CONTROLLING A ROBOT CAR USING ANDROID APPLICATION

UNIVERSITAS MUHAMMADIYAH SURAKARTA

SCIENTIFIC PUBLICATIONS

Compiled as a condition completing Bachelor Degree Program at the Department of Engineering, Faculty of Electrical Engineering

By:

HISHAM ATEF MUSTAFA

D 400 122 008

ENGINEERING DEPARTMENT

FACULTY OF ELECTRICAL ENGINEERING

UNIVERSITAS MUHAMMADIYAH SURAKARTA

2016

PAGE APPROVAL

CONTROLLING A ROBOT CAR USING ANDROID APPLICATION
UNIVERSITAS MUHAMMADIYAH SURAKARTA

SCIENTIFIC PUBLICATIONS

by:

HISHAM ATEF MUSTAFA
D 400 122 008

Has been inspected and approved to be tested by:

Supervisor

Dediary Prasetya, S.T, M.Eng.

NIP.982

ENDORSEMENT PAGE

CONTROLLING A ROBOT CAR USING ANDROID APPLICATION
UNIVERSITAS MUHAMMADIYAH SURAKARTA
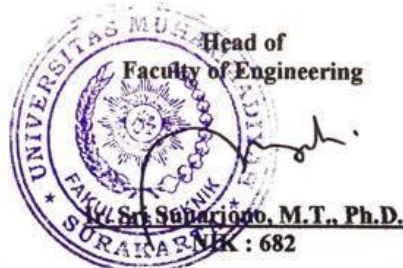
BY

HISHAM ATEF MUSTAFA

D 400 122 008

It has been maintained in front of the Board of Examiners
Faculty of Engineering
Universitas Muhammadiyah Surakarta
On the Day Thursday, 4 of August 2016
and declared eligible

Board of Examiners:

1. Dediary Prasetya, S.T, M.Eng.   (................................)
   (Supervisor)
2. Pratomo Budi Santoso,IR.MT.   (................................)
   (Examiner I)
3. Fajar Suryawan,S.T,M.Eng.   (................................)
   (Examiner II)

This scientific publication has been accepted as one of the requirements

To obtain a bachelor's degree

Date: 4\August\2016

Knowing,

Head of
Faculty of Engineering

Ir. Sri Sunarjono, M.T., Ph.D.
NIK : 682

ii

DECLARATION

I hereby declare that this researches my own work and its carried out under the auspic

the department of electrical engineering as part fulfillment of the requirements of the bachel

electrical engineering ,it contains no material previously published or written by another person

Surakarta, 4\August\2016

Author

HISHAM ATEF MUSTAFA

D 400 122 008

CONTROLLING A ROBOT CAR USING ANDROID APPLICATION

CONTROLLING A ROBOT USING ANDROID APPLICTION

Abstract

The Android Operating System is one of the biggest number in usage operating system in the smartphone that also commonly known in our life, for order of entertainment, invention, research, social etc, meanwhile for the research purpose there are many ways those can be done to invent a product to be researched. The objective of this research is to develop a program or an Android application to control a robot powered by *Arduino* using a motor driver and a Bluetooth modem. The process involved in building the robot includes the assembling of a chassis used for the robot, programing the *Arduino* as well as the interface for the *Android* device. This thesis document contains the design of process for the robot and programming for the android interface. The details in the research give the information about the different aspects of computing involved in the whole project. The advantages those might be obtained are the cheap research cost because in the other hand Arduino and *Android* are open source. The outcome of the project is a combination of embedded computing and programming, the researcher used *APP Inventor*2to integrate A*rduino* with *Android*, based on the test methods it can be concluded that it is easy to implement *Arduino* with android the

Keywords: *Android, Arduino, Bluetooth shield, embedded computing*.

Sistem Operasi Android adalah salah satu jumlah terbesar dalam sistem operasi penggunaan di smartphone yang juga dikenal dalam hidup kita, untuk pesanan hiburan, penemuan, penelitian, dll sosial, sementara untuk tujuan penelitian ada banyak cara yang bisa dilakukan untuk menciptakan produk yang akan diteliti. Tujuan dari penelitian ini adalah untuk mengembangkan sebuah program atau aplikasi Android untuk mengontrol robot didukung oleh Arduino menggunakan driver motor dan modem Bluetooth. Proses yang terlibat dalam membangun robot meliputi perakitan chassis yang digunakan untuk robot, programing Arduino serta antarmuka untuk perangkat Android. Dokumen skripsi ini berisi desain proses untuk robot dan pemrograman untuk antarmuka android. Rincian dalam penelitian memberikan informasi tentang aspek-aspek yang berbeda dari komputasi yang terlibat dalam seluruh proyek. Keuntungan yang mungkin diperoleh adalah biaya riset murah karena di sisi lain Arduino dan Android yang open source. Hasil dari proyek ini adalah kombinasi dari komputasi tertanam dan pemrograman, peneliti menggunakan APP Inventor2to mengintegrasikan Arduino dengan Android, berdasarkan metode pengujian dapat disimpulkan bahwa adalah mudah untuk menerapkan Arduino dengan android

Kata kunci: Android, Arduino, perisai Bluetooth, komputasi embedded.

1. INTRODUCTION

Android is a very familiar word in the world today. Millions of devices are running the Google Android OS and millions are being developed daily. Google has made the Android development platform open to everyone around the world, so there are millions of developers. Although some developers just focus on building the apps or games for the android devices, there are numerous possibilities as well. One of the possibilities of Android development is its fusion with Arduino (a microprocessor), which in itself is a tiny computer. Possibilities from the combination of these two-development platforms cannot be derived

from any permutation or combination logics. While there are many results already published, there are more innovations every day.

This research focuses on the outcome of the possible combination of Android and Arduino. Although the project has been carried out numerous times before, this research gives detailed information on building a robot which can be controlled by any android device and also through the voice over the android device. This research includes two parts: i. the hardware and ii. The Software. The first part focuses on assembling the robot parts and building a circuit and the second part is about programming the interface on the android device.

The research is being divided in two aspects of computing and the author had to focus on both aspects. The first part of the thesis, which is hardware, requires a brief knowledge of electronics circuit design and the second part (android interface) was designed using MIT App Inventor.This research starts with assembling the chassis for the robot in Part 1, designing the circuit in Arduino in Part 2 and building the android interface in Part 3.

RitikaPahuja and Narender Kumar in their research Android Mobile Phone Controlled Bluetooth Robot Using 8051 Microcontroller. A robot is usually an electro-mechanical machine that is guided by computer and electronic programming. Many robots have been built for manufacturing purpose and can be found in factories around the world. Designing of the latest inverted robot which can be controlling using an App for android mobile. We are developing the remote buttons in the android app by which we can control the robot motion with them. And in which we use Bluetooth communication to interface controller and android. Controller can be interfaced to the Bluetooth module though UART protocol. According to commands received from android the robot motion can be controlled. The consistent output of a robotic system along with quality and repeatability are unmatched. Pick and Place robots can be reprogrammable and tooling can be interchanged to provide for multiple applications.

M.Selvam in SMART PHONE BASED ROBOTIC CONTROL FOR SURVEILLANCE APPLICATIONS,the robotics and automation industry which is ruled the sectors from manufacturing to household entertainments. It is widely used because of its simplicity and ability to modify to meet changes of needs. The project is designed to develop a robotic vehicle using android.

Stephan Gobel, Ruben Jubeh, Simon-LennertRaesch, Albert Zundorf in Using the Android Platform to control Robots. The Android Mobile Phone Platform by Google becomes more and more popular among software developers, because of its powerful capabilities and open architecture. As it's based on the java programming language, its ideal lecture content of specialized computer science courses or applicable to student projects. We think it is a great platform for a robotic system control, as it provides plenty of resources and already integrates a lot of sensors. The java language makes the system very attractive to apply state-of-the-art software engineering techniques, which is our main research topic. The unsolved issue is to make the android device interoperate with the remaining parts of the robot: actuators, specialized sensors and maybe coprocessors. In this paper we discuss various connection methods and present a first approach to connect Android with the car robotic system, which we successfully used in our robotics/software engineering courses so far.

2. **METHOD**

The author used two method in this research, first method is studying method by collecting and gathering information from books, article, and research are related to the topic. The second

method is conducting an interview with expert android programmer and ask for some recommendation.

The research begins in May 2016, supposed to be finished in June 2016, the place of the project in UMS library, lab, class room and boarding house.

Main equipment divided into two types' *hardware* and *software*that been used in the research, the software has been used is MIT APP inventor and Arduino and the hardware has been used is DC motor, Arduino board, motor driver L298N, Bluetooth Hc05, lipo battery, wires.

In system design the author create the required diagrams for the proposed system block diagram, flow chart and electronic circuit for the system.

2.3.1 Flowchart

The flowchart is a diagram that represent an algorithm, workflow or process; showing the steps in order, the flow chart for the system as shown in figure 1.
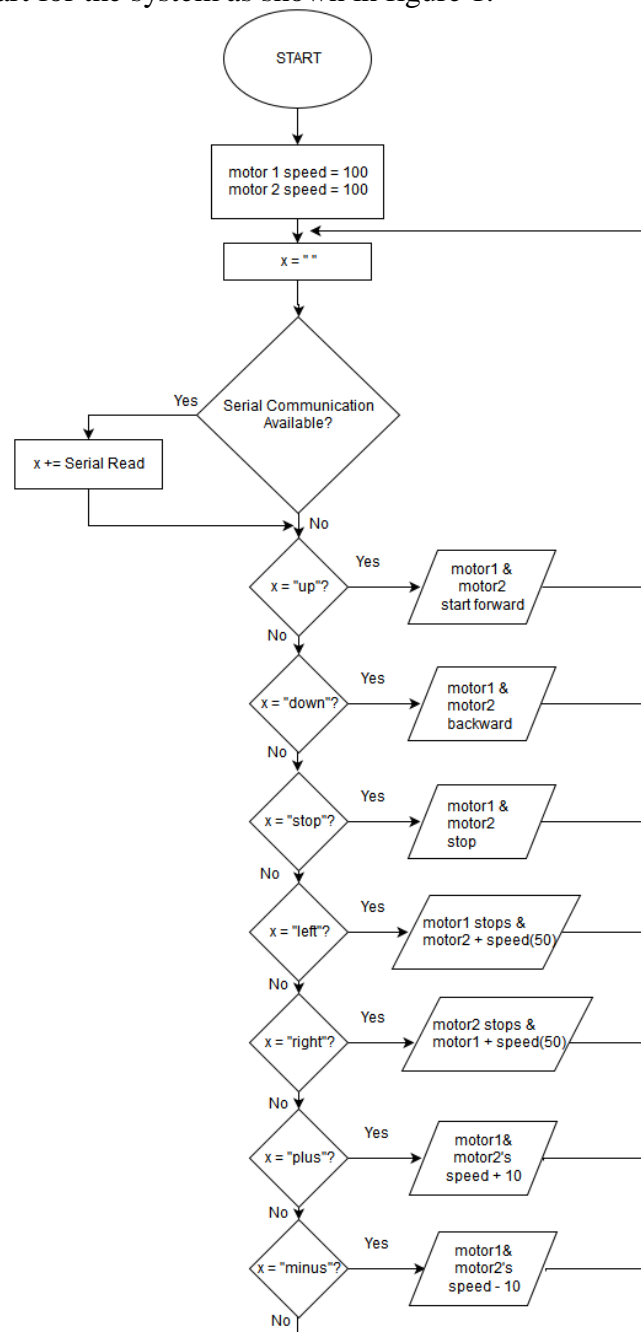

Figure 1. System Flowchart

The flowchart above shows the algorithm used in the robot. Firstly, it initiates the initial speed of the motors. Then waiting for serial communication availability, which is the bluetooth communication that occurs between arduino and Bluetooth HC-05. If the availability of serial communication checked or exists, then it will decide the conditions. There are five conditions that will picked. The condition is picked when matched with string data that sent by the android smartphone. *The conditions of the robot:* arduino receives *"up"* string, then the two motors start to rotate forward, arduino receives *"down"* string, then the two motor rotate backward, arduino receives *"left"* string, then the robot makes left turn, by stopping left motor and adding speed in right motor, arduino receives *"right"* string, then the robot makes left turn, by stopping right motor and adding speed in left motor, arduino receives *"plus"* string, then the robot adding speed for both motors by 10, arduino receives *"minus"* string, then the robot reducing speed for both motors by 10, arduino receives *"stop"* string, then the robot will stop the motor.

2.3.2   Block diagram

Is a diagram showing in schematic form the general arrangement of the parts or components of a complex system or process, such as an industrial apparatus, the block diagram as shown in figure 2.
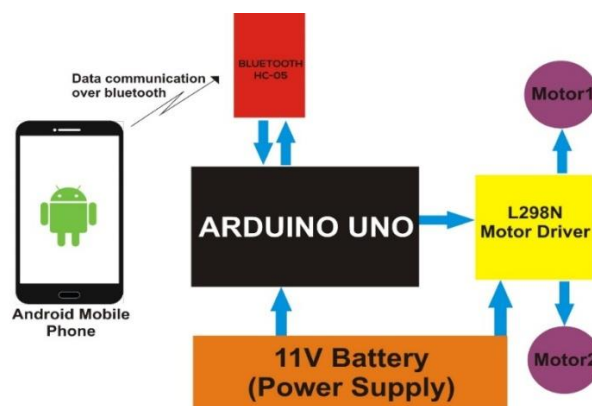

Figure 2. System Block Diagram

2.3.3 Arduino Circuit Design

The circuit design shows the proper way to connect the hardware with wire, and connect the entire component together, as shown in figure 3.
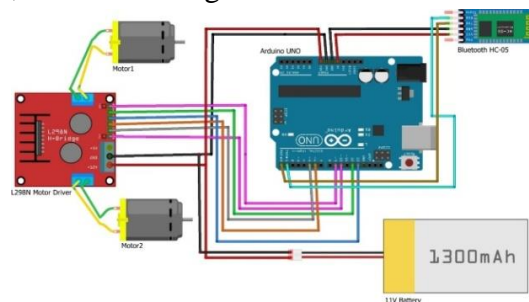

Figure 3. Circuit Design

2.3.4 Arduino Code

Here the the code that has been used by the author to control the proposed robot, the code has been uploaded to the arduino using the arduino code editor.

2.3.5 Android Application Design

In this project, App Inventor is used to make layout and the logic built in the android application. It is friendly to make for electronic projects.

A) Layout

The layout design of this android application has only one layout with few buttons and display data. The following Figure 4 shows the layout design application.
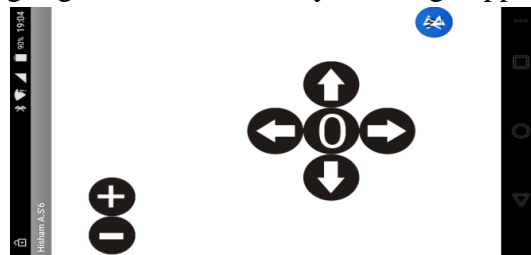

Figure 4. Layout of Android App

Explanation of the image based on the letter as follows: 1) Name of the application that shows in the header. 2) Plus button that allow the user to increase the speed of robot car. 3) Plus button that allow the user to increase the speed of robot car. 4) Button that allow user to make robot make a left turn when clicked. 5) Button that allow user to stop the robot 6) Button that allow allow user to make robot going forward 7) Button that allow allow user to make robot going backward 8) Button that allow user to make robot make a right turn when clicked. 9) The button to connect and disconnect the bluetooth connection.

a) Program

The process of making program or codes in app inventor is drag and drop some blocks of logic that provided in software developer.

3   RESULT AND DISCUSSION

The test is conducted to determine the working and performance of the robot, if it can work well with certain condition. The condition means the distance between android smartphone and the robot. When the robot controlled by smartphone, it will shows the performance of working.

Figure 5. The Robot

The Figure 5 above shows the location of each part on the robot. The battery will supply the power arduino uno and motor driver L298N. Motor driver itself works in 12 Volt. Arduino uno

will receive power supplied from battery and converts it to 5V as its need, because inside arduino uno, the is 7805 IC that convert the voltage to 5 V. The mechanism of wheels controlling is using PWM signal that sent by arduino to L298N Driver. Then L298N will amplify it to 12V voltage from 5V digital signal provided by arduino uno. 12V PWM signal finally sent to two motors that attached to L298N.

The communication between android smartphone and arduino bridged by bluetooth device called Bluetooth HC-05. Serial communication occurs between arduino uno and Bluetooth HC-05 with 9600 baudrate. Also the android smartphone uses bluetooth signal to connect to Bluetooth HC-05.

The data received from android smartphone will be forwarded by Bluetooth HC-05 to arduino as string object. From this string object received to arduino, arduino will decide the condition of the robot, such going forward, backward, left, right, stop and increasing and decreasing the speed.

For going forward, android smartphone sends "up" string. For going backward, android smartphone sends "down" string. For going right, android smartphone sends "right" string. For going left, android smartphone sends "left" string. For going stop, android smartphone sends "stop" string. For increasing speed, android smartphone sends "plus" string. For decreasing speed, android smartphone sends "minus" string.

Pins used in arduino uno is digital pin 9, 10, 12, 13, 5 and 6. Pin 9 is used to control the speed of motor 1. Pin 10 is used to control speed of motor 2. Pin 12 is used to control the rotation of motor 1 which is forward. Pin 13 is used to control the rotation of motor 1 which is backward. Pin 5 is used to control the rotation of motor 2 which is forward. Pin 6 is used to control rotation of motor 2 which is backward. Pin 12, 13, 5 and 6 connect to enable pins of L298N. The Enable pin is used to decide the rotation of motors. Pin 9 and 10 connect to PWM pin of L298N. PWM pins are used to control the speed of the motors.

3.1 Smartphone Android Testing

Tests on android smartphone emphasis on testing distance. This test was conducted to determine the maximum distance between measuring devices with android smartphone. Table 1 shows the result of android testing.

Table 1. Distance Testing using Bluetooth

No.	Distance	Result	Explanation
1	5 Meters	Connected	Working smoothly
2	6 Meters	Connected	Working smoothly
3	8 Meters	Connected	Working smoothly
4	9 Meters	Connected	Working smoothly
5	10 Meters	Connected	Working smoothly
6	12 Meters	Connected	Working smoothly

7	15 Meters	Connected	Delayed 1-2 second
8	17 Meters	Connected	Delayed more than 3 seconds
9	19 Meters	Not Connected	Not working
10	20 Meters	Not Connected	Not working

In this experiment of testing android and bluetooth performance, we use various distance to test it. The distance ranges start from 1 meters until 20 meters away from the robot.

From the Table 1 above we can say that the range of bluetooth is affecting the performance of the robot. The effective range of bluetooth is below 12 meters. When the distance of android reach 15 meters away, the performace starts delaying and slow response occurs. And after the range reachs 17 meters, the delay is more than three seconds. It means that in this range, android smartphone reach its peak to control the robot. Finally, the bluetooth performance getting very bad in 19 meters away because it is definately stop connecting.

3.2 Robot Performance

In this experiment of testing performance of the robot, we concern about how the battery capacity affects the robot performance, in this case is the motors. Because, the motors need certain PWM signal level to work in stable performance. This experiment conducted in 1 meter area of control, so the bluetooth range parameter is not used, Table 2 below will show how the battery capacity affects the robot performance.

Table 2. Robot Performances

No.	Battery Level	Robot Performance	Stability
1	80 - 100%	Excellent	Stable
2	60 - 75%	Very good	Stable
3	40 - 50%	Good	Stable
4	20 - 25%	Bad	Not Stable
5	0 - 10%	Very Bad	Not Stable

In this experiment, Table 2 shows that the battery capacity affects the robot performance. When the battery fully charged, the robot performance is excellent. But in various capacity, it starts dropping the performance.

Table 3.Movement Performances (Forward and Backward)

Movement	Trial Number	Speed	Error (1 meter range)	Error Average

	1	3.0 m/sec	20 cm	
	2	3.0 m/sec	17 cm	
Forward	3	3.2 m/sec	19 cm	17.3
	4	3.4 m/sec	23 cm	
	5	3.4 m/sec	9 cm	
	1	3.1 m/sec	28 cm	
	2	3.1 m/sec	15 cm	
Backward	3	3.3 m/sec	8 cm	19.2
	4	3.4 m/sec	10 cm	
	5	3.4 m/sec	17 cm	

In this experiment, Table 3 shows some errors that occurs when we want to make forward and backward movements. The goal is exactly straight in 1 meter, but the robot shifts from the goal as shown in the table. There are five trials in each movement. This experiment will be visualized easily in figure 6 below.
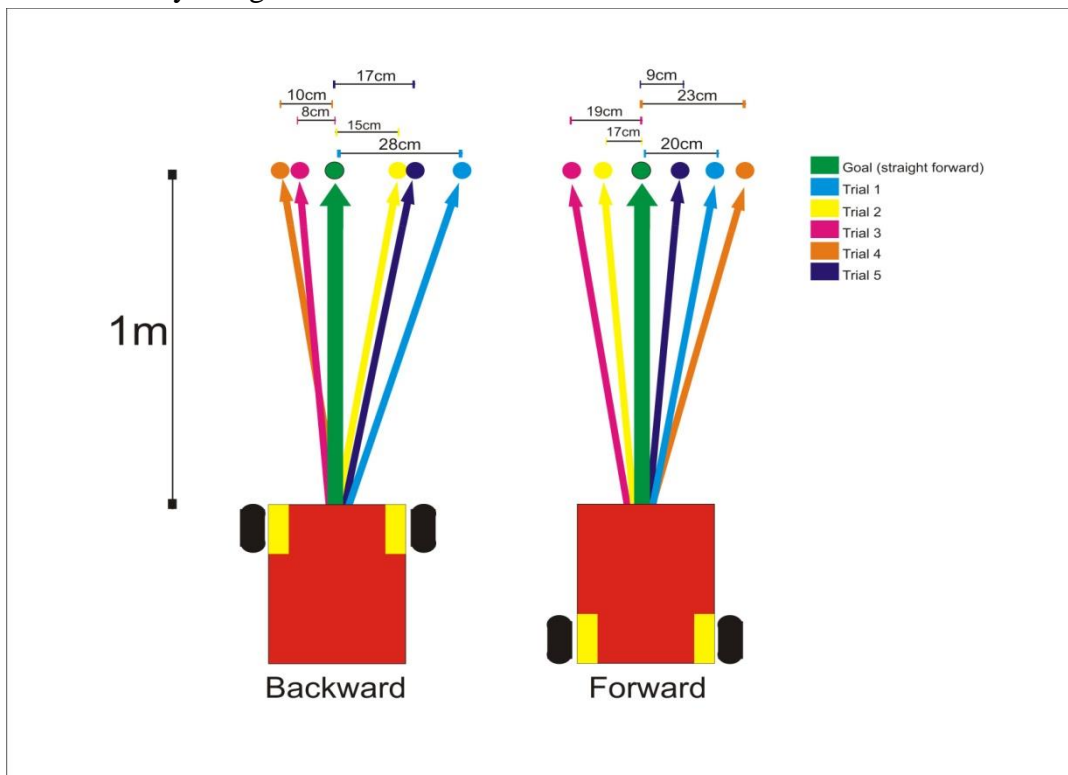

Figure 6. Forward-Backward Movement Experiment

Table 4. Movement Performance (Left and Right)

Movement	Trial Number	Degree	Average (Degree)
	1	120	
	2	80	
Left	3	110	95
	4	95	

	5	70	
Right	1	80	94.4
	2	95	
	3	85	
	4	97	
	5	115	

In this experiment, Table 4 shows some errors that occurs when we want to make left and right movements. The goal is exactly 90 degree turn, but the robot shifts some degrees from the goal as shown in the table. There are five trials in each movement. This experiment will be visualized easily in figure 7 below.
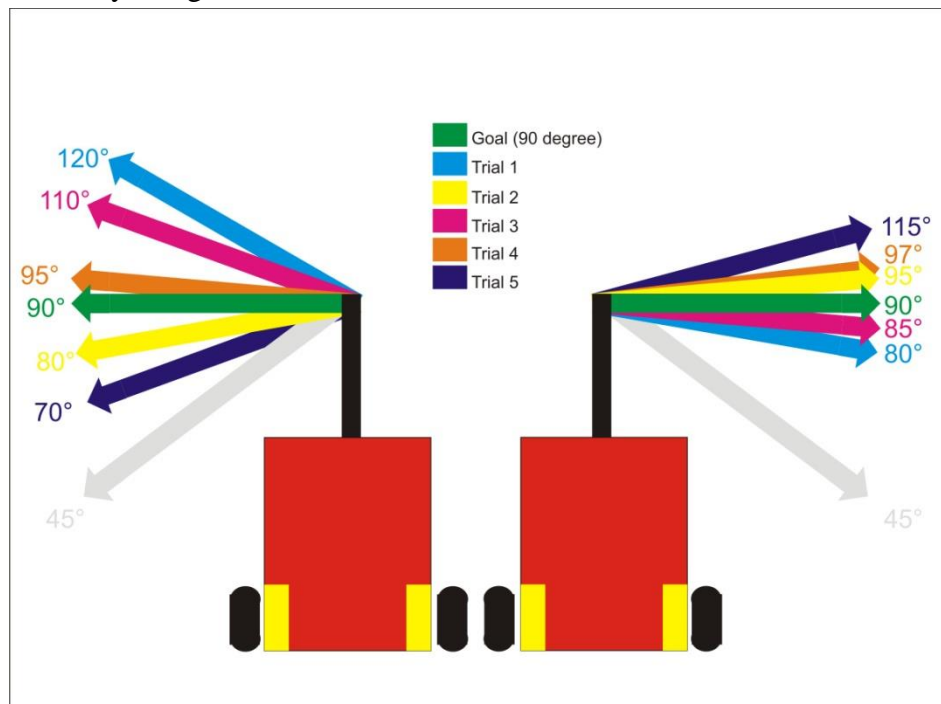

Figure 7. Left-Right Movement Experiment

3.3 Analysis

We can analyze from two experiments conducted, which is the experiment of how bluetooth range and battery capacity can affect the robot performance. Every robot made, always has limits that makes robot performance good or not. From the first experiment, the robot received data in various distance of controlling. So if the robot receives data trough bluetooth in 1 – 12 meters range, the performance is still in good condition. But if the controlling area getting wider more than 15 meters, we will get a lack of control.

The second experiment shows how battery capacity affects the robot performance. When The battery capacity is 100%, the robot shows its best performance. And the performance will drop if the capacity also decrease. The robot has its worst performance when reaching of 10% capacity.

4   CONCLUSION

After going through the testing phase, It concluded robot car can be made easily using arduino UNO.To control motor speed automatically, there a bunch of motor drivers on the market, one of it is L298N.If we make no-load robot car, we can pick motor with low torque.Bluetooth HC-05 works on 9600 baudrate.L298N motor driver amplifies PWM signals to 12V.We need to understand enable pins and PWM pin on L298N motor driver to determine the condition of motors.App Inventor is friendly user for one who makes electronic projects that combined with android application.Bluetooth range affects robot performance with various distance because its capability.Battery capacity also affects robot performance.

The author gives advice to those people who wants to develop a robot car based on arduinoand android smartphone as follows: The appearance on android smartphone should be moreattractive, Use good quality lipo battery and Place every component of robot tidy.

5   ACKNOWLADGEMENT

I am grateful to the God for the good health and wellbeing that were necessary to complete this book. I wish to express my sincere thanks to Mr. Umar , the Principal of the Department, for providing me with with all the necessary facilities in the research.

I am also grateful to Mr. Dediary Prasetya, lecturer in the Department of ELECTRICAL ENGINEERING. I am extremely thankful and indebted to him for sharing expertise, and sincere andvaluable guidance and encouragement extended to me.

And especially thanks for my fiance, Afnan, who always gives me romantic feeling to embrace my soul to do my final projects.

I take this opportunity to express gratitude to all of the department faculty members for their help and support. I also thank my parents for the unceasing encouragement, support andattention. I am also grateful to my partners who supported me through this venture.

I also place on record, my sense of gratitude to one and all, who directly or indirectly, have given their hand in this venture.

6. REFERENCES

Alasdair Allan, Make: Bluetooth: Bluetooth LE Projects with Arduino, Raspberry Pi, and Smartphones. Maker Media, Inc; 1 edition (December 28, 2015)

Boylestad, R. (2003). *Introductory Circuit Analysis, Tenth Edition.* New York: Prentice Hall.

Don Wilcher's Arduino Robotic Motor Controllers, Apress; 1 edition (September 5, 2012)

Kurfess, Thomas (2005). Robotics and Automation Handbook

Robot Building for Beginners by David CookApress, December 2009, Second Edition

William H. Yeadon, Alan W. Yeadon. Handbook of small electric motors. McGraw-Hill Professional, 2001. Page 4-134.