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Date :

Smartphone Control Legged Robot

Mohammad Shamrin Bin Dol

A report submitted in partial fulfilment of requirements for the degree
of Bachelor in Electrical Engineering (Control, Instrumentation And Automation) with
Honors

Faculty of Electrical Engineering
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2016

I declare that this report “Smartphone Control Legged Robot” is the result of my own research except as cite in the reference. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

Name :

Date :

To my beloved mother, father and my family member.

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Abstract

The purpose of this project was to develop and design a legged robot that can be controlled by smartphone wirelessly. The smartphone use was Android based operating system. The application of smartphone was designed and developed so that it will be easier for user to use. The range of communication for the robot operate was also improved. This can be done by changing the Bluetooth module to the Wi-Fi module. The legged robot will move when user start to give command at the smartphone application. This command will be received by Wi-Fi module of the legged robot microcontroller. The microcontroller used is an 8-bit microcontroller. The proposed legged robot must have 4 leg which can reduce the amount of cost to build. Each leg will have 2 servos motor. The 8-bit microcontroller is used to control the servo motor attach on the legged robot. The conceptual design of the legged robot is done by using SolidWork 2015 software. The phone app is made using Android Studio 2015.

Abstrak

Tujuan projek ini adalah untuk membangun dan mereka robot pintar yang boleh dikawal oleh telefon pintar. Telefon pintar yang digunakan merupakan telefon pintar yang menggunakan sistem operasi Android. Aplikasi telefon pintar direka dan dibangunkan supaya lebih mesra pengguna. Jarak komunikasi untuk robot beroperasi juga telah ditambah baik. Ini dilakukan dengan menukar penggunaan modul Bluetooth kepada penggunaan modul Wi-Fi. Robot berkaki ini akan bergerak apabila pengguna memberi arahan dengan menekan butang yang ada didalam aplikasi telefon pintar. Arahan-arahan ini akan diterima oleh modul Wi-Fi yang terdapat di microcontroller. Microcontroller yang digunakan adalah microcontroller 8-bit. Robot berkaki yang dibangunkan mestilah mempunyai empat kaki sahaja untuk mengurangkan kos pembuatan. Setiap kaki robot akan diletakkan dua motor servo sahaja. Motor-motor servo ini akan dikawal oleh 8-bit Microcontroller. Rekabentuk konsep robot berkaki adalah direka dan dibuat menggunakan aplikasi SolidWork 2015. Aplikasi telefon pintar dibuat menggunakan Android studio 2015.

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Chapter 1

Introduction

1.1 Overview

Robot is mechanical and virtual artificial agent made by human. Robot is developed based on the Zeroth Law that was inspired by Isaac Asimov in the year 1985 [1]. According to the Zeroth Law, there are 3 law that need to follow. The first law is; the robot must not injure the humanity. The robot also must obey the order given by human and lastly, robot must defend its own presence without breaking the first two rule.

Mobile robot is one of the robotic field. There are many engineering field of studies include in order to developed a mobile robot. [2] The field of studies include are such as electrical, mechanical, electronic and computer engineering. Nowadays, numerous mobile robot has been developed. The different of the developed robot is its locomotion mechanism. [3] There is mobile robot that move using wheel, legged, flying and underwater robot.

The robot mobile robot can be control to move by various controller. The previous system uses remote control to control the mobile robot. Nowadays, smartphone is the gadget that is widely used in the world. Based on smartphone survey in Malaysia, smartphone user is about 53.4% while 46.4% using the feature phone. [4] The technology of smartphone has improved rapidly. The smartphone now has become more powerful with the improve processor, larger capacity and various of useful application. [5] This technology can be apply to mobile robot and become remote controller. This can be done wirelessly between smartphone to the mobile robot.

1.2 Motivation

The motivation for doing this project was primarily an interest in undertaking a challenging project in an interesting area of research. The opportunity to learn about a new area of computing not covered in lectures was appealing. The challenge come when there is no legged robot control by smartphone yet. There are few wheel robot that controlled by smartphone. [5]–[7] The existing system only control the legged robot using joystick as the remote control. Besides, many wheel robot use Bluetooth module as the wireless connection between smartphone and robot.[5], [6] Bluetooth area of communication is limited compared to Wi-Fi. This will make the robot to lost signal from smartphone if the robot moves outside the area of communication of bluetooth. The legged robot design must have a sufficient number of degree-of-freedom in order for robot to move in proper way. Servo motor will make the leg to move forward, backward, swing, and lifting. This will make the number of degree-of-freedom of increases.

1.2 Objective

The main objective of this project is to make a robot that can be control by smartphone. Below are the objectives needed to be achieved in order to complete the project.

- I. Design and develop a legged robot.
- II. Design the electronic robot controller
- III. Design and develop a user friendly android application
- IV. Evaluate the legged robot range of operation

1.3 Project scope

This project is aim to design and develop a legged robot that have 4 legs. Each legs are moved by 2 servo motor. The electronic robot controller is design using 8-bit microcontroller. The android application is design and develop to have a 7 button. Five buttons that are forward, reverse, stop, left and right assign for robot movement and the other two buttons are assign for connecting and disconnecting the smartphone to the robot.

1.5 Problem statement

Robot is design with wheel or legged for locomotion. Legged robot locomotion is important as wheel robot locomotion. In difficult terrain, a legged robot mobility is much better than wheel robot mobility. [8] The legged robot stability is important for the robot to move in rough terrain. The six-legged robot is commonly developed because the six-legged robot is stable. [9] more legged for the robot, the stable the robot will come and this will make the cost for developing the robot increases. Thus, the four-legged robot is suitable for this project. As the legged is enough for the robot to become stable and the cost to develop is lesser than the cost to develop six-legged robot.

Nowadays, embedded system containing the microprocessor is commonly used by society. The processing of input and output of the system can be done by using microcontroller. [10] The logic circuit can be used for robot controller, but logic circuit is hard to troubleshoot and construct. Unlike the logic circuit, the microcontroller can be programmed by storing the coded program into microprocessor memory. This will make the construction cost for robot controller decreased.

PC instead of smartphone can control application that need high computational power such as robotic field. Smartphone can replace this PC function to control the robot. This can be done by using the 32 bit Symbian smartphone. This smartphone act as the robot brain. The Symbian smartphone will connect to the robot using Bluetooth connection that will carry signal to the robot. [6] Nowadays, Android based smartphone system is commonly used in community. [11] For robot control application, on the Symbian based smartphone application is design to work with keypad while on the Android application is design to work with touch screen. [6] The android application can be developed to become more user friendly. this can be done by develop a simple button on the application. Each of this button will assign to make the legged robot move accordingly. Therefore, the robot that control by Symbian base software must be upgrade to android base software which is more updated. An android software is also needed when this upgrading occurs.

Existing system used Bluetooth as a medium connection between robot and smartphone. Data from smartphone such as command for robot to move or stop receive by Bluetooth module. This Bluetooth module act as input to the controller. Then controller will give the signal to DC motor of the robot. Bluetooth is well known for short range communication. The range for average is about 10 meter. [12] This communication range need to extend in order for robot to work more faraway. The Wi-Fi range of operation is wider than Bluetooth. [13] In order for the legged robot to operate more far away, the legged robot need to use Wi-Fi connection between Smartphone to the legged robot.

Chapter 2

Literature review

2.1 Review on previous project related with “Smartphone controlled robot”

2.1.1 Overview

There are many project that related to robot control smartphone. There is not much similarity in each of review projects. The methodology is slightly different. Each project has pros and cons.

2.1.2 Smartphone Control Robots Through Bluetooth by Hebah Nasereddin

Based on this project which have been developed by Hebah Nasereddin in the year 2010, the purpose of this project is to control the robot using smartphone. This project use Symbian os smartphone to control the robot as the Symbian smartphone is the world leading mobile phone manufactured that current time. This project use Bluetooth as the medium connection to transfer signal between smartphone to robot.

The robot will have two modes. First mode, is direct drive mode. [6] In this mode, the user will directly command and direct the robot to move. Direct drive mode is the mode where user will directly control the robot by pressing the arrow on the smartphone keypad. For example, when user want robot to move backward, the Down arrow on smartphone. The robot then will move backward.

The second mode is a map based mode, which the robot can interacting with the environmental area and avoid the obstacle. [6] In this mode, the user will draw a map for a robot which is the start point and end point, the system then will calculate the shortest distance to travel between start point and end point. Map based mode is the mode where robot find the shortest distance by its own. The user will set the set point and end point to the robot. The

robot then will avoid the obstacle and calculating the shortest distance need to travel. In this mode, the system will handle 15x15 map.

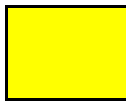
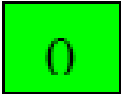
	5	4	5		
5	4	3	4	5	
4	3	2	3	4	5
3	2	1	2	3	4
2	1		1	2	3
3	2	1	2	3	4

Figure 2.1: The 15x15 map. The yellow square is robot location while the green square is end target

2.1.3 Smartphone Controlled Robot using ATMEGA328 Microcontroller by Aniket R. Yeole

This project was developed by Aniket R. Yeole in January 2015. The purpose of this project is to control a robot using microcontroller ATMEGA328 and smartphone. In this system, Bluetooth is used as a replacement of serial port line. [14] This will make the smartphone to the robot is connected wirelessly. The system uses Android OS based smartphone.

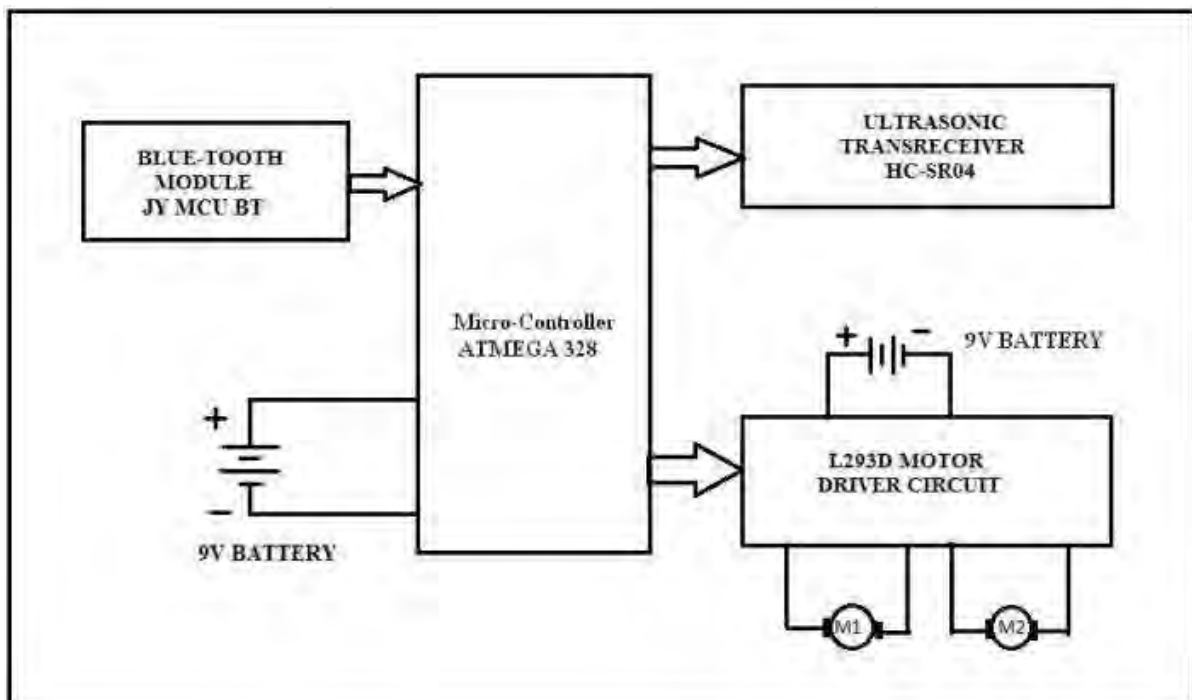


Figure 2.2: Block diagram of the system consist of bluetooth module, ATMEGA328, Ultrasonic Transceiver and motor driver circuit

The figure 2.2 show the block diagram of this system work. The Bluetooth module will receive the signal from smartphone and send the signal to ATMEGA328 which is microcontroller for this system. The ATMEGA328 then will give the command for motor circuit driver to work. This robot system also consists of ultrasonic transceiver sensor. This ultrasonic transceiver sensor use for calculating the distance of an object to the robot. [14] This will help robot to avoid the obstacle and smoothen the robot movement.

2.1.4 Robot Control Design Based on Smartphone by Xiao Lu

This project was developed by Xiao Lu in the year of 2013. This project purpose is to control a robot using smartphone. The connection between smartphone and robot will use Wi-Fi. [7] For the robot to accomplish various function, the wireless network card which is compatible with Wi-Fi IEEE 802.11 N standard use. The figure 2.3 below is the schematic diagram of the system composition.

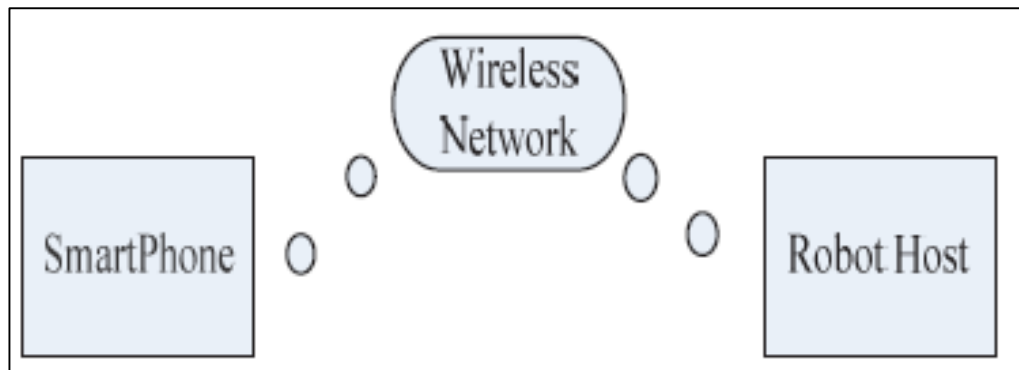


Figure 2.3: The schematic diagram of system composition

This system is design to make the communication between the intelligent mobile and robot come to realize. [7] This system is design and develop on robot and also the smartphone. On the robot part, the system socket is bound to local address. This will make the robot in monitor mode. In this mode, the robot is ready to receive the connection request. The smartphone then will send a request to the robot, and if the robot accept the request, the connection between the robot and the smartphone will establish.

On smartphone part, the android system based is used to control the robot. The development of this system used Java language. The intelligent mobile then will make a connection to the robot using Wi-Fi connection. Using this connection, the smartphone can communicate with robot.

2.1.5 Legged Robot by Yvonne So

This project was developed by Yvonne So in the year 1998. The purpose of this was to design and implement a legged robot with RC servo motors. [15] The legged robot is design to move straight forward and move to turn. The leg of the robot consists of two servo motor. The servo motor is operated by interface circuit. The interface circuit is fed up by binary number from the 68HC11. [15]

The interface circuit then will generate a Pulse-width-modulation signal. The servo movement is based on Pulse-width-modulated signal. To avoid robot from falling, the tripod gait is used to coordinate the legs motion. The robot was also design to save power consumption. While in standing position, the robot's leg will lock up so that no movement will be made.

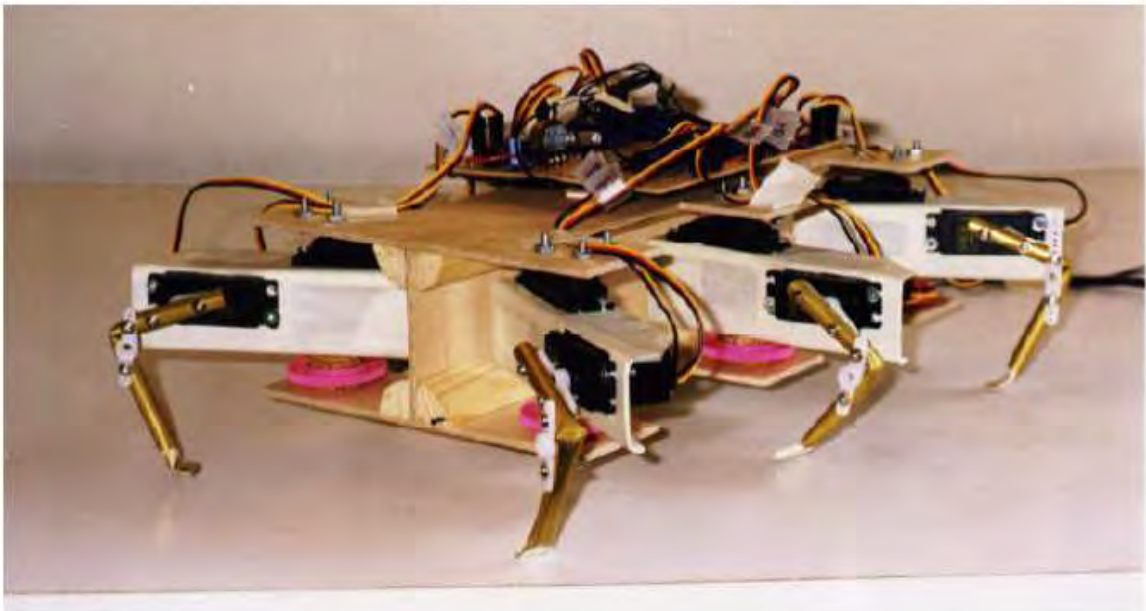


Figure 2.4: The legged robot by Yvonne So

2.1.6 Comparison of the review project

The table below is the comparison between the related project discussed. The project is numbered as following:

- 1 = Smartphone Control Robots Through Bluetooth
- 2 = Smartphone Controlled Robot using ATMEGA328 Microcontroller
- 3 = Robot Control Design Based on Smartphone
- 4 = Legged Robot

Table 2.1: Comparison of the review project

Project number	Journal
1	Smartphone Control Robots Through Bluetooth
2	Smartphone Controlled Robot using ATMEGA328 Microcontroller
3	Robot Control Design Based on Smartphone
4	Legged Robot
	Year
1	2010
2	2015
3	2013
4	1998
	Author(s)
1	Hebah Nasereddin
2	Aniket R. Yeole
3	Xiao Lu
4	Yvonne So
	Type of Robot
1	Wheel
2	Wheel
3	Wheel
4	Legged
	Wireless
1	Bluetooth
2	Bluetooth
3	Wi-Fi
4	Not in use
	Smartphone Operating system
1	Symbian
2	Android
3	Android
4	Not in use
	Robot operating