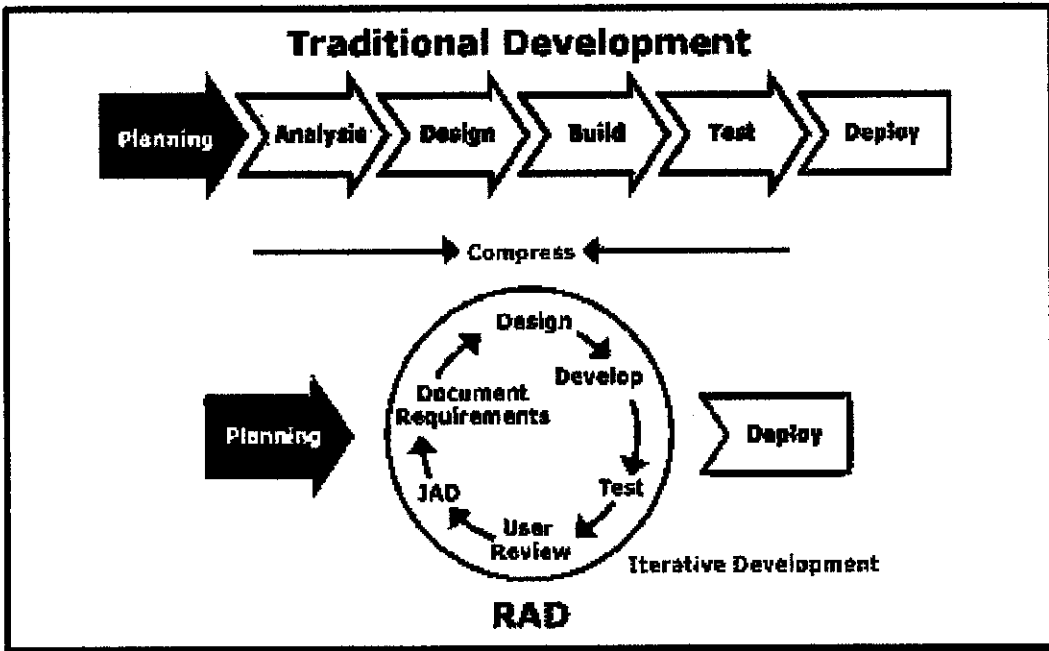


Figure 3.1 Rapid Application Development Diagram

### 3.2 Planning Phase

The planning phase involved assigning topic for the project by supervisor and preparing for project proposal. The problems and issues regarding the project are observed and identified. The methods done for data gathering and problems identification are by interview, internet searching, journals, articles and reference books. The list of references and literature review related to the project topic are looked for after the proposed topic has been approved. The literature review and research found is studied and the selected research papers are as appeared in Chapter 2. The methodology used for the project development is Rapid Application Development (RAD). Gantt chart is developed as the results of project schedule and the system requirement is being identified during project planning. (Refer to Appendix 1-1).

The system requirement involves the expected tools needed for project, the expected software required, expected cost and expenses for the project, and the expected hardware specification. The initial results and findings of project planning are reported in the Preliminary Report and Progress Report as well as Weekly Report.

### 3.3 Analyzing Phase

The additional and available information collected during planning phase is used to design the system flow, system framework, system requirement, and software and hardware specification. The cost estimation of the project development also has been calculated. The results of the analysis will be discussed as follow:

#### 3.3.1 Related System Requirements

##### **User Requirement definition**

1. The V-PSLS shall be available most of the time especially during peak hours and respond within 5 minits on user request.
2. User shall view the current image of parking space of the parking area with the location information.
3. The system shall provide the expected information within the parking area maximum of 100m range (current maximum range)
4. The cost of installing the application for the administrator shall be as low as possible and affordable for drivers (with Bluetooth enabled devices) upon request.

##### **System Requirements specification**

1. On user request for the location and image for empty parking space from the V-PSLS, the requestor shall enable their Bluetooth connection using Bluetooth devices and the system shall enable the Bluetooth connection at all time.
2. The images shall be captured in half-real time method (e.g. every 5 seconds) and stored in the system database.
3. The images in the database shall be kept in the system for at least 3 years to ensure system availability and security. Backup of all the old files shall be stored in different place.
3. The system shall maintain a log of all requests that have been made to the system
4. The user shall be within the Bluetooth wireless maximum range in order to request the information from the system.
5. The position of the webcam/CCTV shall be fixed in particular location such that the particular parking can be viewed.



### **Product Requirement**

1. The user interface for V-PSLS shall be implemented using simple navigation in Visual Basic.NET software and integrate the image processing with MATLAB Image Processing Toolbox.
2. The interface should be reliable and user-friendly to users (system administrator).
3. The overall system performance should maintain or improve the available FYP project.

### **External Requirements**

1. The project shall follow the standards and laws requirements and shall not violate any legislative requirement or university laws.
2. The project shall bind to all the safety requirements and ethical requirements of the university.
3. The system shall not disclose any personal information about the system users apart from their name and id number to others.
4. User shall read and agree to system requirements or product conditions before using the system for safety.

### **3.3.2 System Framework**

The V-PSLS is aimed at providing service to mobile users. As shown in Figure 4-1, mobile users should be able to access the system within the service area as long as their Bluetooth connection is on. Their mobile device will detect the Bluetooth devices of the system and view the system interface. When user requests for available parking from the system, the signal is sent through Bluetooth to the system. Then the system will store the user's information such as IP address into the system. In return, the system will send the information about the location of available parking space, at which level with corresponding parking area image.

The system should be able to capture the images of the parking area periodically for instance every 5 seconds to ensure that the availability of parking space and accuracy of images give to user. This is also for security purpose, where the system

can monitor and identify the parking area activities. An alarm will be generated if the system detects any unusual actions or events happen in the parking area.

As an initial draft of the system, a webcam will be used as a substitute for CCTV. A parking area prototype of A3 paper size will be build due to the limited field of view range of webcam. This project will be using Bluetooth operating area of 10 meters. This can be extended up to 100 meters for wider covered-area and better service. The image of the prototype parking area will be captured periodically using webcam. These images will be processed and compared using Matlab 7.0 Image Processing Toolbox, before it will be stored into the database application. Then, the images can be viewed from the system interface which will be developed using Visual Basic.NET.

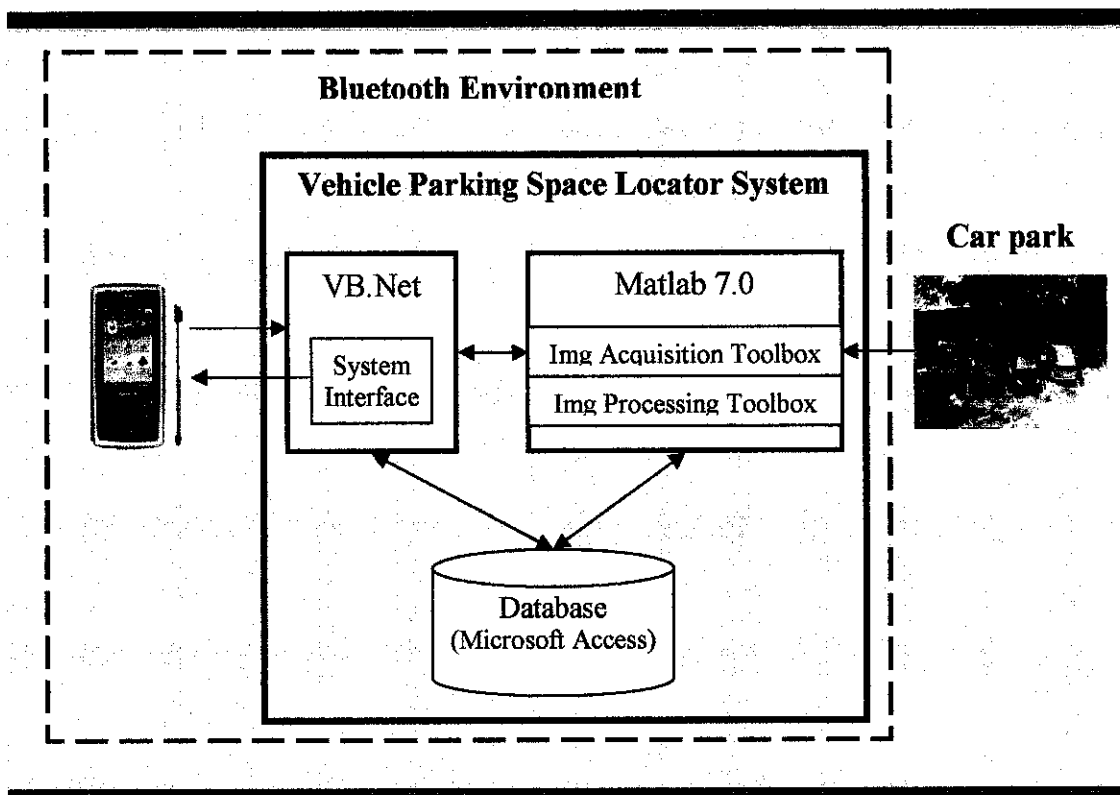


Figure 3.2 System Framework

### 3.3.3 Use-Case Diagram

Use-case Diagram is used to describe the functionality of the system, who initiates the events, and flow of the events, and how the system responds to those events.

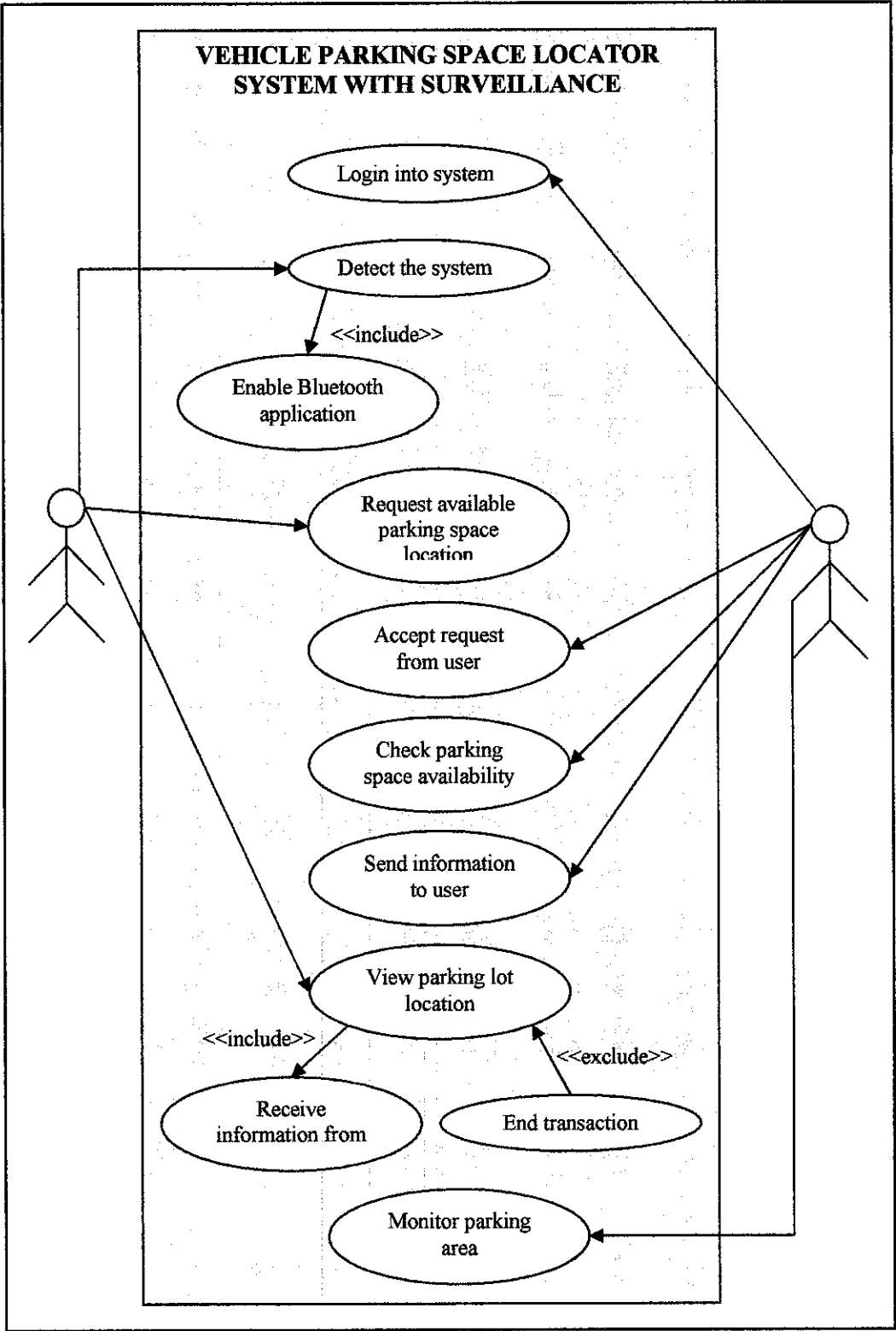


Figure 3.3 Use-Case diagram of V-PSLS

### **3.3.4 Minimum Software Requirements**

(i) Visual Studio .NET 2003/2005 with Visual Basic.NET

Visual Basic.NET is the main application used to capture the image and to design system interface. Additional installer also needed for the system to work better such as Microsoft .NET framework SDK v1.2. Additional ActiveX installed for this project is IcImagingControl application for video/image processing.

(ii) MATLAB 7.0 (or above)

Matlab is used to process the images of parking area that are captured using webcam. Image Processing Toolbox is required during installation for this purpose. Other important features are Matlab Builder for .NET and Matlab Builder for COM Integration. These toolboxes are needed and very helpful when comes to the integration with VB.NET part.

(iii) Microsoft Access / Microsoft Excel

Microsoft Access or Microsoft Excel can be used as a database application to store processed image information, for system that has limited disk space. Other database application also can be use to store the images but it requires larger amount of disk space and memory space.

(iv) Bluetooth Software – IVT BlueSoleil

IVT BlueSoleil, which is Bluetooth software, comes with the Bluetooth USB Adapter. The installer is require before the Bluetooth Adapter is plug in to the PC for the first time. Other Bluetooth software may also be used as long as they are compatible with the PC operating system and Graphic Card requirements.

### **3.3.5 Minimum Hardware Requirement (For project development)**

Hardware	Specification
(i) Desktop PC	Operating system: Windows XP Processor: Intel Pentium 4 2.8 GHz Memory: 256MB DDR RAM (512MB or above is recommended) Hard disk: 80GB or above Graphic Card: Updated graphic card drivers
(ii) Webcam	Video Resolution: 640x480 (300K pixels) Speed: 30 frames/seconds Digital Zoom: 3x PC Interface: USB Port
(iii) Bluetooth USB Adapter (Bluetooth Dongle)	Bluetooth v1.2/2.0 compliant USB UHCI/OHCI specification 2.0 compliant Up to 100 meter range Works well with Bluetooth enabled mobile phones
(iv) Bluetooth-enabled mobile phone	Any mobile phone with Bluetooth. The mobile phone model used for this system is NOKIA.

Table 3.1 Hardware Specification

### 3.3.6 Project Development Cost Estimation

Project Development Cost Estimation				
No	Items	Quantity	Expected Cost (RM)	Actual Cost (RM)
	Hardware Requirement			
1	Parking Prototype (car toys)	10	30.00	28.90
2	Webcam	1	60.00	58.00
3	Bluetooth Adapter	1	30.00	35.00
	Additional Requirement			
4	Upgrade DDR RAM (from 256MB to 512MB)	1	200.00	230.00
5	Replace Graphic Card (broken)	1	150.00	280.00

Miscellaneous				
6	Papers (reports and research paper)	2 rim	15.00	20.00
7	Printer Ink (EPSON C59)	3	66.00	69.00
8	Bluetooth Mobile Phone	1	1000.00	680.00
<b>TOTAL</b>			<b>1551.00</b>	<b>1400.90</b>

Table 3.2 Project Development Cost Estimation

### 3.4 Designing Phase

In designing phase, storyboard of the system is drafted based on the information gathered during analysis phases. The system interface and actual algorithms to be used for the system are identified and applied during this phase. The sub-systems and functional part of the system is developed. The development method for the system is bottom-up, from functional parts and sub-function of the system to development of system interfaces. The designing part is started by developing the system interface for the system using Visual Basic.NET. Then, continue with image processing using MATLAB Image Processing Toolbox. Next step, which is one of the most important parts, is calling the MATLAB code functions from Visual Basic.NET. After the integration part is completed, the linkage between MATLAB information and database is created to store the information about location of empty parking spaces. It is then follows with configuring the connection between Bluetooth mobile devices and the system.

### 3.5 System Testing and Validation

Testing phase involve unit testing, component testing, functionality testing, and reliability testing. However, unit testing and component testing are done frequently during the designing the system. The tests that shall be done are:

- (i) Functionality of each controls, link, forms, and buttons on the interface
- (ii) The correct linkage between the system and the database
- (iii) The outputs, results, and information are produced as expected.

- (iv) The connectivity between Bluetooth mobile phone and system are working appropriately
- (v) The availability of the database
- (vi) Whether any enhancement needed for the system to perform better results.

The loops in the methodology helps recognizes issues or updates in during the design, and testing phase, which requires changes to the specifications phase. When changes are made at any phase, the relevant documentation should also be updated to reflect that changes.

### **3.6 Implementation and Deployment Phase**

The implementation phase will be done interchangeably with the testing phase to ensure the result and performance of the system works as expected as well as to reduce errors. The prototype of the system is presented and ready for external testing. Feedback and further suggestion for the system improvement is however required for future enhancement.

## **CHAPTER 4**

### **RESULTS AND DISCUSSION**

#### **4.1 Results and Findings**

Results obtained from research and findings during planning and analysis phases are literature review, the advantage of using Bluetooth technology, and quick survey results. The results of the system development and system testing, present the system interface, as well as the algorithms and codes that connect between system methods.

##### **4.1.1 Advantage of Using Bluetooth**

Bluetooth is now incorporated into most of the mobile phones and almost everyone owns a Bluetooth device, so that it would not be long before every driver has a Bluetooth enabled mobile phone.

Hallberg, Nilsson and Synnes (2003) points out that, “Bluetooth is designed to have low power consumption and has several power saving functions built into the protocol”. They say that low power consumption is preferred when developing systems for mobile devices. Bluetooth also provides fast data transfer rate, which is better than WAP.

Currently, Bluetooth technology provides personal area range up to 100 meters in client-to-client open air and 30 meters in a building. Unlike Infrared that needs to have a line of sight in order to be connected, Bluetooth radio waves do not require two connected devices to be in direct sight of each other. This feature allows mobile user to move around within the Bluetooth range (100 meters).



This system does not require licensing or registration from any communication service providers (e.g. MAXIS or CELCOM) compare to WAP-based system that need collaboration with communication service providers. Thus the cost of having the service is very inexpensive; hence give benefits to mobile users/drivers.

As for security measure, Bluetooth make use of the encryption algorithm that was designed as a candidate for US Advanced Encyption Standard (AES). Bluetooth makes it hard to eavesdrop on a communication between Bluetooth units compare to WiFi that suffers from eavesdropping and false authentication [17]. Bluetooth pairing is said to be safer for transmitting data between mobile users in wireless environment.

#### 4.1.2 Quick Survey and Questionnaire Results

Based on quick survey and interview done within university and shoppers in shopping complex in Penang, 60% of students and user of shopping complex agree to have a parking locator service that is cost-saving, and provide fast service delivery with clear information about empty parking space.

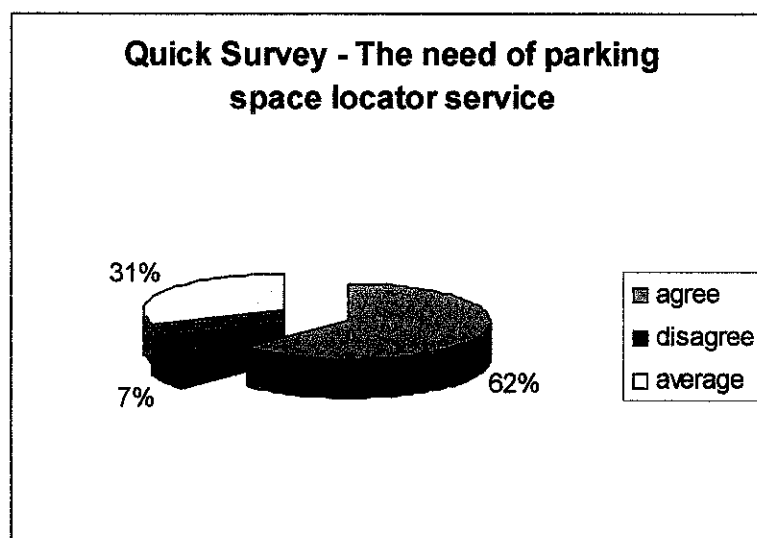


Figure 4.1 Quick Survey Pie Chart

### 4.1.3 System Development

**Main Interface.** System development involves creating interface and functionality between each window forms, as well as the form controls such as buttons, menus, image capturing toolbox and labels. The main interface of the system is shown as below (Figure 4.2). Initial state of the webcam is in Stop Mode. The Live video state starts once user click the View -> Play link in the Menu bar, or click on the Play Button (🎬) in the Icon Bar.

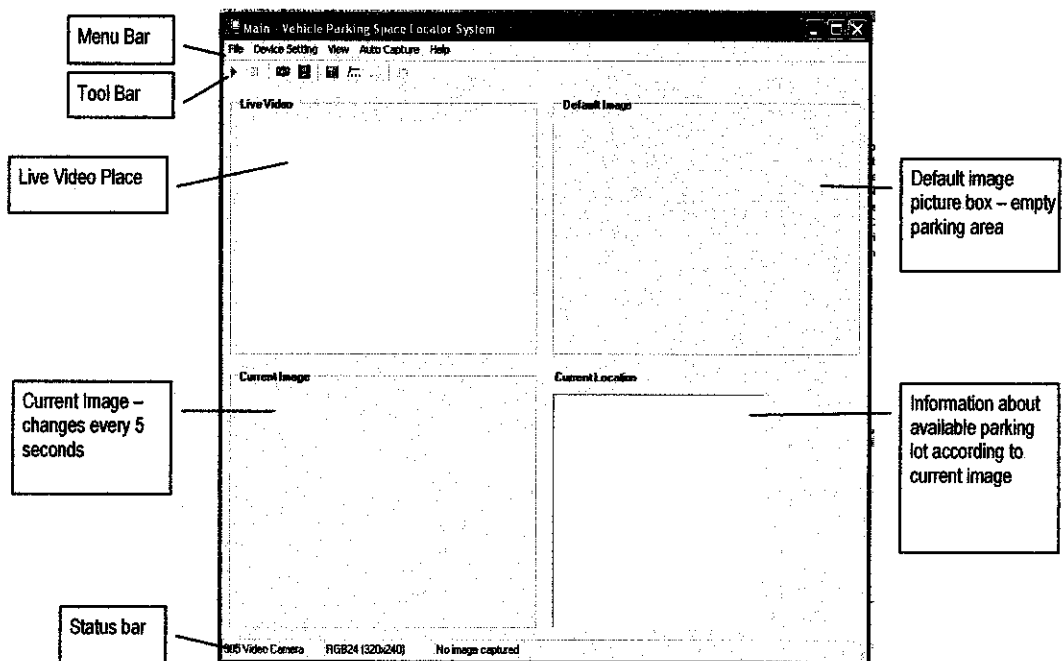


Figure 4.2 Main Interface of Vehicle Parking Space Locator System (Initial State)

**Device Setting.** User can change the device setting for the webcam by clicking on the Device Setting -> Device... or Image... in the Menu bar, and on the (📷) or (🎬) in the Icon bar. The device setting property depends on the webcam used by user. The Device Setting (Figure 4.3) and Device Property (Figure 4.4) window is shown as below:

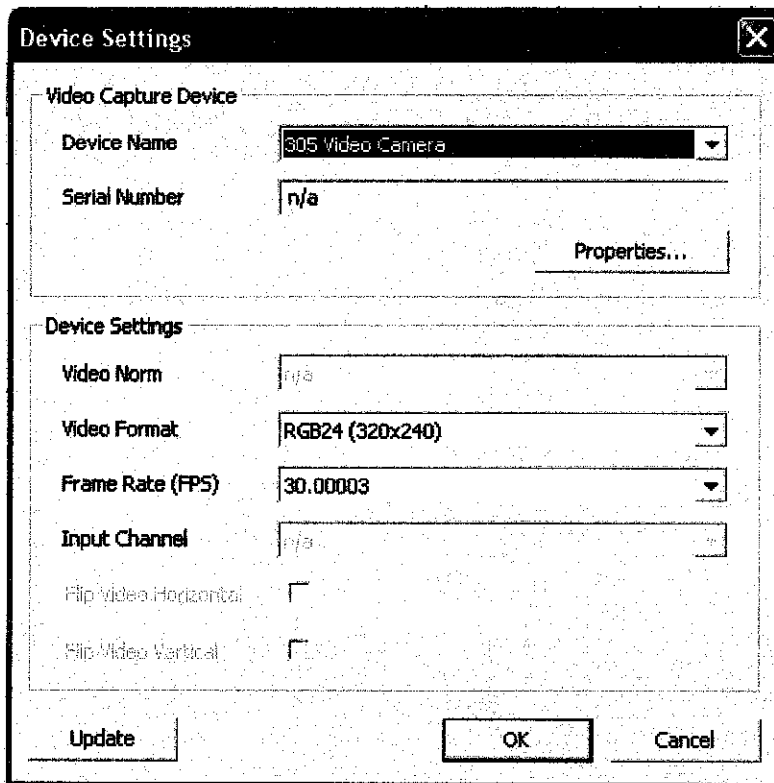


Figure 4.3 Device Setting

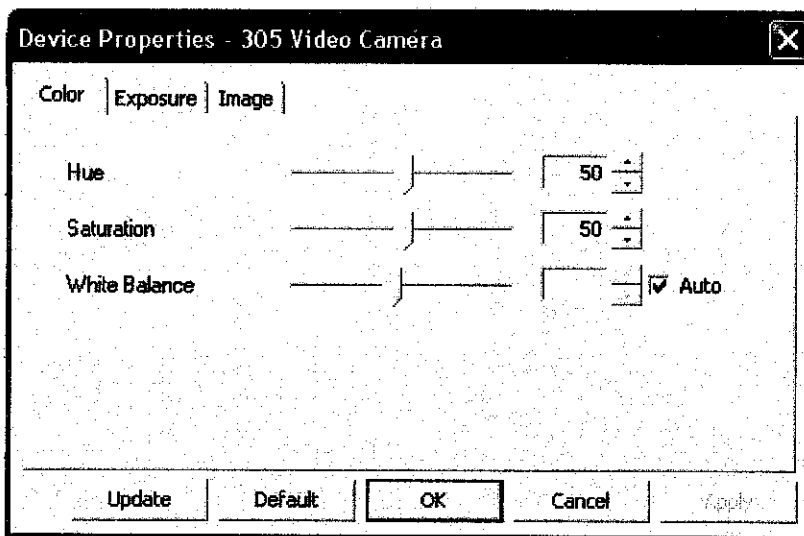


Figure 4.4 Device Properties

**Saving Image.** User can save the single image by clicking on the File -> Save Image and saves sequence of images every 5 seconds by clicking on Auto Capture -> Starts in the Menu bar. The Save Image menu item is used to save single image, which is the default image. Once the image is saved as filename specified by user,

the image is loaded onto the Default Image picture box. For sequence of images, once the Auto Capture -> Starts menu item is clicked, user need to specify a folder where all images that will be captured every 5 seconds, will be stored. Every captured image is renamed accordingly and loaded onto the Current Image picture box. The status of each image being captured is showed in the Status bar and the location information about each lot is displayed on the Current Location text box. The interface is shown as below (Figure 4.5):

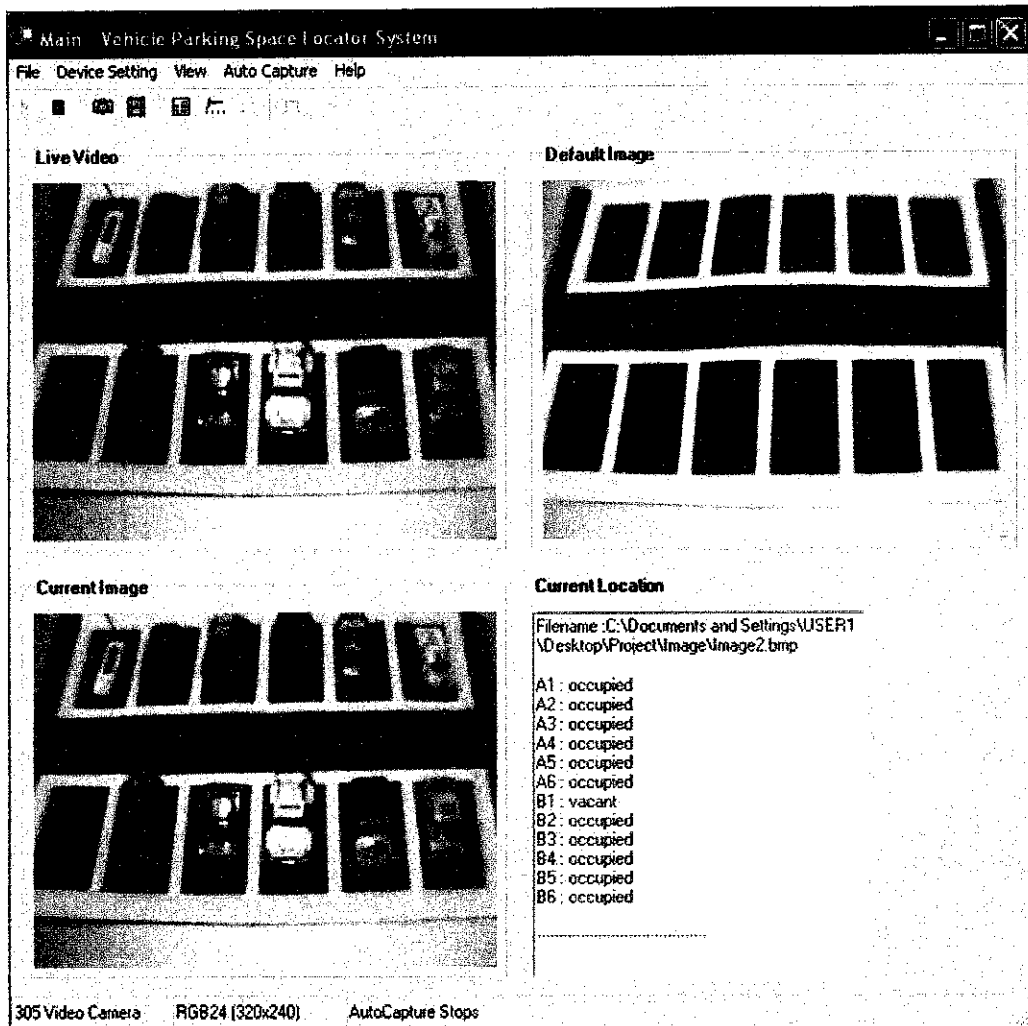



Figure 4.5 Capturing images

Saving AVI File. Saving the AVI files can be done by clicking on the File -> Save Video in the Menu bar or click on the icon (  ) in the Icon bar. User can set the codec properties and save the codec file. Then, the filename and directory of the file to be saved is browsed. The video capturing starts once the user clicks on the Start button, and it stops capturing when user clicks on the Stop button. User can choose to pause the video by Check the Pause.

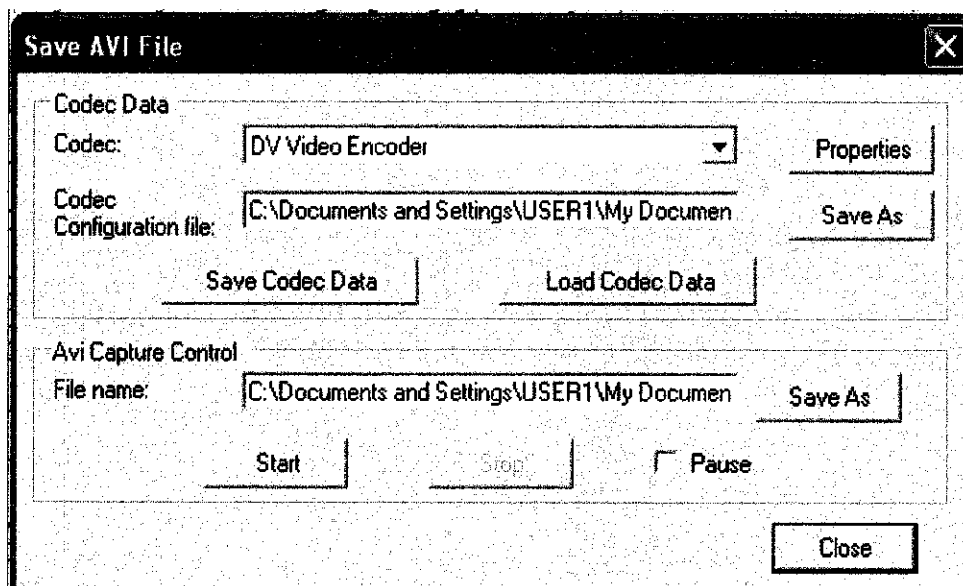


Figure 4.6 Saving AVI File Dialog

#### 4.1.4 Algorithm and Codes

##### (i) Starting and stopping image previewing:

```

Private Sub StartLiveVideo()
    If IcImagingControl1.DeviceValid Then
        IcImagingControl1.LiveStart()
        mnuPlay.Enabled = False
        mnuStop.Enabled = True
        ToolbarPlayButton.Enabled = False
        ToolBarStopButton.Enabled = True
    End If
End Sub

```

```

Private Sub StopLiveVideo()
    If IcImagingControl1.DeviceValid Then
        IcImagingControl1.LiveStop()
        mnuPlay.Enabled = True
        mnuStop.Enabled = False
        ToolbarPlayButton.Enabled = True
        ToolBarStopButton.Enabled = False
    End If
End Sub

```

## (ii) Setting Device Properties

```

' Show the device selection dialog.
'
Private Sub SelectDevice()

    If IcImagingControl1.LiveVideoRunning Then
        IcImagingControl1.LiveStop()
        IcImagingControl1.ShowDeviceSettingsDialog()

        If IcImagingControl1.DeviceValid Then
            IcImagingControl1.LiveStart()
        End If
    Else
        IcImagingControl1.ShowDeviceSettingsDialog()
    End If

    UpdateControls()
    SetWindowSizeToImagesize()
    SaveSelectedDevice(IcImagingControl1)
End Sub

'
' ShowProperties
'
' Show the property dialog of the current video capture device.
'
Private Sub ShowProperties()
    If IcImagingControl1.DeviceValid Then
        IcImagingControl1.ShowPropertyDialog()
        UpdateControls()
    End If
End Sub

```

### (iii) Capturing and saving image

```
Private Sub SaveImage()  
    If IcImagingControll1.DeviceValid Then  
        ' Snap (capture) an image to the memory  
        IcImagingControll1.MemorySnapImage()  
  
        ' Call the save file dialog to enter the file name of the  
image  
        Dim saveFileDialog1 As New SaveFileDialog  
        saveFileDialog1.Filter = "bmp files (*.bmp)|*.bmp|All  
files (*.*)|*.*"  
        saveFileDialog1.FilterIndex = 1  
        saveFileDialog1.RestoreDirectory = True  
  
        If saveFileDialog1.ShowDialog() = DialogResult.OK Then  
            ' Save the image.  
  
            IcImagingControll1.MemorySaveImage(saveFileDialog1.FileName)  
            PictureBox1.Image = new Img.FromFile(saveFileDialog1.FileName)  
            refPath = saveFileDialog1.FileName  
            ProcessImage(refPath, saveFileDialog1.FileName)  
            End If  
        End If  
    End Sub
```

### (iv) Image Processing: Identifying the available parking space in parking area (MATLAB)

```
function park = imgDiff(Ref_gray, Cur_gray)  
  
img_diff = imabsdiff(Ref_gray, Cur_gray);  
total_diff = sum(sum(img_diff));  
Avg_Img_diff = total_diff / (10*10);  
  
if Avg_Img_diff <= 15  
    park = 'vacant';  
    %status = 0;  
else  
    park = 'occupied';  
    %status = 1;  
end
```

**(v) Image Processing: Displaying the status of each parking space.**

```
Ref_gray = imcrop ( picRef_gray , [47 33 10 10]);
A1_gray = imcrop ( picCur_gray , [47 33 10 10]);
park = imgDiff(Ref_gray,A1_gray);
A1 = strcat( 'A1 :', park)

Ref_gray = imcrop ( picRef_gray , [90 33 10 10]);
A2_gray = imcrop ( picCur_gray , [90 33 10 10]);
park = imgDiff(Ref_gray,A2_gray);
A2 = strcat( 'A2 :', park)
```

**(vi) Saving AVI Video**

```
Private Sub ShowAVIDialog()
    If IcImagingControl1.DeviceValid Then
        Dim AVIDlg As AviDialog = New
        AviDialog(IcImagingControl1)
        AVIDlg.ShowDialog()
        AVIDlg.Dispose()
        AVIDlg = Nothing
    End If
End Sub

' Start the AVI capturing.
,
Private Sub cmdStartButton_Click(ByVal sender As System.Object,
ByVal e As System.EventArgs) Handles cmdStartButton.Click
    If ImagingControl.DeviceValid Then
        ImagingControl.AviStartCapture(edtAVIFile.Text,
        CodecBox.SelectedItem)
        cmdStartButton.Enabled = False
        cmdStopButton.Enabled = True
    End If
End Sub
,
' Stop the AVI capturing.
,
Private Sub cmdStopButton_Click(ByVal sender As System.Object,
ByVal e As System.EventArgs) Handles cmdStopButton.Click
    If ImagingControl.DeviceValid Then
        ImagingControl.AviStopCapture()
        cmdStartButton.Enabled = True
        cmdStopButton.Enabled = False
    End If
End Sub
```



### 4.1.5 System Input and Output

#### (i) Example of images as system input

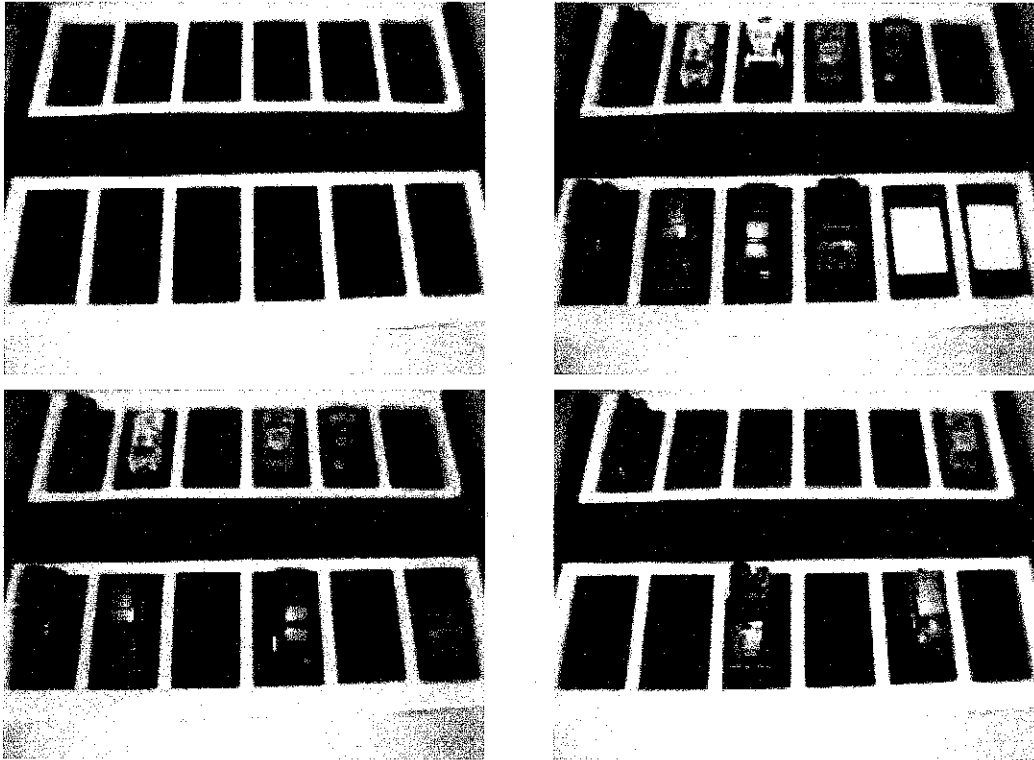


Figure 4.7 Example of system input

#### (ii) System output on Bluetooth enabled devices

This is the expected output should be displayed on the user's Bluetooth enabled devices, which contains image of parking area and the information of each parking lot location (Right: Figure 4.8). However, currently this system is able to display images to user's Bluetooth enabled devices, without the information of the parking space. The hand phone being used for this project is Nokia 6111 (Left: Figure 4.8).

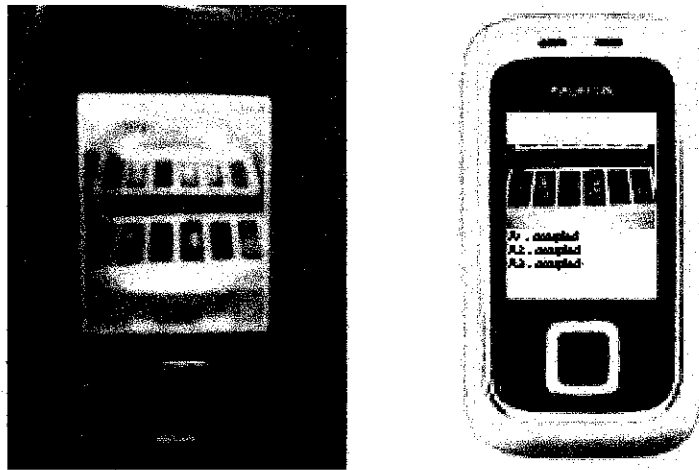


Figure 4.8 System output on Bluetooth enabled device

**(ii) Example of data after image processing from Matlab**

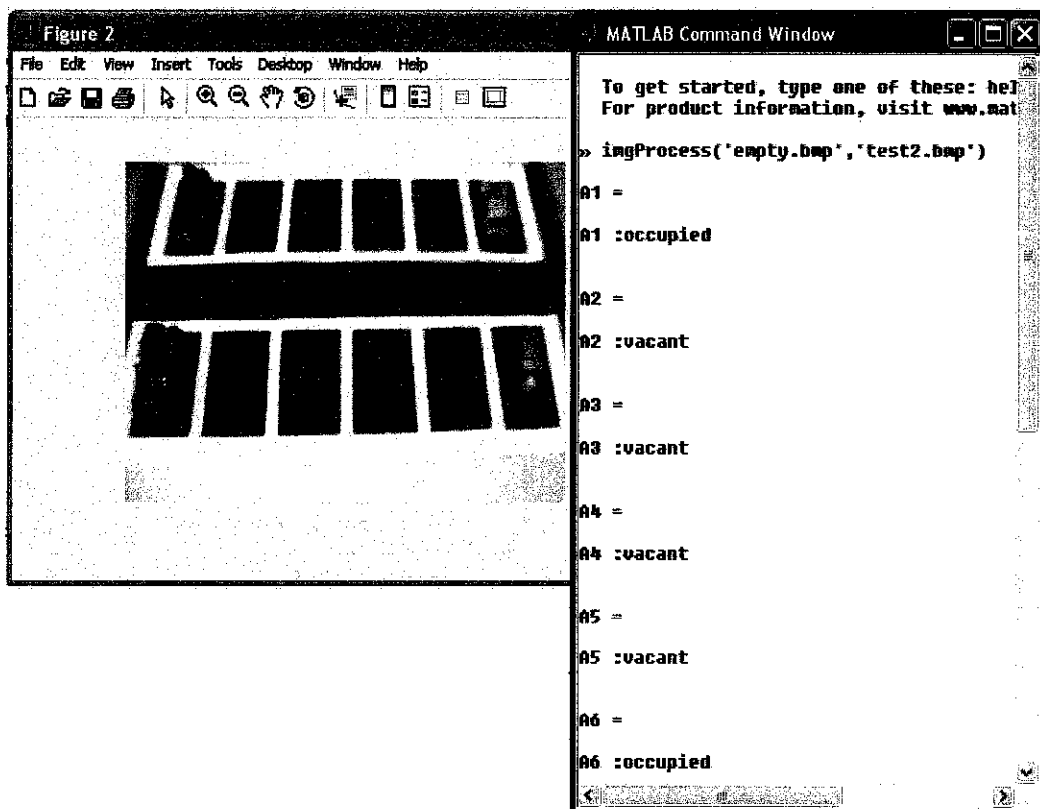


Figure 4.9 Example of Image Processing output.

### **(iii) System Constraint**

Systems constrain that need to be considered is:

- The position of the camera needs to be static in particular location, where it can view the whole parking area. If the position of the camera is moved to the left or to the right (as shown in Figure 4.10), from the initial setup position, the image of the parking area still would be captured but the information about the available parking spaces would be inaccurate.

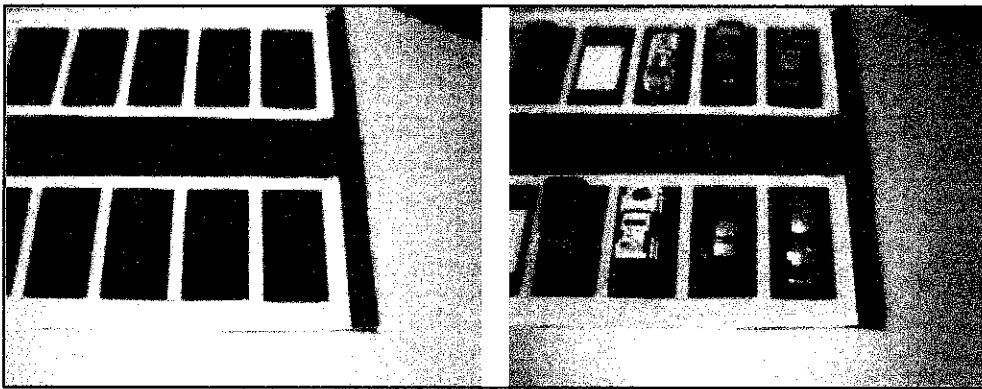


Figure 4.10 Example of system input from a moved camera

## **4.2 Discussion**

### **4.2.1 Integrating MATLAB and VB.NET**

The integration between matlab and visual basic is done by calling a COM object and .dll, which are created by MATLAB, from Visual Basic. The ProcessImage function (VB.Net) calls the imgProcessing function (Matlab) and run the m-file. Each of the output is saved into the database. The integration is automated without opening the workspace window. The system captures and saves the images in a particular folder. Then, the latest image is grabbed and processed (by calling the m-file function in matlab) automatically. The image and available location can be viewed by administrator. (Figure 4.11)

## 4.2.2 Data extraction

The information of available parking space and numbers of available parking space is extract from MATLAB function to Microsoft Excel (as database). This information then is shall be viewed by administrator as well as Bluetooth-enabled mobile user (drivers). The information includes image name, row and column of each parking space.

```
Private Sub ProcessImage(ByVal refPath As String, ByVal curImg
As String)
    Dim imgFile As String
    Dim p As Processing.processImgClass
    p = New Processing.processImgClass
    Try

        p.imgProcessing(refPath, curImg)
        imgFile = curImg & ".txt"

        Dim fReader As StreamReader = New StreamReader(imgFile)
        rchLocation.Text = fReader.ReadToEnd
        fReader.Close()
        fReader = Nothing

    Catch ex As System.Exception
        MsgBox(Err.Description)
    End Try
End Sub
```

Figure 4.11 ProcessImage function – calling m-file function from VB.Net

## 4.2.3 Help Function

This system also provides Help function as a guide for end-user. The Help function provides user manual and detail explanation on every menu items, buttons, and functions of each toolbar, as well as the interface of every window in the system. The Help function focus on guiding user especially novice user, to ease their navigation on the system and provide a user-friendly system. User can click on the Help -> User Guide menu item to view this window (Figure 4.12) or press F1.

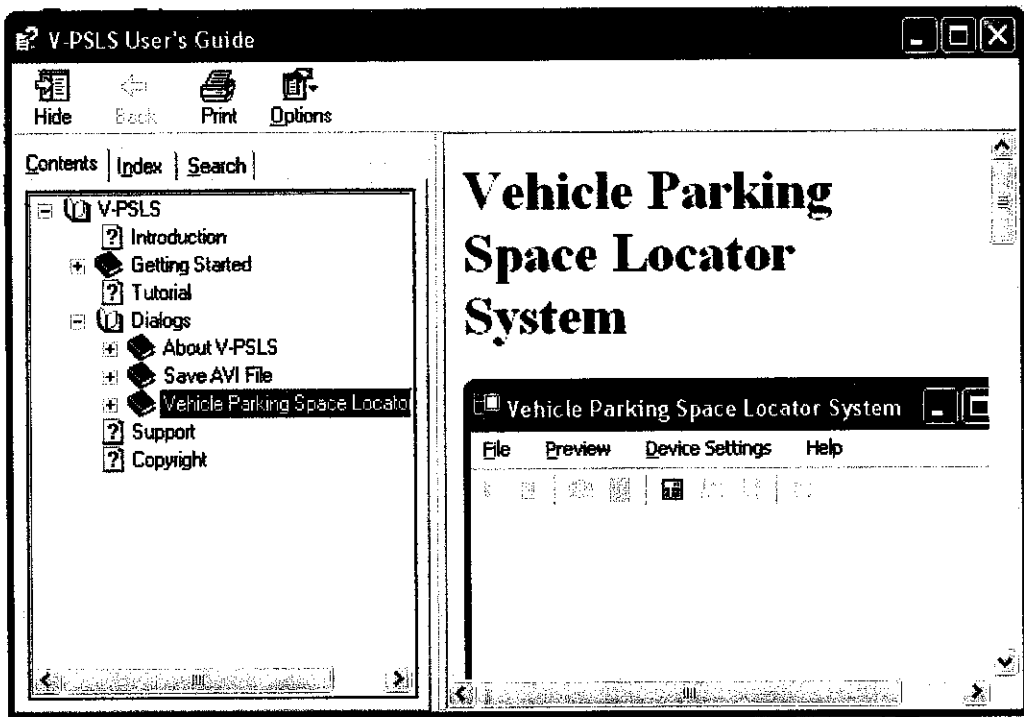


Figure 4.12 Help function

## **CHAPTER 5**

### **CONCLUSION AND RECOMMENDATION**

#### **5.1 Conclusion**

This report describes the overview of the Vehicle Parking Space Locator for Surveillance system development. The system is utilizing the Bluetooth wireless technology with mobile phone. The development of this system has to successfully resolve the problems derived from the finding of parking space in parking area and provide reliable and accessible system for all mobile users. This report also explains the appropriate methodology to be used in developing the system, which is Rapid Application Development (RAD). The system hardware and software requirements and specifications to be used also mentioned briefly. The system application is aim at giving mobile clients maximum facilities of the mobile phones and comfortableness in searching parking space.

This system is expected to benefits mobile users and drivers, as well as parking area providers with some enhancements on certain area of the system. The results show that by utilizing Bluetooth technology, the system provides low service cost and expects to meet user needs. This project shows the capability of developing new idea and technology to improve on existing applications for better human lifestyle. In addition, I believe I have gained both practically and academically in acquiring management and communication skill throughout the project development. This project is quite challenging since it require the developer to have sufficient knowledge of all the application being used in order to come out with excellent results. There are a lot to be improved on the system especially on the database part and integrating with other Bluetooth applications, which may require a lot of memory spaces to make sure the system functions smoothly.

## **5.2 Recommendation**

Suggested future work for expansion and continuation:

### **(i) Provide more security measure with surveillance**

Currently, the system only provides monitoring service, which administrator can monitor the parking area and vehicles activities, enter and exit the parking area only. It would be better if the system can detect and identify the vehicle that enter and exit the parking area and trigger an alarm if there are different activities or suspicious activities going on. For instance, if there's someone or unauthorized person, who suddenly change the position of the camera, an alarm is triggered.

The system also should support error detection codes to detect incorrect user input and output. For example, if the system can not process the image correctly, a pop up message would appear to inform the administrator "The image is invalid" instead of displaying the incorrect location information.

The system also may provide backup data for the images and data. However, this may require a big system storage and memory space.

### **(ii) Can detect if the parking area is resized**

The system should also be able to detect if the parking area size has been resize, and be able to grab the correct number of parking lot after it has been resize and produce the correct output. For example, if the number of parking lot is added from 12 to 18, the system should be able to detect that the current parking lot is 18, and process 18 parking lot instead of just 12, providing the camera also has been resize accordingly.

### **(iii) Computer storage and memory space**

It would be better if the developer/administrator could have better data storage so that all the images can be kept for specific time (3 or 4 months) for reference. Larger memory space (RAM) also needed to ensure the system can run smoothly without hang or rebooting, since image processing using Matlab and the integration made requires a lot of memory spaces.

**(iv) 'Refresh' function and more user friendly system.**

The system also should provide 'Refresh' button so that user can always return to clear state/previous state if inappropriate condition happens on the system. The system should also provide more option for administrator to view the previous saved image or saved video file from the system interface while monitoring the parking area. Admin do not have to minimize the system window and go the folder and search for the image manually.

Easy navigation from one link to another is required especially for beginner users. It would be better if next future enhancement have more user-friendly interface that provide user with easy navigation. Currently, the system provides Help function to guide user to setting up the device and previewing methods.

**(v) Gives more option for user/drivers to get information about parking space.**

Current system focus on helping drivers who are on the way to the parking area, that need information about empty parking space in a particular parking area. This system only applicable if the user have Bluetooth-enabled devices/mobile phone. For future enhancement, the system may have two options, which are Bluetooth technology and web-based application for other people outside the Bluetooth system range. For instance, a driver A, who do not have Bluetooth-enable device, wants to park his/her car to Parking ABC (that has parking system), then if he/she can call his/her friend from outside to look for available parking space on the internet/website.



**(vi) Detect and display the expected output on real user's Bluetooth enabled devices**

The system should be able to detect when a user connects with the system using their Bluetooth mobile phone, and the system should be able to send the image of the current parking area WITH the location information automatically (as shown in Figure 4.8). Currently, the system is able to send the current image of parking area to user's Bluetooth mobile phone but WITHOUT the location information, and it is done manually (administrator get the current image and send it to user)

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**Gantt Chart for Final Year Project Part 2**

		Final Year Project Part 2													
Project Task/Output	w1	w2	w3	w4	w5	w6	w7		w8	w9	w10	w11	w12	w13	w14
<b>Designing Phase</b>															
Interface development	█								█						
Image Processing development	█								█						
Integration between MATLAB Image Processing Toolbox and Visual Basic.NET															
- Find review and available codes	█								█						
- Error and risk analysis															
Component testing and unit testing	█								█						
Database linkage															
<b>Testing and Implementation Phase</b>															
System Testing and Validation									█						
Submission of Progress Report 1				●											
Seminar 1									●						
Submission of Progress Report 2										●					
Seminar 2										●					
Poster Exhibition (Pre-EDX)											●				
Submission of Dissertation (soft bound)												●			
Oral Presentation														●	
Submission of Dissertation (hard bound)															●

MID SEMESTER BREAK