ANDROID MOBILE GRIPPING ROBOT

TAN KIT OON

B.ENG (HONS.) MECHATRONICS ENGINEERING

UNIVERSITI MALAYSIA PAHANG

ANDROID MOBILE GRIPPING ROBOT

TAN KIT OON

Thesis submitted in partial fulfilment of the requirements for the award of the degree of Bachelor of Mechatronics Engineering (hons.)

Faculty of Manufacturing Engineering
UNIVERSITY MALAYSIA PAHANG

JUNE 2015

UNIVERSITI MALAYSIA PAHANG

DECLARATION OF THESIS AND COPYRIGHT

Author's Full Name : TAN KIT OON

Identification Card No : 910408-07-5501

Title : ANDROID MOBILE GRIPPING ROBOT

Academic Session : 2014/2015

I declare that this thesis is classified as:

☐ **CONFIDENTIAL** (Contains confidential information under the Official Secret Act 1972)

☐ **RESTRICTED** (Contains restricted information as specified by the organization where research was done)*

☐ **OPEN ACCESS** I agree that my thesis to be published as online open access (Full text)

I acknowledge that Universiti Malaysia Pahang reserve the right as follows:

1. The Thesis is the Property of University Malaysia Pahang.
2. The Library of University Malaysia Pahang has the right to make copies for the purpose of research only.
3. The Library has the right to make copies of the thesis for academic exchange.

Certified by:

_____ _____

(Signature of author) (Signature of supervisor)

TAN KIT OON (910408-07-5501)

Name of Supervisor

Date: _____ Date: _____

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of Bachelor of Mechatronics Engineering.

Signature :
Name of Supervisor : Dr. Ng Liang Shing
Position : Senior lecturer
Date :

EXAMINER'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of Bachelor of Mechatronics Engineering.

Signature :
Name of Supervisor : Mr. Zulkifli Bin Md Yusof
Position : Senior lecturer
Date :

STUDENT'S DECLARATION

I hereby declare that the work in this thesis is my own hardwork except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

Signature :
Name : Tan Kit Oon
ID Number : FB 11057
Date :

ACKNOWLEDGEMENT

I would like to express my greatest gratitude to my parents who always give the support when it is needed. I would like to thank University Malaysia Pahang for allowing to study and complete this course in here. I would also like to thanks to Faculty of Manufacturing Engineering for providing the facility for me to complete the entire project. Last but not least, I would like to aknowledge my project supervisor Dr. Ng Liang Shing, I am sincerely appreciate and feeling thankful for his guidance and and wisdom which enlighten me throughout the project period.

ABSTRACT

Mobile gripping robot is one of the well known robot platform for development in the field of robotic. It is the best platform of robot before further develops into advance autonomous robot with picking object features. The main features of the mobile robot is able to be control wirelessly form a distance. This can be achieved by Bluetooth communication with an Android device. As the technology of Android operating system has been developing rapidly, it has been in of the most used platform in smartphones and it has been implements to control all kinds of peripheral devices like servos, motors and others. MIT App Inventor is one of the software available in the market which can be used for developing Android app. The main objective of this project is to develop an Android app using the MIT App Inventor software to control a mobile gripping robot. Additionally, this project is also to implement the feautres of an Accelerometer in an Android device to control the movement of the mobile gripping robot. The implementation of MIT App Inventor software ‘s block programming simplify the development of an Android app which can be used in the field of robotic to control a robot. Other than that, with MIT App inventor software the Accelerometer of an Android device can be used for control purpose too. The implementation of the Android device for controlling a mobile robot will save a lot of cost and time of the researchers of robotic field in building a controller for a premilinary stage robot. As the implementation of the Android device as controller of a mobile robot can be achieved by developing app using MIT App Inventor Software.

ABSTRAK

Robot kawalan jauh adalah salah satu platform robot yang terkenal dalam pembangunan bidang robotik. Ia adalah platform yang terbaik untuk robot sebelum dipertingkatkan lagi kebolehannya untuk menjadi robot autonomi. Ciri-ciri utama robot kawalan jauh ialah dapat dikawal dari jarak jauh. Ini boleh dicapai dengan komunikasi Bluetooth dengan peranti Android. Sebagai teknologi sistem operasi Android telah berkembang pesat, ia telah menjadi platform yang paling banyak digunakan dalam telefon pintar dan ia telah menjadi alat untuk mengawal semua jenis peranti persisian seperti servo, motor dan lain-lain. Perisian MIT App Inventor adalah salah satu perisian yang terdapat di pasaran yang boleh digunakan untuk membangunkan Android aplikasi. Objektif utama projek ini adalah untuk membina sebuah aplikasi Android menggunakan perisian MIT App Inventor untuk mengawal robot menggenggam mudah alih. Selain itu, projek ini juga adalah untuk menggunakan kelebihan daripada jangka pecut dalam peranti Android untuk mengawal pergerakan robot kawalan jauh untuk mengengam objek. Pelaksanaan pengaturcaraan blok perisian MIT App Pencipta memudahkan pembangunan aplikasi Android yang boleh digunakan dalam bidang robotik untuk mengawal robot. Selain itu, dengan MIT App pencipta perisian pecutan bagi peranti Android boleh digunakan untuk tujuan kawalan juga. Pelaksanaan peranti Android untuk mengawal robot mudah alih akan menjimatkan banyak kos dan masa penyelidik bidang robotik dalam membina pengawal untuk robot peringkat premilinary. Sebagai pelaksanaan peranti Android sebagai pengawal robot mudah alih boleh dicapai dengan membangunkan aplikasi menggunakan MIT App Pencipta Perisian.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVATIONS

MIT	Massachusetts Institute of Technology

CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

Android is a well-known operating system for smartphones like Samsung, Lenovo, and others. This operating system is based on the free source Linux kernel which is developed by Google. It is designed for smartphones with features touchscreen features which enable the users to touch, tap, swipe and pinching to control the function of the phone of to utilize the built in tools of the smartphones.

The rapid increasing number of smartphones user has make the Android operating system top of the chart of number of users in operating system. As a consequent, this also developed interest of people in utilize the smartphone's operating system to wirelessly control the servo, motor, and others. This has been a new way of controlling which has a lot of benefits. The implementation of Android based smartphones has a lot of benefits as Android operating system is free and easily can be developed by using different kind of software. For example, Eclipse and MIT App Inventor Software which both of this software can easily available online and it is open source.

The advantages of open source and it can wirelessly control all kinds of actuator mentioned make it an ideal way of developing into a robot controller. This is because it is easy, versatile and it can save cost as it is suitable to be implemented as a wireless controller for preliminary stage of robot before further develop a better controller when

the whole robot project is complete. It also provide good versatility of controlling the robot as the smartphones can control it either by Bluetooth or the WiFi.

Figure 1.1: Android operating system

Source: www.android.com

Figure 1.2: MIT App Inventor softwar**e**

Source : appinventor.mit.edu/explore

Figure 1.3: Eclipse development software

Souce: https://**eclipse**.org

1.2 PROBLEM STATEMENT

In the recent year, the robotic field has been develops rapidly but still there are researchers and students who are still beyond reaching the advancement of the technology. One of the major problems is the development of controller for controlling the mobile robot wirelessly. As it is difficult to build and develop a proper controller which is portable, convenient and simple.

The controller which is usually used is by using laptop to control the robot wirelessly either through Wi-Fi or Bluetooth. However, using laptop has some major disadvantages which is laptop is not portable which makes the user inconvenient compares to using the low powered tablets or smartphones as Android devices is lighter compares to laptop.

Other than that, one of the famous used wireless communication medium is the radio frequency control (RF control). This type of control has advantages in term of range. It is able to cover a further range compares to Bluetooth. However, it stills has some limitation as it is prone to disturbance when several party is operating in the same range of frequency which makes the communication to be faulty On the other hand, using

Bluetooth for communication it has some drawback in terms of range but it properly secured. Bluetooth communication has certain protocol which required both party to pair with each other before the transmission can be initiate. Bluetooth also operates using the frequency hopping spectrum policy which means that for each second the frequency of transmission changes 1600 times in order to prevent interference of other network.

RF control is not easy to develop a stable module as it is prone to noise and on the other hand Wi-Fi module is not cheap to be implement for controlling a mobile robot. Bluetooth as mentioned above is secured and free from interference of other party which operates in the same frequency and Bluetooth module is easier to obtain and cheaper compares to Wi-Fi module. Therefore, Bluetooth is suitable to be used a preliminary stage of controller for trial stage before further develop to more advance level of controller which can cover further range.

From the problem mentioned which include the weight of controller which cause inconvenience to the user, interference of other network with same frequency of operation, and other module of communication which is more expensive than Bluetooth module that is the problem to be solved.

1.3 OBJECTIVES

I. Develop an Android app using the MIT App Inventor software and control the movement of the mobile gripping robot by using the android device.
II. Utilize the accelerometer of the android devices for controlling the movement of the mobile gripping robot.

1.4 PROJECT SCOPE

I. Add in Bluetooth module to the RC truck controller for communication purpose.
II. Add on ultrasonic sensor to the RC truck for detecting the obstacles in front of the mobile robot.
III. Develop an Android app using MIT App Inventor software to control the mobile gripping robot through the Bluetooth module.

1.5 PROJECT OUTLINE

The progress flow on the implementation of the project is written into five chapters including this chapter. The content of each chapter is outline as follows:

Chapter 1 is about the overview, problem statement, objectives and scopes of the project.

Chapter 2 is about the literature reviews on the methods of implementation of Android devices and Android app in controlling a mobile robot which conducted by researcher or developers in the recent years.

Chapter 3 is about the description of hardware, sensor, controller and methodology which is implemented on this project.

Chapter 4 is about the results and discussions of this project. The outcome of the project is expected to be an Android app which is used to control the mobile gripping robot accordingly

Chapter 5 represents the overall conclusion of the project stages. Suggestion on the improvement for future studies regarding the hardware and software.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter is about the review and discussion of other researcher developers who conducted project which is related to Android app and Bluetooth module for communication purpose and controlling a mobile robot.

2.2 ANDROID CONTROL MOBILE ROBOT

2.2.1 BLUETOOTH CONTROL ROBOT

One of the mostly used of communication medium is Bluetooth which is easily can be implement for controlling a mobile robot. The implementation of controlling robot through Bluetooth with addition of display, voice and ultrasonic sensor (Nadvornik J., 2014).

Basically this robot is build base on the platform of the LEGO Mindstorm construction kit which easy and can be customize to suit different kind of design of chassis. It consists of the electric motor, motor driver, power cables, and wheels. This robot also equipped with different kind of sensors which include ultrasonic sensor which is use for measuring the distance, a light sensor, a sound sensor, and 2 touch sensors.

In terms of the Android app used is developed in the Java programming language by using Android Software Development Kit with additional of other plugins which include Eclipse programming software. While in terms of controller it used NXT kit

which is programmed using the box programming method under development of NXT-G which graphical programming environment.

In communication wise, the communication medium chosen is Bluetooth because it has lower power consumption compares to Wi-Fi which can cover a wider range but consume more power.

The user interface created which is the Android app initially consist of home screen which enable user to scan and connect to specific robot through robot. After connected, user can initiate control by moving a displayed red ball than the application running screen will appear for user to control the direction and the speed of the robot.

Figure 2.1: Lego Mindstorm robot

Source: Nadvornik J. (2014)

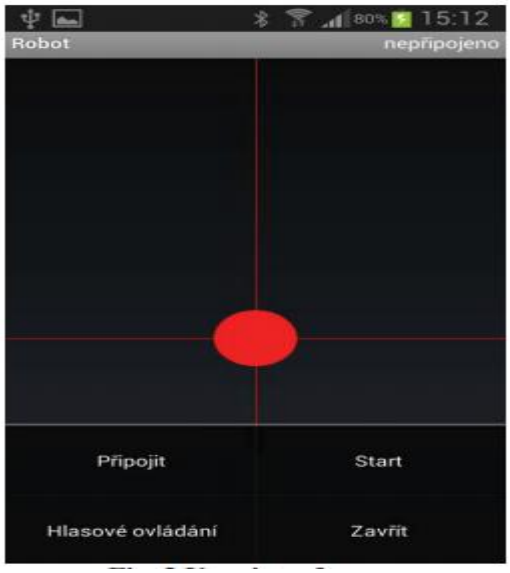


Figure 2.2: Home screen of the developed Android app

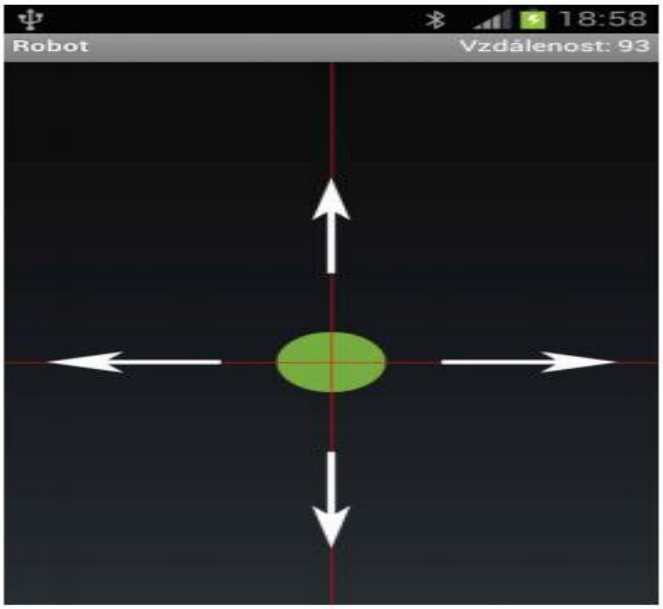


Figure 2.3: Application running screen

Source: Nadvornik J. (2014)

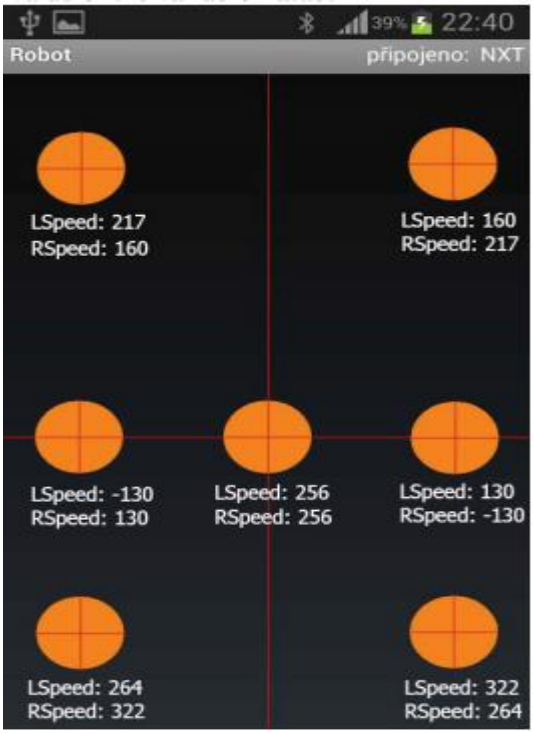


Figure 2.4: Data received by sensor

Source: Nadvornik J. (2014)

2.2.2 BLUETOOTH LEGO MINDSTORM ROBOT

In the Technical University of Kosice another Lego Mindstorm robot controlled by Android smartphone has been done (Vince.T et al., 2013). This robot is also build using the LEGO Mindstorm contruction kit which flexible for modification and suit the installation of the NXT controller brick. The robot develop by Technical University of Kosice basically consist of three main parts which are the robot platform, NXT brick which is the controller and the sensors. This project basically developed under the quite similar platform design of another LEGO Mindstorm construction kits by Nadvornik J., 2014.

The controller which is NXT brick contains 3 output and 4 inputs which attached with three motors and four sensors respectively. The program can be uploaded through the USB port provided. A communication with an Android device has been established

by using Bluetooth communication for controlling the movement and reading the sensors input.

Figure 2.5: NXT brick

Source: Vince.T et al.(2013)

Figure 2.6: Normal mode – controlling robot through touch button.

Source: Vince.T et al.(2013)

Figure 2.1: Progressive mode: controlling the robot through sliding the arrow.

Source: Vince.T et al. (2013)

Figure 2.2: Gyroscope mode- controlling the robot through the smartphone's gyroscope

Source: Vince.T et al. (2013)

2.2.3 ROBOT CONTROL DESIGN BASED ON SMARTPHONE

On the 60th anniversary of Shandong University of Science and Technology a service robot was designed and built (Lu X. et al., 2013). Instead of designing the robot to be controlled by keyboard and mouse, the robot was built to be controlled by an Android devices. It's able to connect with mobile phones by wireless communication.

Basically, it consist of two main parts which are the smartphones part and the robot host part.

The communication of the robot is perform using WiFi which required certain protocol. The wireless network consist of the AP (Access Point) and Wireless network card. It has high transmission speed better range of coverage.

Firstly, the communication is established and ensure that the network between the smartphone and the robot can be established. The socket established will send connection request for robot to accept the request. When connection is established, the Android system in the smartphone is acting as the wireless controller to send input the robot. The app is developed based on Linux platform which is developed by Google and run under Java programming language.

The effectiveness of the Android mobile is reliable and it runs the program using the double thread and synchronous network sockets to communicate with the robot. On the other hand the smartphone can support different kind of input which includes the voice input or handwritten input from the user.

Figure 2.3: System composition

Source: Lu X. et al. (2013)

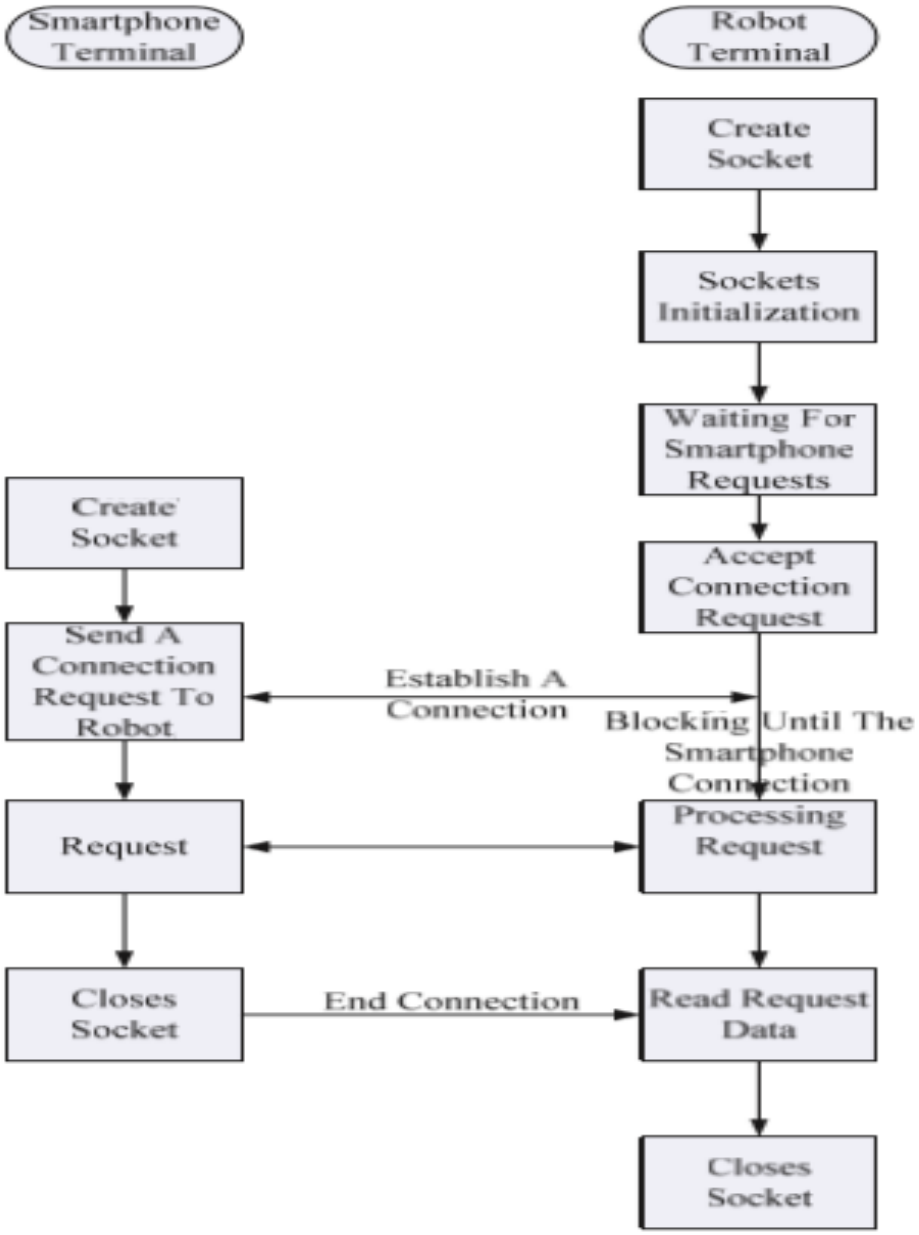


Figure 2.4: Smartphone system flow chart

Source: Lu X. et al. (2013)

\

Figure 2.5: GUI Interface

Source: Lu X. et al. (2013)

2.2.4 BLUETOOTH TOY CAR BY ANDROID EQUIPMENT

Bluetooth is used to control a toy car with 2 small wheel. The mobile platform will established a communication with the toy car which received instruction to be control by the Android Bluetooth system APL (Cai Jian P. et al., 2013).

This project is divided into major part which are hardware part and mobile software part. On the mobile software part, it uses the Android 2.0 with four level of development. The core level which is the bottom is also based on Linux, and the Library. And the top level is application program. The Bluetooth protocol involves is call BlueZ which is a standard and authorized communication protocol by SIG (Bluetooth Special Interesting Group). On the other hand, for the hardware part it is designed to be mobile within a maze and equipped with 2 39mm stepper motor and driver. The front part of car is installed with IR sensor which issued to sense the maze information.

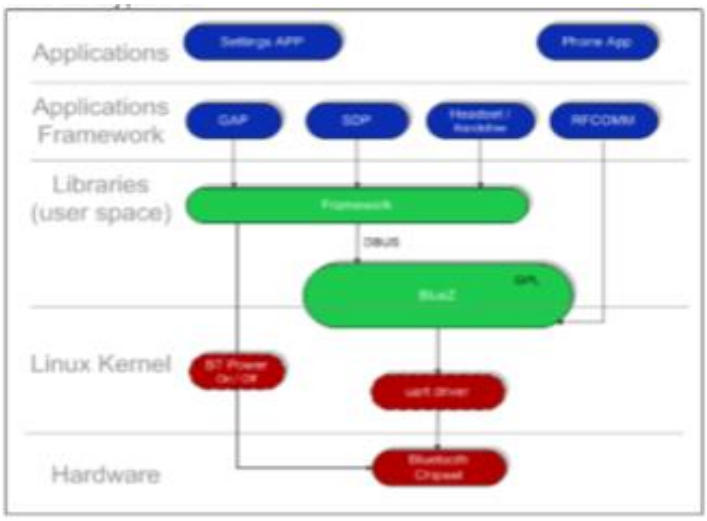


Figure 2.6: Bluetooth protocol

Source: Cai Jian P. et al. (2013)

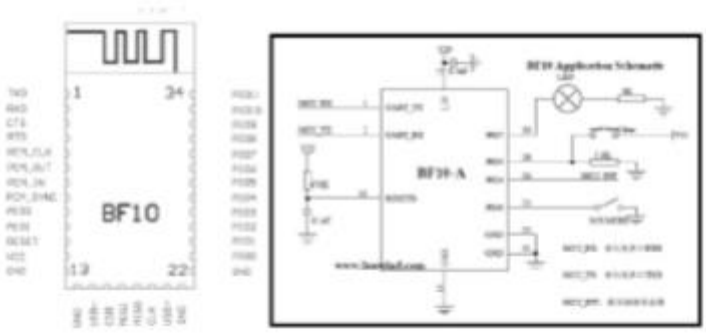


Figure 2.7: Bluetooth module designed

Source: CAI Jian P. et al. (2013)

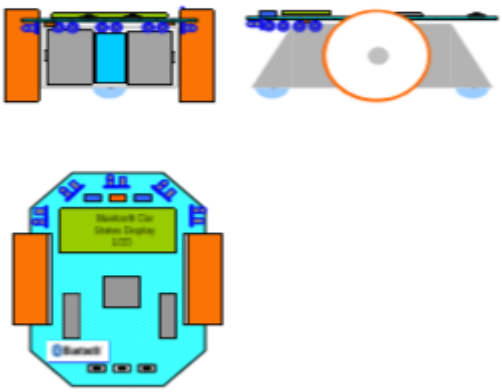


Figure 2.8: Toy car design

Source: Cai Jian P. et al. (2013)

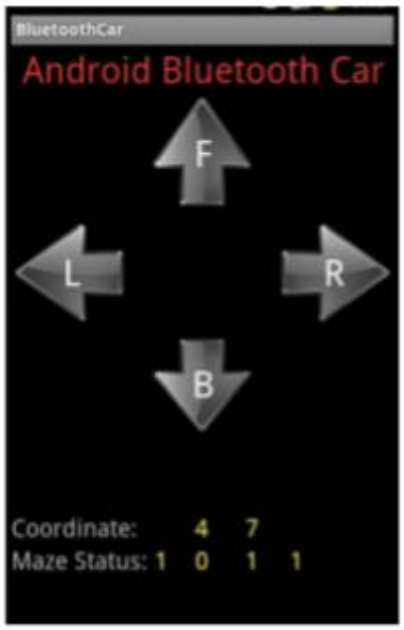


Figure 2.9: Android mobile GUI

Source: CAI Jian P. et al. (2013)

Figure 2.10: Real toy car trial

Source: CAI Jian P. et al. (2013)

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter will be description about the software and hardware involved in this project. The software involved is MIT App Inventor for developing the Android app and Arduino IDE which is used for programming the Arduino Mega. While the hardware is the inclusion of ultrasonic onto the RC truck.

3.2 HARDWARE

3.2.1 ULTRASONIC SENSOR

The sensor used for this project is the ultrasonic sensor. The ultrasonic sensor used is HC- SR04 which is easily available on any electronic store. The purpose of it is to detect the distance between the robot and any object or obstacles in front of the robot.

The working principle of this ultrasonic sensor is the same as the sonar echo used by the creature bat as shown in the Figure 21 below. The sensor itself will generate ultrasonic sonar echo which is 40 kHz and is beyond the range of hearing of human ear. The sonar echo is reflected back to the sensor when the sonar echo hit on any object of obstacles. The reflected echo is detected by the sensor echo sensor. The time for a pulse of sonar echo generated from the sensor to travel to the object and reflected is used to calculate the distance between the sensor and the object.

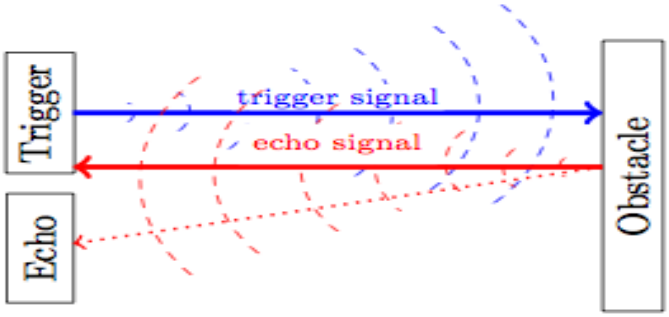


Figure 3.1: Ultrasonic principle of detection

Source: www.electronics-lab.com

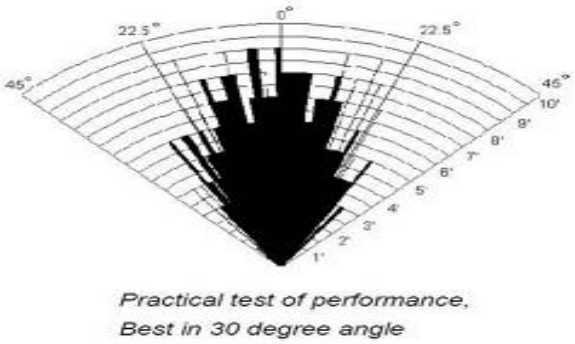
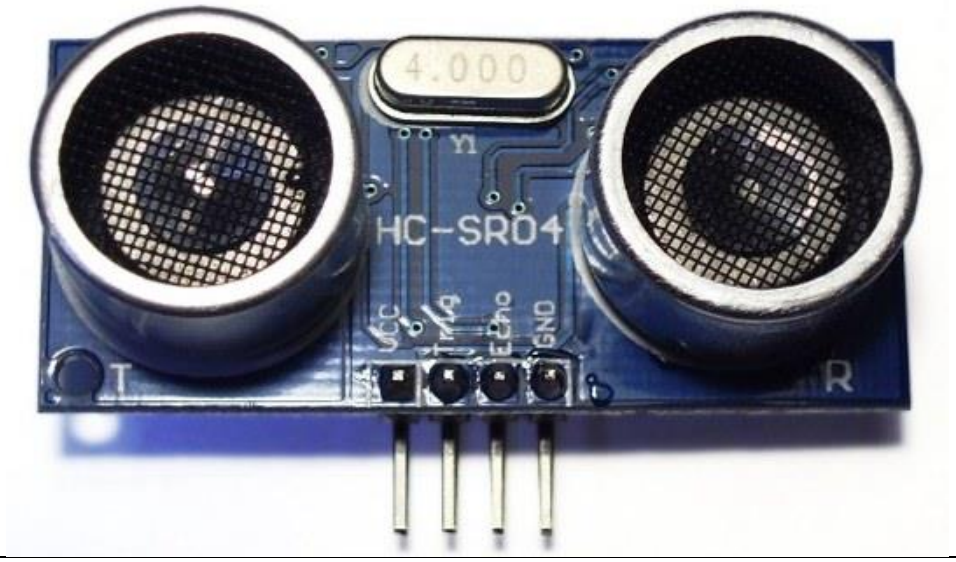


Figure3.2: The range of angle for detection.

Source: www.ce.rit.edu

Table 3.1: Specifications of the ultrasonic sensor.



Features

- Provides precise, non-contact distance measurements within a 2 cm to 3 m range
- Detect up to 22.5° of angle
- Simple pulse in/pulse out communication
- Burst indicator LED shows measurement in progress
- 20 mA power consumption
- Narrow acceptance angle
- 3-pin header makes it easy to connect using a servo extension cable

Key specifications

- Power requirements: +5 VDC
- Communication: Positive TTL pulse
- Dimensions: 0.81 x 1.8 x 0.6 in (22 x 46 x 16 mm)
- Operating temp range: +32 to +158 °F (0 to +70 °C)

3.2.2 BLUETOOTH MODULE

The communication between the android device and the mobile robot itself is established by using the Bluetooth module which is HT Bluetooth Module HC-05. Using the Bluetooth module the wireless communication between the robot and the android device easily can be established compare to other type of communication. For example, RF control which is prone to interference when it is operating in the same frequency with other network.

This module communicates in term of serial communication which transfer data through the RX/ TX pin. It also able to serial stream from 4800bps to 115200 bps. For proper established communication network the connected party has to operate in the same berate. To established the connection of the Bluetooth module the pairing protocol has to be done in advance with default pairing key of "1234". After pairing process complete, the communication can be initiates.

This Bluetooth module is easy to establish a proper communication with other devices. Other than that, this module is easy to interface with microcontroller, Arduino. This is because Arduino also contains the TX/ RX pin which enable serial communication with the Bluetooth module.

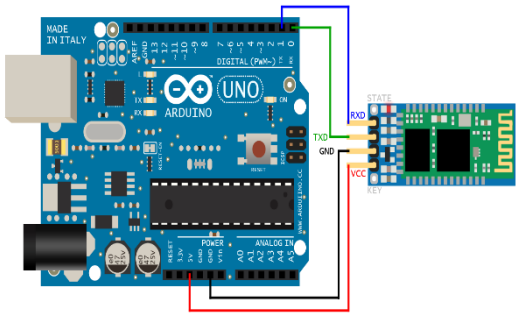
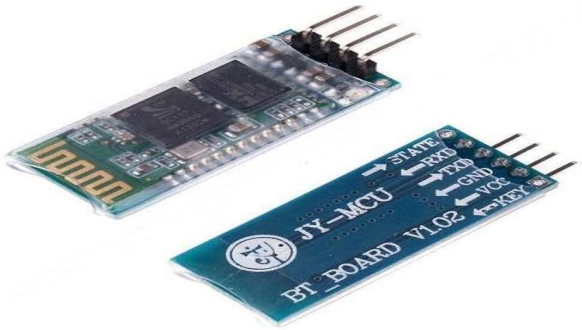


Figure 3.3: Connection of Arduino and Bluetooth module

Source: robotosh.blogspot.com

Table 3.1: Bluetooth module, HC-05 specifications



Features

- Typical -80dBm sensitivity
- Up to +4dBm RF transmit power
- UART interface with programmable baud rate
- With integrated antenna
- With edge connector

Key specifications

- Bluetooth protocol: Bluetooth Specification v2.0+EDR
- Frequency: 2.4GHz ISM band
- Modulation: GFSK(Gaussian Frequency Shift Keying)
- Emission power: ≤4dBm, Class 2
- Sensitivity: ≤-84dBm at 0.1% BER
- Speed: Asynchronous: 2.1Mbps(Max) / 160 kbps, Synchronous: 1Mbps/1Mbps
- Security: Authentication and encryption
- Profiles: Bluetooth serial port
- Power supply: +3.3VDC 50mA
- Working temperature: -20 ~ +75Centigrade
- Dimension: 26.9mm x 13mm x 2.2 mm

3.2.3 MICROCONTROLLER

In this project, the microcontroller used is Arduino Mega 2560 which is used to replace the original controller of the RC truck. The Arduino microcontroller is an open source project which is easy available for free. It is easy to be used and it has already built compiler which is Arduino IDE. The developer of the IDE is based on Java Programming Language. It has some significant advantages compare to the other controller.

It is a properly shielded and designed microcontroller which able to provide stable and with minimum of noise at the input and output of the controller. By comparing the stand alone microcontroller a lot factors has to be considered. For example, the supply to the microcontroller and the filter which is required for the input and output of the microcontroller. Other than that, Arduino is an open source project which means a lot reference can be obtain easily compare.Other than that, Arduino can established serial communication which is required for setting the Bluetooth communication network between the Android device and the mobile griping robot.

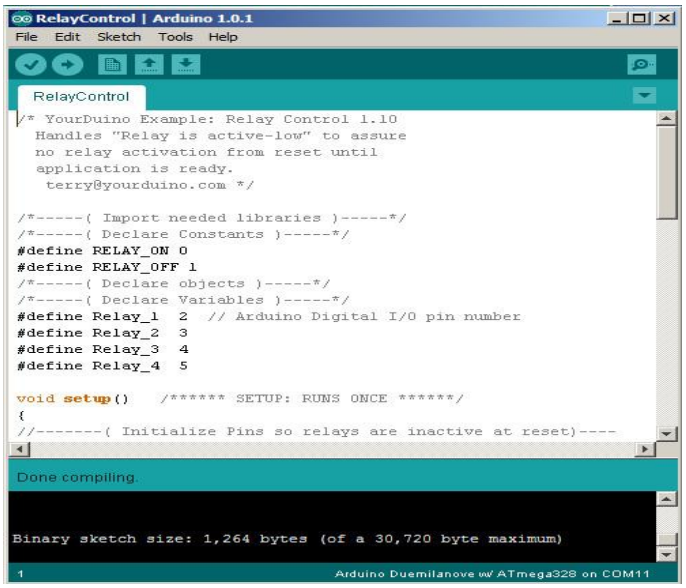


Figure 3.4: Arduino IDE

Source: robotosh.blogspot.com

Table 2.3: Specifications of Arduino ATmega 2560

Key specifications	
• Microcontroller	ATmega2560
• Operating Voltage	5V
• Input Voltage (recommended)	7-12V
• Input Voltage (limits)	6-20V
• Digital I/O Pins	54 (of which 15 provide PWM output)
• Analog Input Pins	16
• DC Current per I/O Pin	40 mA
• DC Current for 3.3V Pin	50 mA
• Flash Memory	256 KB of which 8 KB used by bootloader
• SRAM	8 KB
• EEPROM	4 KB
• Clock Speed	16 MHz

3.2.5 ROBOT PLATFORM

The robot platform is consist of a RC truck which has quite considerable torque and speed which is required to carry the new controller with the gripper attached. The RC truck which is powered by a DC geared motor for movement and a servo motor for determininig the direction of turning of the platform. This is very suitable to be the robot platform which it can be further develop to become a outdoor mobile robot which can maneusverer over different kind of terrain and obstacles.

3.2 SOFTWARE

In completing this project, combination of two software has been used. The two mentioned software are Arduino IDE and MIT App Inventor software which is used to program the Arduino microcontroller and develop Android app respectively.

3.3.1 ARDUINO IDE

Arduino IDE is an open source software which is written specially to program Arduino board. It easily can be download from http://www.arduino.cc/en/Main/Software wihtout the needs to pay anything. It is written based on Java programming language and it is available for all kinds of environment which include Linux, Windows, and Mac OSX. Other than that, Arduino software is also hosted by Github which all different kinds of code which has been developed by different developers can be found in Github.

This project Arduino IDE is used to program the Arduino ATmega 2560 board which is used to control all the actuators of the mobile gripping robot which includes the a DC geared motor and 4 servos motor. It also trigger and read the input from the ultrasonic sensor which used for measuring the distance. In order to coomunicate with the Android device, in the IDE the serial communication of the Arduino board will be initialized for receiving command from the Android device. The flow of the whole system is shown in the Figure 3.6.

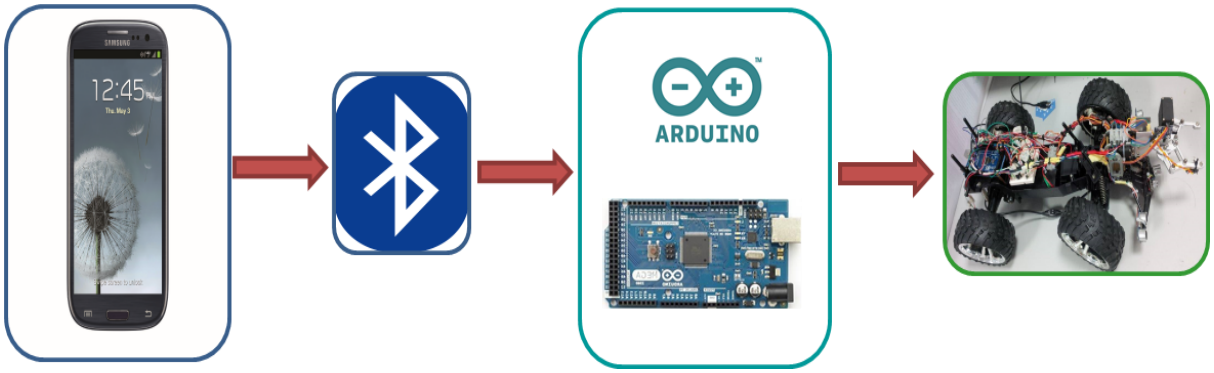


Figure 3.5: Flow of the whole system.

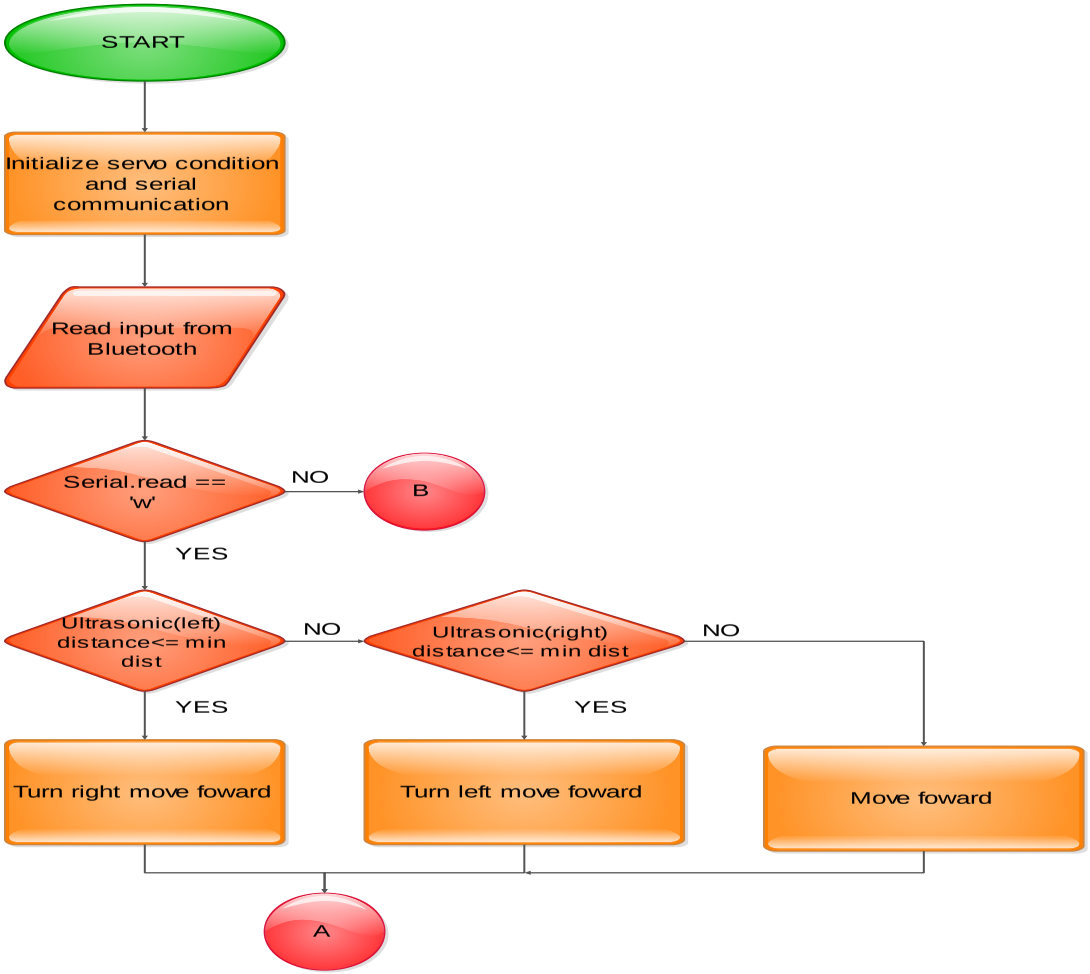


Figure3.6: Flow chart of controller's program (Part 1)

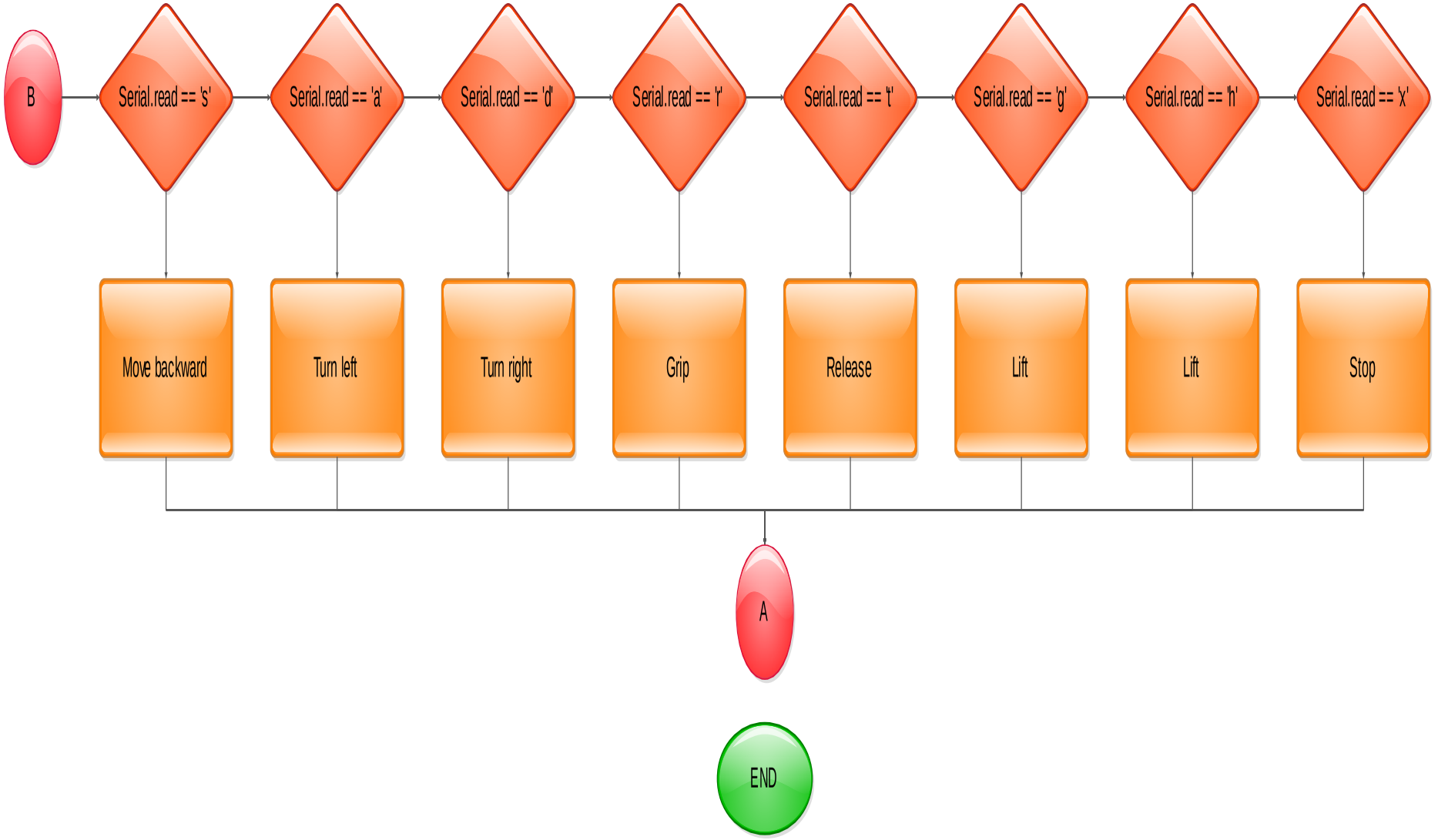


Figure 0.7: Flow chart of controller's program

3.3.2 MIT APP INVENTOR

MIT App Inventor software was originally developed by Google but now it is fully under Massachusetts Institute of Technology (MIT). This software has been developed since 2010 under Google's Mark Friedman and MIT Professor Hal Abelson co-led the development of App Inventor while Hal was on sabbatical at Google.

This software is based on the block programming where all the codes of program are represented in the terms of simplify blocks. Therefore, it is easy to be use and simplify a lot of work in developing an Android app. It is also free and easily available at the web site with free cloud base which linked with Google mail to store all the data that has been developed by the user.

It is easy to be use as an Android smartphones user just have to install the "MIT Ai2 Companion" app to linked the Android device with the MIT App Inventor software. An emulator of Android device is avaialable too for the user without personal Android device.

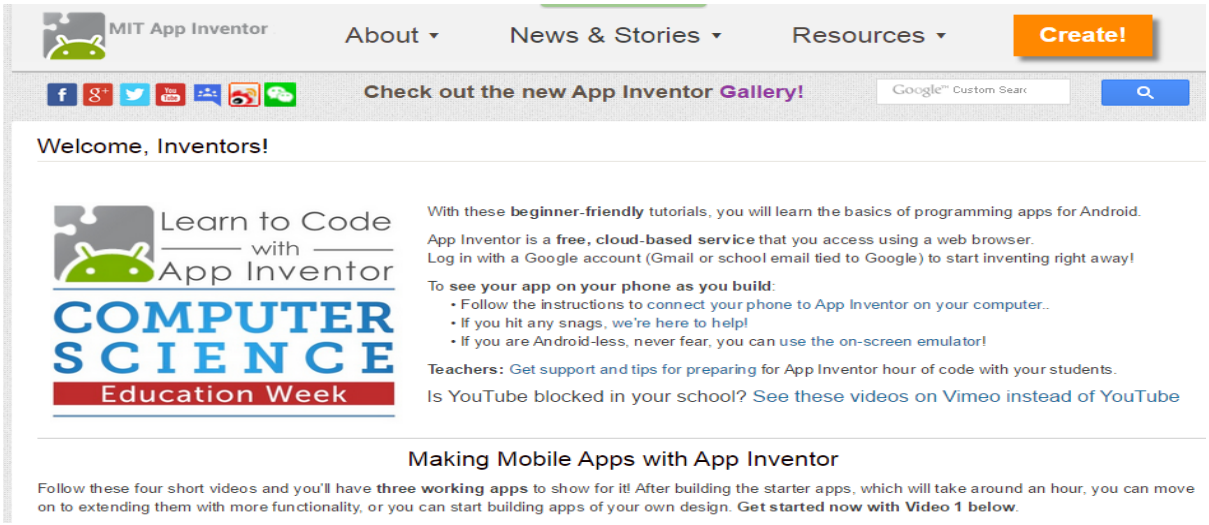


Figure: 3.8: Home page of MIT App Inventor software

Source: http://appinventor.mit.edu/explore/

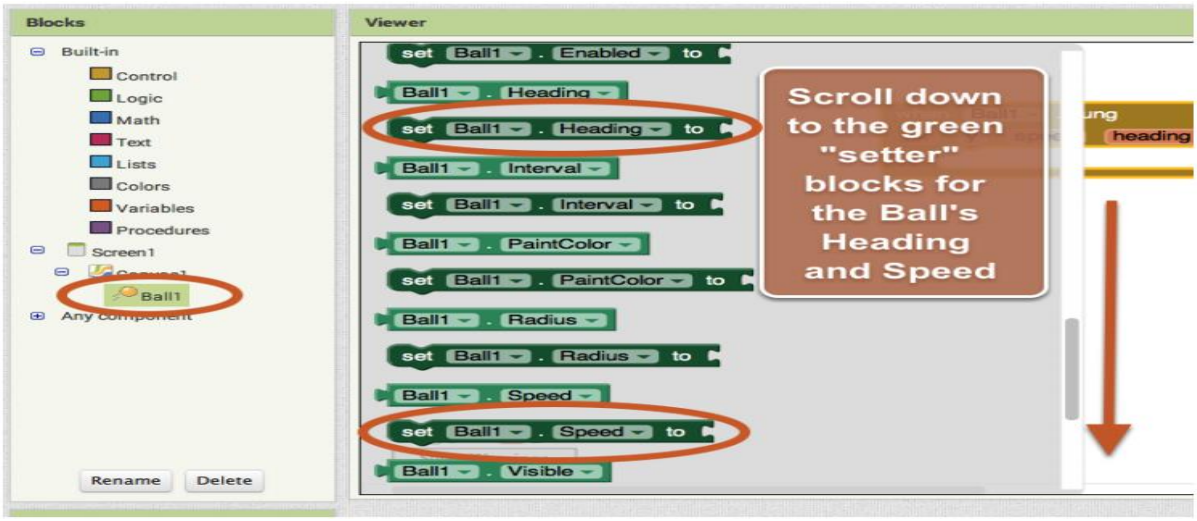


Figure 3.9: -Example of coding block in MIT App inventor software

Source: http://appinventor.mit.edu/explore/

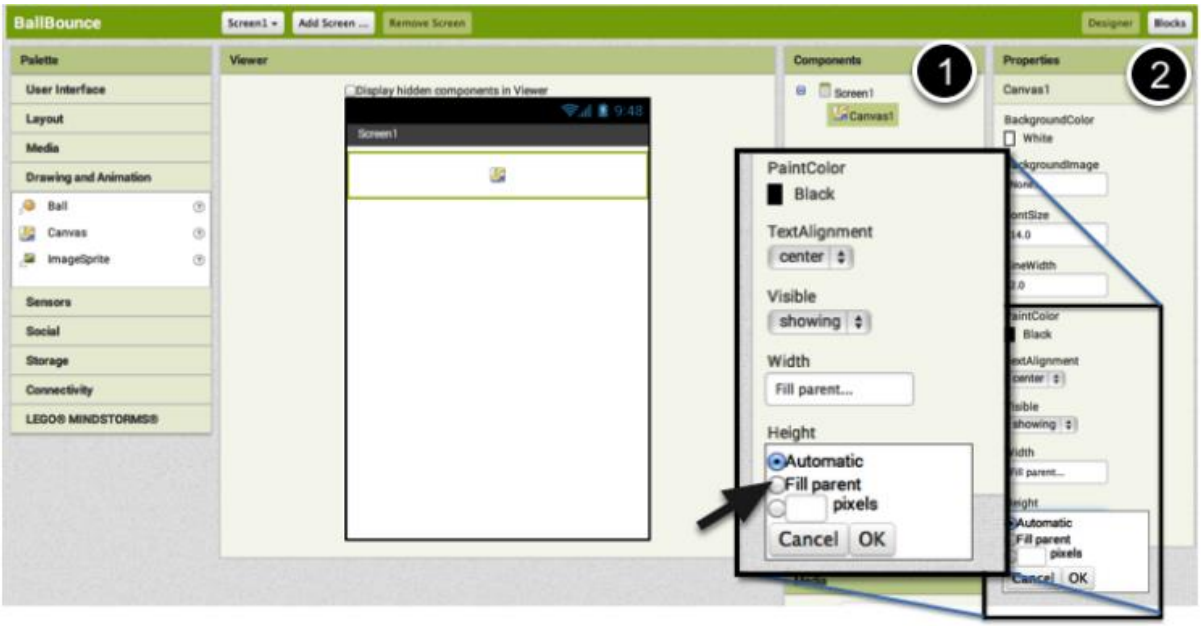


Figure 3.10: -Example of designing an Android app using MIT App Inventor software

Source: http://appinventor.mit.edu/explore/

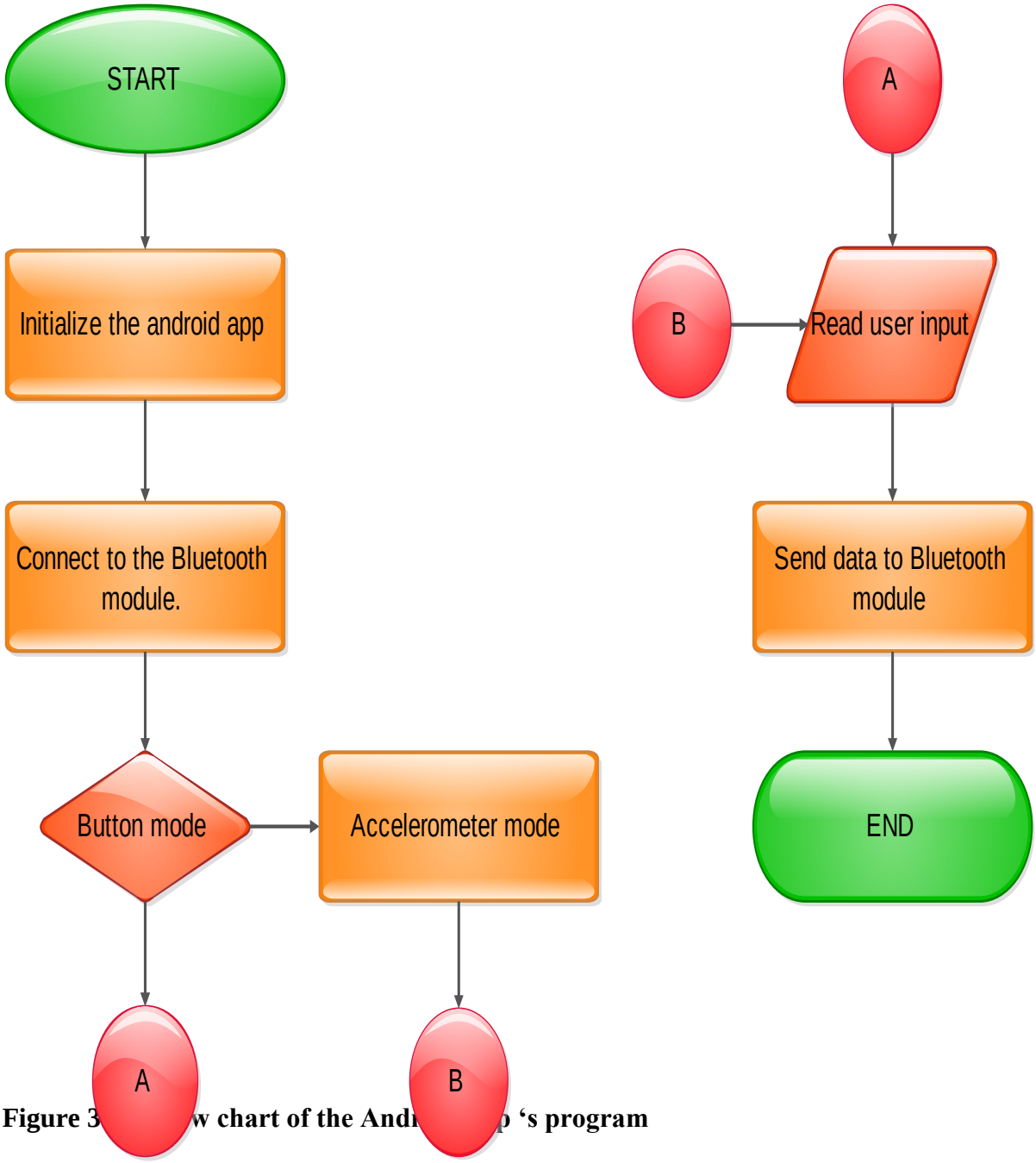


Figure 3 w chart of the Andi p 's program

3.3 PROJECT METHODOLOGY

The mothod used to complete this project includes the planning for hardware and software completion is shown in figure below.

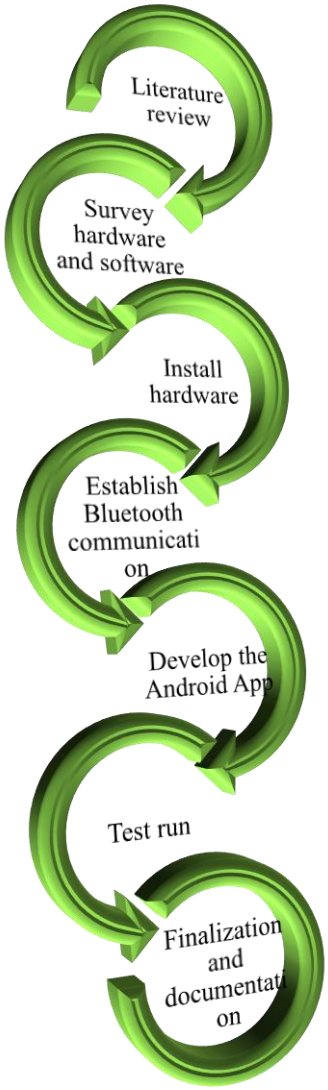


Figure 3.12: Project flow chart

CHAPTER 4

RESULT AND DICUSSION

4.1 INTRODUCTION

This chapter is about the result or the outcome obtain from the project. This include the developed app, the communication through Bluetooth and the control of the mobile gripping robot's movement.

4.2 ANDROID APP

The app is developed using MIT App Inventor Software which ultilize the Android device Bluetooth module to control either from the input of touch button or the using the Accelerometer by tilting the Android device.

After turning on the Android device 's Bluetooth module, initiate the app which will automatically connects to the MAC address of the Bluetooth module of the mobile gripping robot. This is convenient for the user by skipping to the process of searching to the available Bluetooth connection. The connection status is shown in the app as shown in Figure 4.5 . In the app as shown in Figure 4.5, it contains two mode which is the "Button Mode" and "Accelerometer Mode".

The latter is available by pushing the "Accelerometer Mode" button which is shown in Figure 4.6. The Android device is needed to be tilted and press on the "ON" button to send the input to the mobile gripping robot. The movement of the robot will be synchronous with the tilting of the Android device each time the "ON" button is pressed.

While, in the “Button Mode” the Android device will read the input from the touch screen to send specific input to the mobile gripping robot which is shown in the Figure 4.5. In this mode the control of the gripper is included comparing to the accelerometer mode which only control the movement of the robot . The button for lift or drop the gripper and grip and release the greipper is available. While, in this mode also included the detection of the ultrasonic sensor which is used avoiding obstacles. With the ultrasonic turned on , the mobile gripping robot will automatically abort the input order to move forward and turn either way by depending on the reading from the sensors.

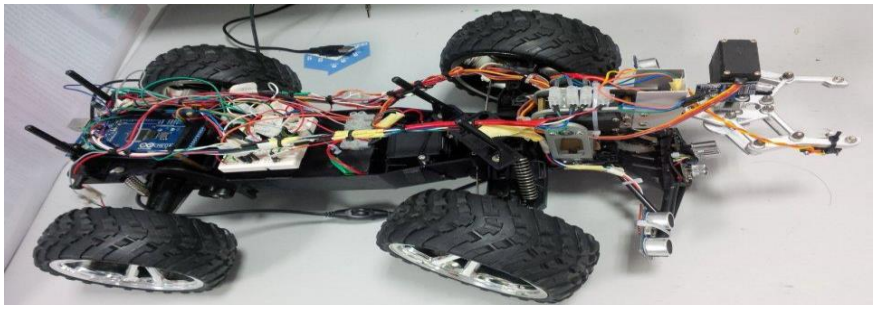


Figure4.1: Turning right

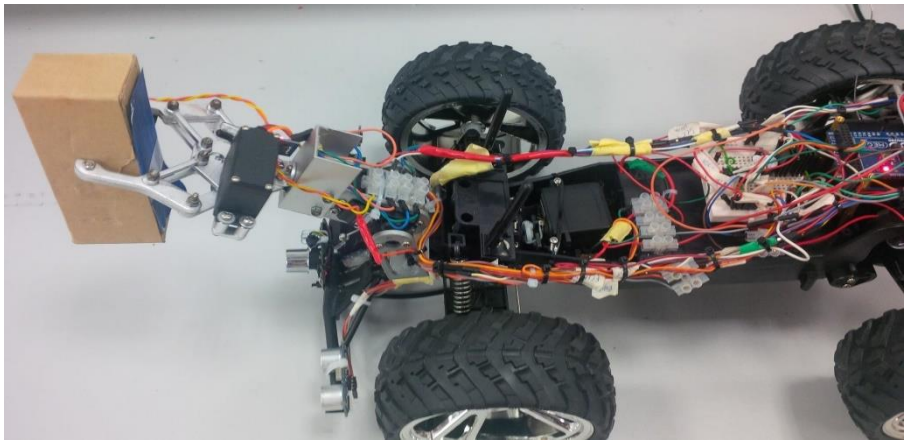


Figure4.2: Lifting object

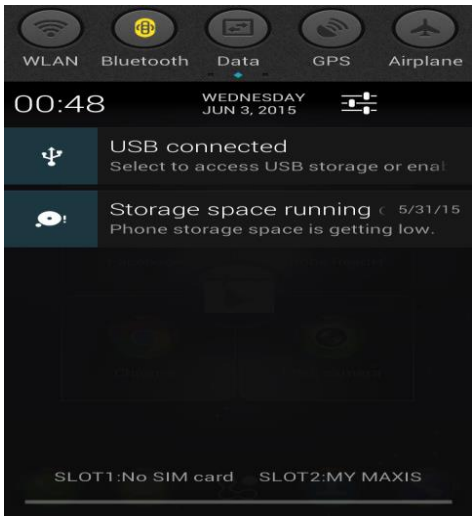


Figure 4.3: -Step 1: Turn on the Bluetooth module of the Android device

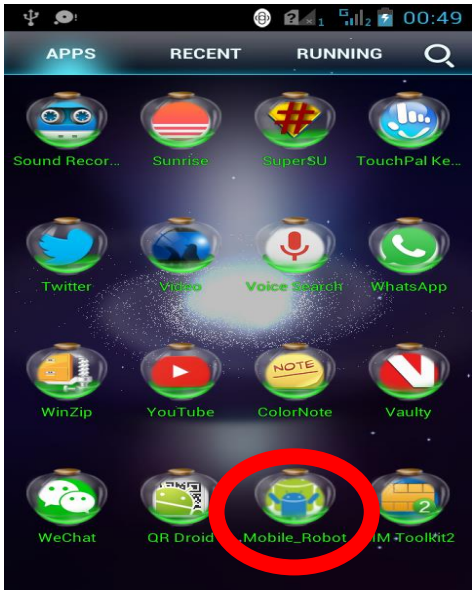


Figure 4.4: Initiate the app (Mobile_Robot)

Figure 4.5: Check the Bluetooth connection status (highlighted in black in colour)

Figure 4.6: Accelerometer mode screen.

4.3 CONTROLLER OF ROBOT

As mentioned in the previous chapter, the robot is controlled by Arduino and ultrasonic sensor with Bluetooth module is added on to the mobile gripping robot. The addition of Bluetooth module with specific MAC address is used in the programming of the Android app so that the app will connected to mobile gripping robot automatically without needing the user to search or scan for the available Bluetooth connection. While,

the ultrasonic sensor is used for detecting the obstacles which come across by the robot so that it can avoid the obstacles.

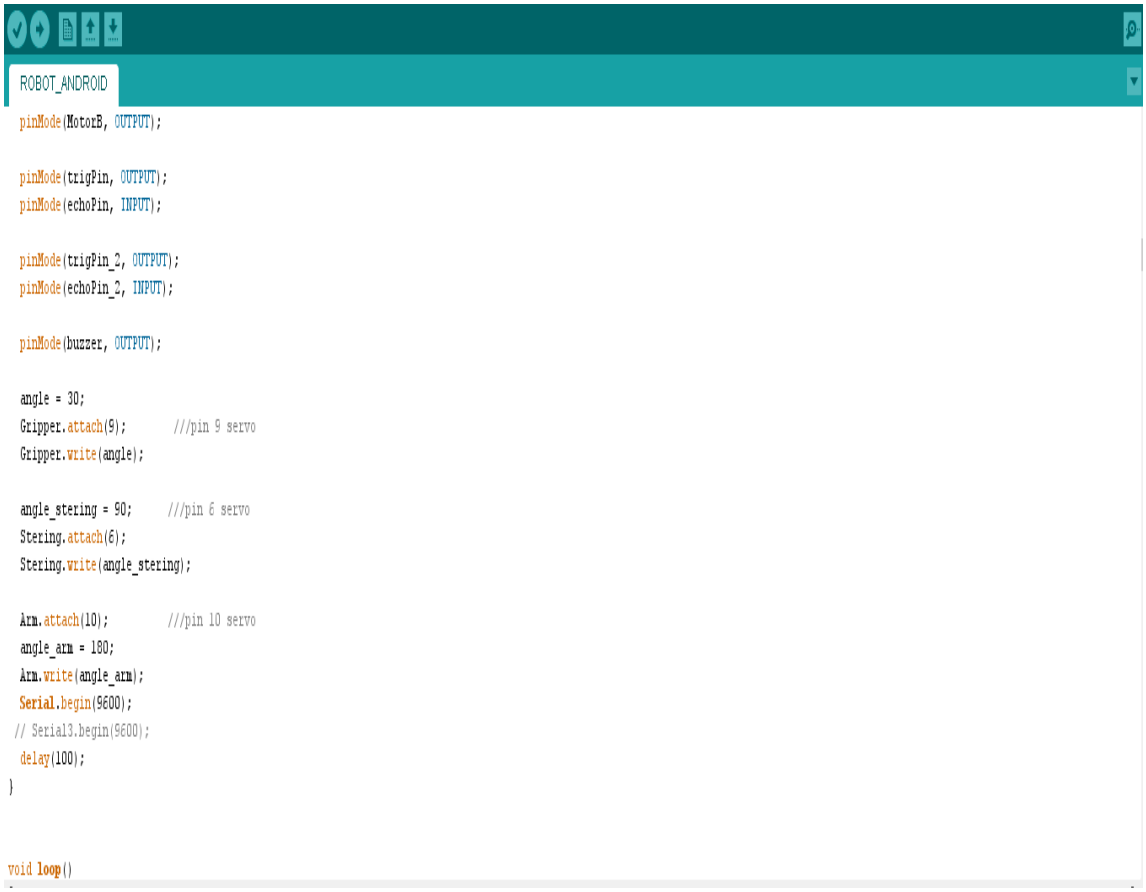


Figure 4.8: Sample coding of the mobile gripping robot

4.4 DISCUSSION

The control of the mobile gripping robot can be done wirelessly by using wireless communication which is Bluetooth. A simple controller of it can be a simple and cheap Android device which has a built in Bluetooth module.

From this project, it obtains that the response time between the input from the Android device and the response of the mobile gripping robot is fairly good. As it is able to achived the response time below 1 second. This is good enough to be implement in controlling a premilinary stage of mobile robot wirelessly. It is useful in robotic field for controlling mobile robot which is still under the development stage. Upon reaching the

final stage of development a better controller can be used for achieving better response time.

This mobile gripping robot has been tested and it shows that fairly poor response time when the mobile robot is further away from the controller which is the Android device. This is because as the distance mentioned increase the signal detected by the Bluetooth module decreases and as a result more trial for receiving the incoming signal has to be done and this decrease the response time of the mobile robot. However, other factors may just affect the poor response time too which are atmospheric condition and geographical condition.

During trial, the mobile gripping robot fails to response when it is approximately 1 meter away from the Android device. This shows the limitation of this Bluetooth module. This is because it has reached the range beyond the coverage of this Bluetooth module which is classified as third class Bluetooth module. However, if first class or second class of Bluetooth is implemented it should be able to cover a further range of communication.

The Android app developed using the MIT App Inventor software is easy to be use as it used Block programming. This software is good as it contains most of the features available in a Android device which include Bluetooth communication, accelerometer, orientation sensor and others. All this features can be used as a controlling input for a mobile robot. In this project, the Bluetooth communication and accelerometer features are used. It shows positive result as the mobile gripping robot able to reponse to the input and the accelerometer sensitivity can be adjusted in the block of programming to suit the condition and requirement of the robot.

The intergration of Bluetooth module with the Android device features has shows a success in becoming a premilinary controller for a development stage mobile robot.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

This project ‘s objectives are achieved and it shows that with a simple Android device and addition of a proper Android app it can be used to control a mobile gripping robot. It is a simpler way comparing of developing and building a specific controller to control the mobile gripping robot. Even though, there are multiple of projects has been completed regarding the control of mobile robot using Androi device but the main purposes of this project is to show that different kind of features available in an Android device can be used to controla mobile robot and an Android app can be properly develop using the MIT App Inventor software which free.

5.1 PROBLEM ENCOUNTERED

In completing this project, several major problem has been encountered. This include the problem regarding the sensor input, and development of the Android app.

The input from the ultrasonic sensor is not consistent and failed to response in time when it is applied in an environment which has multiple obstacles or objects. This still remain unsolved as the response time has reached limitation. A higher end or a more suitable sensor could be used to replace it for better performance.

In developing the app for reading the input from the Android device accelerometer a problem occurred which is the app fails to reponse at instant when the tilt angle and direction of the Android device changes. However, it is able to response

immediately when it is programmed to be triggered by the “ON” button. It maybe due to limited function of block programming for accelerometer in the MIT App Inventor Software as this software is still new.

5.3 RECOMMENDATION

The achievement of this project can be use as a platform for other project with quite similar function. In addition, this mobile gripping robot is already equipped with a gripper, a wireless communication, and Arduino controller which can be implement as a rubbish picking robot.

The ultrasonic sensor show poor performance and inconsistent reading when the it is implemented in an environment with multiple obstacles which is a major drawback for a mobile robot. This can be further improve by replacing it with a sonar sensor or a laser range finder. A sonar sensor can be used to detect the whole environment and with the addition of image processing it able to plot the whole environment detected by the mobile robot. While, the laser range finder can provide accurate measurement of obstacles’s distance and its result is not affected even encountered environment with multipls obstacles.

In communication wise, the Bluetooth module should be replaced with Xbee which is able to interface with Arduino microcontroller and it able to overcome the limitation of range covered for communication. Other than that, it also transmit data at higher speed in comparison to speed can be achieved by Bluetooth module.

This mobile robot is a well developed platform to be improvise into rubbish picking robot which required image processing for detecting the environment and the object. OpenCV is an open source image processing software which is suitable as it is can be develops in different kind of plaform and environment. Most importantly, it can be intergrates with Android environment by using AndroidCV which is using Java programming language.

REFERENCES

[1] Y. W. S. C. C. S. Jin Syan Lee, "A Comparative Study of Wireless Protocols: Bluetooth, UWB, ZigBee and WiFI," *The 33rd Annual Conference of the IEEE Industrial Electronics Society(IECON),* pp. 5-8, 2007.

[2] H. H. A. R. S. T. B. Fazli Subham, "Analysis of Bluetooth Signal Parameters for Indoor Positioninig Systems," *2012 International Conference & Information Science(iccis),* 2012.

[3] F. P. Erna Ferro, "Bluetooth and WiFi Wireless Protocols: A survey and Comparison," *IEEE Wireless Communications ,* vol. 5, 2005.

[4] M. S. Rami Ahola Daniel Wallner, "Bluetooth Transceiver Design with VHDL-AMS," *Precedings of Design, Automation and Test in Europe Conference and Exhibition,* vol. 3, 2010.

[5] M. N. J. I. O. J. J. W. A. Jaap Haartsen, "Bluetooth: Vision, Goal, and Architecture," *Mobile Computing and Communications Review,* vol. 2, 2009.

[6] W. S. K. M. J. H. Stefan Zurbes, "Radio Network Performance of Bluetooth," *IEEE,* 2006.

[7] S. M, "Smart Phone Based Robotic Control for Surveillance Application," vol. 4, no. IJRET: International Journal of Research in Engineering and Technology, p. 223, 2010.

[8] S. Paul, "Visual Programming for Smartphones," no. 12th International Carpathian Control Conference (ICCC), 2011.

[9] R. I. M. F. A. A. G. Pioggia, "Computer Vision using Android Phones," no. IEEE, 2008.

APPENDICES A

```
#include <Servo.h>
#include <math.h>
int A = 0;
//-calculation
long a = 0;
long b = 0;
long x = 0;
long y = 0;
long sum_distance = 0;

//- Robot Gripper
Servo Gripper;
int angle = 0;
int n = 180;
bool object = false;  //to detect arm_up w object mode || arm_up w/o object mode

//- Robot Arm
Servo Arm;
int angle_arm;
int n_A = 0;

//-Stering
Servo Stering;
int angle_stering = 0;
int n_1 = 0;

//-motor
int MotorA = 13;
int MotorB = 12;

//-serial read
int incomingByte = 0;    //for incoming serial data

//- ir sensor
int irReceive = 8;     // IR Led on this pin
int buttonIrR = 0;    //  Digitalread

//-limit switch between the gripper
const int buttonPin = 33;  //button
int buttonPIN = 0;        //Digitalread
```

```
//-limit switch between the arm
const int buttonLimit = 31;  //button


void setup()
{
  pinMode(potential_meter, INPUT);

  pinMode(irReceive, INPUT);

  pinMode(buttonPin, INPUT);

  pinMode(MotorA, OUTPUT);
  pinMode(MotorB, OUTPUT);

  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);

  pinMode(trigPin_2, OUTPUT);
  pinMode(echoPin_2, INPUT);

  pinMode(buzzer, OUTPUT);

  angle = 30;
  Gripper.attach(9);        ///pin 9 servo
  Gripper.write(angle);

  angle_stering = 90;      ///pin 6 servo
  Stering.attach(6);
  Stering.write(angle_stering);

  Arm.attach(10);          ///pin 10 servo
  angle_arm = 180;
  Arm.write(angle_arm);
  Serial.begin(9600);
 // Serial3.begin(9600);
  delay(100);
}


void loop()
{
```

```
//    analogWrite(MotorA, Speed);
//  digitalWrite(MotorB, LOW);
//////////
buttonTouch();
 Serial.print("null = ");
 Serial.println(null_0);
if(incomingByte =='b')
{
  null_0++;
}

else if(null_0 == 0)
{
  ultrasonic_left();
  ultrasonic_right();
  buzzer_sound();
  adjust();
}

else if( null_0 > 1 )
{
  null_0 = 0;
}

//else if(incomingByte == 'v' && incomingByte != 'b')
//{
  //null_0 = 0;
//}
//buzzer_sound();
//////////////////////
Serial.print("incomingByte = ");
Serial.println(incomingByte);

  incomingByte = Serial.read();
  //-- read the incoming byte:
  switch (incomingByte)
  {
    //-- send character to stop obstacle
    case 'b':
    delay(10);
    //Serial.flush();
    break;
```

```
//--lift up
case 'g':
servoHAND_up();
delay(10);
//Serial.flush();
break;

//-- lift down
case 'h':
servoHAND_down();
delay(10);
//Serial.flush();
break;

//--no turn
case 'z':
no_turn();
delay(10);
//Serial.flush();
break;

//-- stop moving
case 'x':
no_turn();
stop_move();
//Serial.flush();
delay(10);
break;

//--motor move forward
case 'w':
move_forward();
delay(10);
//Serial.flush();
break;

//--motor move backward
case 's':
move_backward();
delay(10);
//Serial.flush();
break;
```

```
//-- motor right
case 'd':
move_forward();
turn_right();
delay(10);
Serial.flush();
break;

//-- motor left
case 'a':
move_forward();
turn_left
```