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MOBILE SURVEILLANCE ROBOT CONTROL BY ANDROID PHONE

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"I hereby declare that I have read through this report entitle "*Mobile Surveillance Robot Controlled by Android Phone*" and found that it has comply the partial fulfillment for awarding the degree of *Bachelor of Mechatronics Engineering with Honours*"

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DEVELOPMENT OF MOBILE SURVEILLANCE ROBOT CONTROLLED BY ANDROID PHONE

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A report submitted in partial fulfillment of the requirements for the degree of Bachelor of Mechatronics Engineering with Honours

Faculty of Electrical Engineering

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JULY 2012

I declare that this report entitle "*Mobile Surveillance Robot Controlled by Android Phone*" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Alhamdulillah, with the patience, strength and wisdom that has been given to me by ALLAH, I eventually manage to complete my final year project. This project has widen my view and given me opportunities to apply my knowledge and skills that I have learnt during 4 years study of Mechatronic course.

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ABSTRACT

An intelligent mobile surveillance robot are required in most of the military and civilian activities, such as an aided device in the military system of a country, as well in the mission of civil defense team, and other functions. Practically, it is an electro mechanical system which usually use device from many types of sensors for navigation and motion control. Smart mobile phones with Android operating system also have some types of sensors that can help for controlling the mobile surveillance robot. The goal of this project is to control the mobile surveillance robot by using android phone and a picture from the camera mounted on the mobile surveillance robot and the illustration also can be viewed from the display screen on the computer. However, there's two types of methods on how to controlling the mobile surveillance robot either by using Wi-Fi or Bluetooth interfaces and this project will use Bluetooth interface for the method of controlling the mobile surveillance robot. This project actually a kick starts to develop mobile security system in the future as the first step is to control mobile robot by using Android phone. At the end of this project, it is able to produce a controller application for Android device to control the robot. The controller consists of basic buttons that are representing the movement of robot by clicking the buttons. The technology of Android phone just not limited only for phone calling or texting, it also can be very useful to the user like surveillance from phone, GPS tracking, portable wireless hotspot and etc. By the power of programming, there's a lot of application can be done to get more better performance for this mobile surveillance robot controlled by Android phone in the future. Therefore, this project needs to achieve the main objective which is to control the robot by using Android phone.

ABSTRAK

Robot pengawasan pintar mudah alih diperlukan dalam kebanyakkan aktiviti ketenteraan dan orang awam, seperti sebuah peranti dalam sistem ketenteraan sesebuah negara , juga dalam misi pasukan pertahanan awam dan lain-lain. Secara praktikal, ia merupakan sistem elektro-mekanikal yang biasanya menggunakan peranti daripada pelbagai jenis 'sensor' untuk pengemudian serta kawalan pergerakan. Telefon bimbit pintar dengan sistem operasi Android juga mempunyai beberapa jenis 'sensor' yang boleh membantu dalam mengawal robot pengawasan mudah alih. Matlamat projek ini adalah untuk mengawal robot pengawasan mudah alih dengan menggunakan telefon Android dan gambar dari kamera yang dipasang pada robot pengawasan mudah alih dan ilustrasi juga dapat dilihat menerusi skrin paparan komputer. Walau bagaimanapun, terdapat dua jenis kaedah untuk mengawal robot pengawasan mudah alih sama ada dengan menggunakan pengantara muka 'Wi-Fi' ataupun 'Bluetooth'. Projek ini akan menggunakan antara muka 'Bluetooth' bagi kaedah mengawal robot pengawasan mudah alih. Projek ini sebenarnya merupakan titik permulaan untuk membangunkan sistem keselamatan mudah alih pada masa akan datang sebagai langkah pertamanya adalah untuk mengawal robot mudah alih dengan menggunakan telefon Android. Pada akhir projek ini, ia mampu untuk menghasilkan aplikasi pengawal untuk peranti Android bagi mengawal robot. Alat kawalan terdiri daripada butang asas yang mewakili pergerakan robot dengan hanya menekan butang pada peranti Android. Teknologi telefon Android tidak hanya terhad untuk membuat panggilan atau menghantar mesej tsahaja, ianya juga memberikan banyak kelebihan kepada pengguna seperti pengawasan dari telefon, pengesanan GPS, hotspot tanpa wayar mudah alih dan sebagainya. Dengan kuasa pengaturcaraan, terdapat banyak applikasi yang boleh dibuat untuk mendapatkan prestasi yang lebih baik bagi robot pengawasan mudah alih yang dikawal oleh telefon Android pada masa akan datang. Oleh itu, projek ini perlulah mencapai objektif utamanya iaitu untuk mengawal robot dengan menggunakan telefon Android

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Robot is a device capable to perform capabilities as human while mobile robot is a platform with a large mobility within its environment such as land, air and underwater. The capability of mobile robot normally its can be move around its environment and also they're not fixed to one location only.

The word 'surveillance' comes from the French word which means *watching over*. In the technologies environment, surveillance system used to monitor the behavior of peoples, objects or process. The observation been applied from a distance by means of electronic equipment such as close-circuit television (CCTV) camera. Thus, the development of mobile surveillance robot has given a lot of benefit in military and civilization field.

The concept of this project is use the android device as the console to control the mobile surveillance robot which means substituted the conventional console with the android device. Therefore, it needs to develop an android application to make the android device as the mobile surveillance robot console.

Generally, android is an operating system (OS) led by Google and developed by Open Handset Alliance companies. Previously, Symbian was the best OS been used in the mobile phones, but today android seem become the most popular among software developers because of its powerful capabilities and open architecture. In Android way, the most commonly used as programming language is java since java is worldwide, faster, secure and more reliable to be use from laptops to mobile phones, from game consoles to the internet, and everywhere. Developing android application can be done by using Android Software Development Kit (SDK) or Android Native Development Kit (NDK) as the tool to compile the source code.

Even Android SDK is the most suitable for application development, but sometimes it is not efficient and need access to native code usually done in C or C++ language. The native code can be access via Java Native Interface (JNI) but the process rather complicated. Usually need to arrange everything in the host computer to the target architecture, which required having the entire tool chain on the development machine. Android NDK simplifies working with native code including the entire tool chain needed to build for the target platform.

1.2 Problem Statement

The purpose of this project is for the student to design mobile surveillance robot as the hardware and develop android application use to control the mobile surveillance robot. This mobile surveillance robot must be robust vehicle capable of travelling indoor mostly on flat surface and able to carry the load of any components that are necessary for it to accomplish its function and its also will provide the student with experience in the design and development process from the conceptual to the implementation. Furthermore, this project will produce a mobile surveillance robot that can be controlled by using android phone once completed. The idea to develop this project occurs to:

1. Enhance the existing security system.
2. Create the dynamic security surveillance system from the initial static security surveillance system.
3. Prevent criminal by giving the power of distance monitoring in residential and business commercial area.
4. Reduce the conventional surveillance system risk and responsibility to the more efficient and effective system.

1.3 Project Objectives

The goal of project is to ensure the movement of mobile surveillance robot remotely controlled by Android device. The main objectives to ensure the successful of the project are as follows:

1. To develop the circuit and hardware including the module for motor control, video sensing, and communication between robot and android device.
2. To develop the android application for the surveillance robot, hence the robot can be remotely controlled from the android device.
3. To evaluate the robot system and Android application developed.

1.4 Scope of the Project

Mobile surveillance robot controlled by using android device is a robot that the movement can be control by using android device as the console. The scopes in this project are stated below:

1. Limitation range of the Bluetooth connection between 5-20 meters.
2. Software application to control the mobile surveillance robot developed using java programming and android SDK.
3. Monitoring are limited for the indoor area only.
4. This mobile surveillance robot only can move on the flat surface.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, a review of previous related projects will be discussed. This study is a tool to generate some ideas about how this project works based on the achievement of the related projects and also to think about the advantages of the proposed solution. This may help in problem solving skills and options required for design and develop the mobile surveillance robot control by using Android phone.

2.2 Related Project

In this part, a review of related project will be discussed in order to achieve on the implementation of the project base on the related project.

2.2.1 Surveyor SRV-1 Blackfin Robot

Surveyor SRV-1 BlackFinRobot is a type of mobile robot that had been developed from the Surveyor Company which is this robot is containing a wireless system robot with video sensing. Surveyor's SRV-1 internet controlled robot employs the SRV-1 Blackfin Camera Board with 1000mips, 500MHz analog devices BlackFin BF537, 32MB SDRAM, 4MB Flash, JTAG processor, a digital camera with resolution from 160x128 to 1280x1024 pixels, laser

pointer or optional ultrasonic ranging and WLAN 802.11b/g networking on a quad-motor tracked mobile robotic base.

Figure 2.1: SRV-1 BlackFin Robot [3].

SRV-1 can be remotely managed from a Windows, Mac Os/X or Linux base station with Python or Java based console software or run onboard interpreted C programs or user-modified firmware due to the operation as a self navigating autonomous robot that can be remotely-controlled webcam. SRV-1 can be monitor and control through a web browser anywhere in the world, as well as video archives consuming demand or on schedule with a Java-based console that includes a built-in web server. RoboRealm machine vision software, Microsoft Robotics Studio and Cyberbotic's Webots were the additional software support available for the SRV-1 [3].

2.2.2 Arduino Robot with Camera Controlled by Android

Donut the drone was the name for this robot given by the developer. Generally the main body part such as the tires and the chassis were from cheap RC car that the developer had recycled its own toy. The developer had placed Arduino and breadboard of the RC car body and hooked the motor wires up to the H-bridge. The developer also fitted a servo motor with wireless cam fastened on top and by using VLC software, the developer able to stream the live

video feed from the camera onto the network. The developer also able to view this feed from Android phone while controlling the robot by using the 'VideoView' control from Android SDK. However, there's about 5 second latency on the video stream on the Android phone that haven't been able to solve [7].

Figure 2.2: Donut the Drone [7].

2.3 Conventional Console of Mobile Robot

The conventional way of controlling the robot is using the joystick as the interfacing with the robot. The capability of joystick is just to make the movement of the robot. In the previous years before, this method is very popular in communication with the robot. It is very easy and convenient to use to control the robot. Figure 2.3 below is an example of the conventional console to control mobile robot.

Figure 2.3: Example of conventional console to control mobile robot [8].

2.4 Android Phone as Console

Android device is the most popular device nowadays. It is because of its capability to do so many things and it's all in your fingertips and it also free architecture. By developing application for android, this device also can be use as remote console to control mobile robot. It's also can be develop with other application in the same user interface for example 'VideoView' widget; its function was to monitor streaming video from the network. This can be done by developing the android user interface. Figure 2.4 (a) below show the example of android user interface.

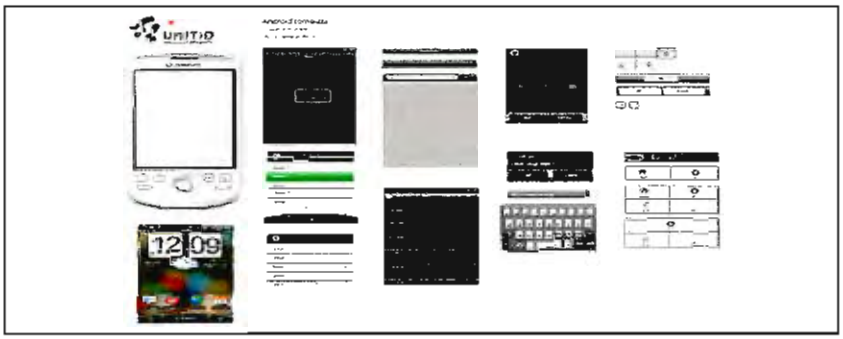

Figure 2.4 (a) : Example of android user interface [8].

Howard Gordon, the maker of SRV-1 Blackfin robot platform had collaboration with Jeffrey Nelson, the maker for Forknife robot and Jeffrey Nelson developed an open source code for SRV-1 Android console application to remotely control the robot and also allowed the view captured from the camera mounted at the robot from G1 phone. Figure 2.4 (b) show the Android console developed by Jeffrey Nelson[6].

Figure 2.4 (b): the Android console developed by Jeffrey Nelson **[6]**.

2.5 Method of Programming Language to Develop Android Application

There were various ways of programming language that can be use to develop an android application such as Java programming language, android (SDK), android (NDK), flash and C/C++ programming language based on a study of development android application. At the end each type of this programming language will also need to do in Java programming language to compile the source code into Dalvik Executable files and then it's zipped into single ".apk" (Android Package) file on the device. The Dalvik Executable files can be created by automatically translating compiled applications written in the Java programming language[1].

The correct project structure for the Android application and to keeps the resources compile to the user automatically can be done by using the Android SDK with Java Eclipse plugin software where by using this software, it was the easiest and the fastest way on developing an Android application [1].

Marko Gargenta on his book said every once in a while you need access to native code even though Android SDK is great for application development. This code usually exposed in C or C++ language. Android application can call some native code and even include some native libraries such as C library and math library by using the NDK. While you were able to access native code via JNI all along, the process was rather hard[2].

2.6 Microcontroller

Microcontroller also one of the main part in this project, it's generally used to control the robot part such as DC motor and other components. Normally, a PIC16F877A microcontroller has been used during our studies but based on related project (Perseus 3 Robot Platform), they used ATMega microcontroller to control the motor, gather data from sensors and interface a serial Bluetooth module[3]. In this part, the comparison between PIC16F877A and ATMega32 microcontroller has been made. Normally, ATMega microcontroller been used in the Arduino board. Table below show the comparison of both microcontrollers [4][5].

Table 2.1: Comparison between PIC16F877A and ATMega32[4][5].

	PIC16F877A	**ATMega32**
Specification	Pin Count: 40-pin PDIP Program Memory: 14KB or 8K 14-bit Flash Max Crystal Speed: 20MHz RAM Bytes: 368 EEPROM Bytes: 256 Timers: 2 x 8 bit, 1 x 16-bit Digital Communication: 1xA/E/USART, 1 x MSSP(SPI/I2C) Capture/Compare/PWM: 2 x CCP ADC: 8ch, 10-bit Comparators: 2	40-Pin PDIP package Max speed: 16MHz or 16 MIPS 32 KBytes of Flash 1024 bytes EEPROM 2 KBytes Internal RAM 2 x 8-bit Timer/Counters 1 x 16-bit Timer/Counters 4 x PWM Channels 8 x 10-bit ADC channel 1 x USART
Advantages	Very good internal reference unit for comparator. The programming can be erased and written a lot more times. The price is much lower compare to ATMega32.	Internal Vref for ADC. Timer can be prescaled to 1024. Differential mode ADC with gain 1x, 10x or 200x. Comparator can be multiplexed to all analog inputs. Compare and PWM modules on each timer.

Thus, both microcontrollers are good but the usage of which microcontroller that been depending on the needs of the projects.

2.7 Connection

There were various types of connection between Android and the mobile surveillance robot such as Bluetooth connection, wireless connection or direct via USB[12]. Observation from related project using the Android Platform to Control Robot in order to establish useful connection between Android and robot, the most popular connection were between wireless internet and Bluetooth.

Controlling robot with Bluetooth connection much easier to used as the function of the Bluetooth module was just like Usart in microC programming software, for example when the button forward been clicked, it will send a 'string' message "F", when the microcontroller receive the message it will generate the motor to move forward.

Compared to Bluetooth, wireless connection was a bit harder than Bluetooth. Basically the function was quite similar to the Bluetooth connection but there was more to do to established a connection between android and robot. For basic connection, it is necessary to set the wireless network configuration parameters such as SSID, passwords, etc. and after it establish the connection[12].