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Autonomous mobile robot following human (software  
movement part) / Tam You Wei.

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**AUTONOMOUS MOBILE ROBOT FOLLOWING HUMAN  
(SOFTWARE MOVEMENT PART)**


**Tam You Wei**

**Bachelor in Mechatronics Engineering  
2009**

**“I hereby declared that I have read through this report entitle “Autonomous Mobile Robot Following Human (Software Movement Part)” and found that it has comply the partial fulfillment for awarding the Degree of Bachelor in Mechatronics Engineering.”**

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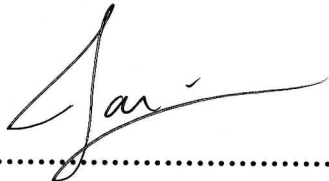
**TAM YOU WEI**

**This report is submitted in partial fulfillment of requirements for the Degree of  
Bachelor in Mechatronics Engineering**

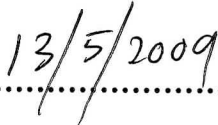
**Faculty of Electrical Engineering  
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**May 2009**

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**Signature** : .....  .....

**Name** : TAM YOU WEI

**Date** : .....  .....

I dedicated this report to my beloved father and mother

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## ABSTRACT

This project will discuss on how to give command to a mobile robot to follow a human movement by using Matlab. An initial study will be done on the serial port communication and the method to control the mobile robot. This project is started by establishing a wireless communication between the serial transmitter and the soccer robot with user manual<sup>[2]</sup> instruction to configure the hardware setting. Then the software reverse engineering is applied on the soccer robot test program by using the free serial port monitor software to obtain the output data of the soccer robot test program for analysis, and then the algorithm to control the mobile robot is identified. After that, this project continue with program design and development to create an algorithm to control the degree of turning of the robot with respect to PWM value, where the PWM value is for controlling the motor speed. Next, a new program is created to control the mobile robot movement using the Matlab with algorithm obtained from software reverse engineering and program design and development. At the end of the project, the control program is combined with the vision program for the mobile robot to follow a human movement automatically after the human coordinated has been identified.

## ABSTRAK

Projek ini akan berbincang tentang bagaimana memberi arahan kepada robot supaya ia mengikut manusia tersebut dengan menggunakan Matlab. Satu kajian tentang data perhubungan *serial port* dan cara untuk mengawal pengerakkan robot. Projek ini dimulakan dengan mewujudkan data komunikasi tanpa wayar di antara pemancar dengan robot tersebut. Kemudian, projek ini diteruskan dengan kejuruteraan terbalik perisian untuk mendapatkan output daripada *soccer robot test program* dengan menggunakan sebuah perisian *Free Serial Port Monitor*. Output tersebut dianalisisikan supaya satu algoritma dikenalpasti untuk mengawal robot tersebut. Projek ini diteruskan lagi dengan mengkaji suatu algoritma untuk mengawal darjah pusingan robot itu dengan nilai pemodulatan lebar denyut (*PWM*) yang berbeza-beza; di mana nilai tersebut adalah untuk mengawal kelajuan motor. Langkah seterusnya, satu program untuk mengawal robot akan dihasilkan dengan Matlab dan akhirnya program tersebut akan bergabung dengan program penglihatan untuk mengarahkan robot itu mengikut manusia selepas kedudukan manusia tersebut ditertentukan.



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## LIST OF ABBREVIATIONS

COM Port	–	Communication port; also refer as serial port
DIP switch	–	Dual in-line package switch
DIY	–	Do it yourself
EXE	–	A common file name extension denoting an executable file in Microsoft Window.
GUI	–	General User Interface
GIUDE	–	GUI builder; a component of Matlab.
Kbps	–	Kilo bits per second
PID controller	–	Proportional–integral–derivative controller
PWM	–	Pulse Width Modulation
RF	–	Radio Frequency
USB	–	Universal Serial Bus

**LIST OF APPENDICES**

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## CHAPTER 1

### INTRODUCTION

In today's world, science and technology of engineering is wide spread. We can see that building a simple DIY (Do it yourself) robot is much easier than before because by browsing through the information from internet and books, every one can do it. Even the common electronic components also easily can get from market. Besides, we also can buy the ready made robot to assembly and modified for other purposes. But a robot consists of hardware and software, if we want to modify an existing robot for other purposes; both hardware and software also need to be changed.

Modification can be simply meant add more input or output but more input also means software will be more complex. Initially the robot is set go to a destination after a command of the destination coordinate (10, 10) is set by user and the robot will go to the destination using the shortest distance which is a straight line pathway. But if a infra – red sensor has been added to detect obstacle, in this case, the software has to be written in a way to read the sensor value and the user input for computation before send a command to the robot. Before that, the system is an open loop system, where no feedback will be given to the robot, the robot receive command and run. With the sensor added, the system become a closed loop system, where the infra – red sensor value a feedback to the system.



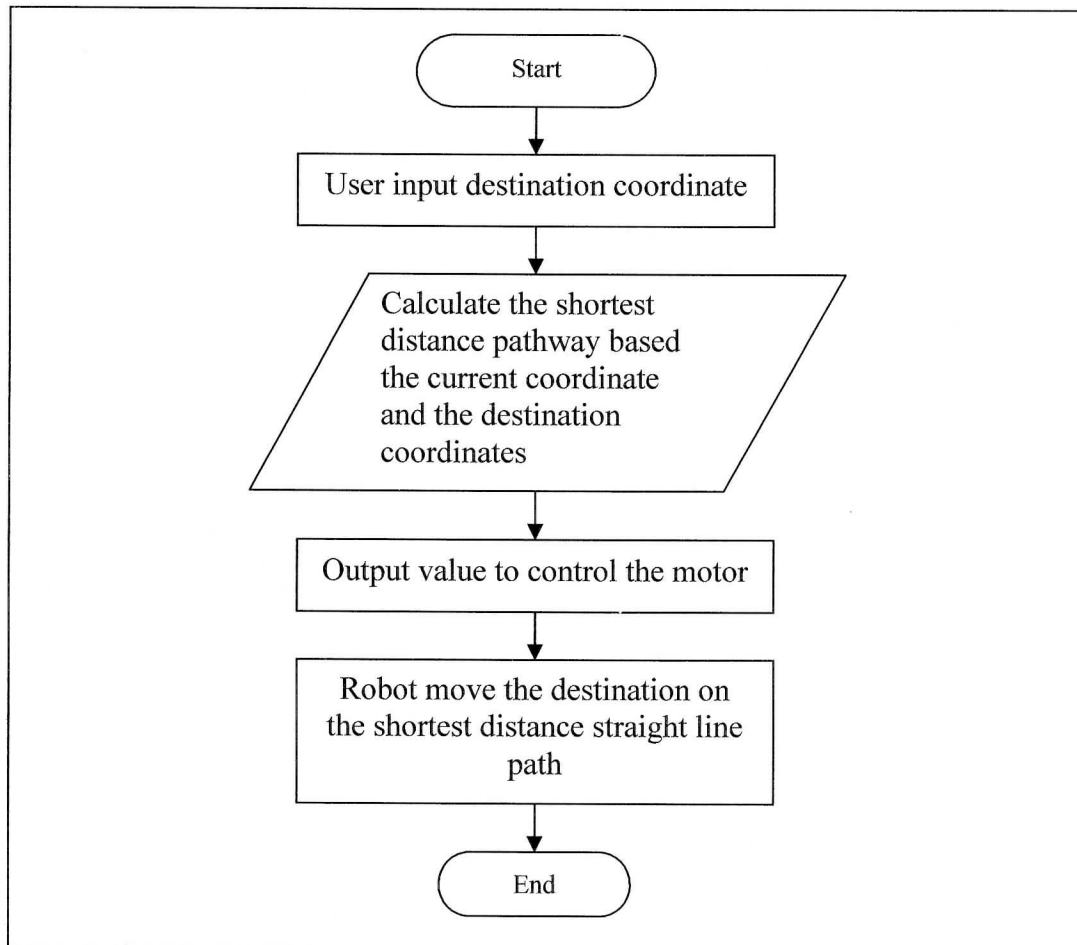


Figure 1.0: Conventional program process flow

Now the new software of two inputs, the software process flow is totally different. Each time the software run, it uses the inputs from the user and the value from the sensor, first is calculate the shortest distance straight line path, then send command for the robot to move the destination. While robot is moving, the robot will stop if there is an input value from the infra - red sensor, then the robot will adjust the direction until no input from the sensor and recalculate the shortest distance straight line path to the destination. The process will be repeated until the robot reached the destination coordinate set by user.

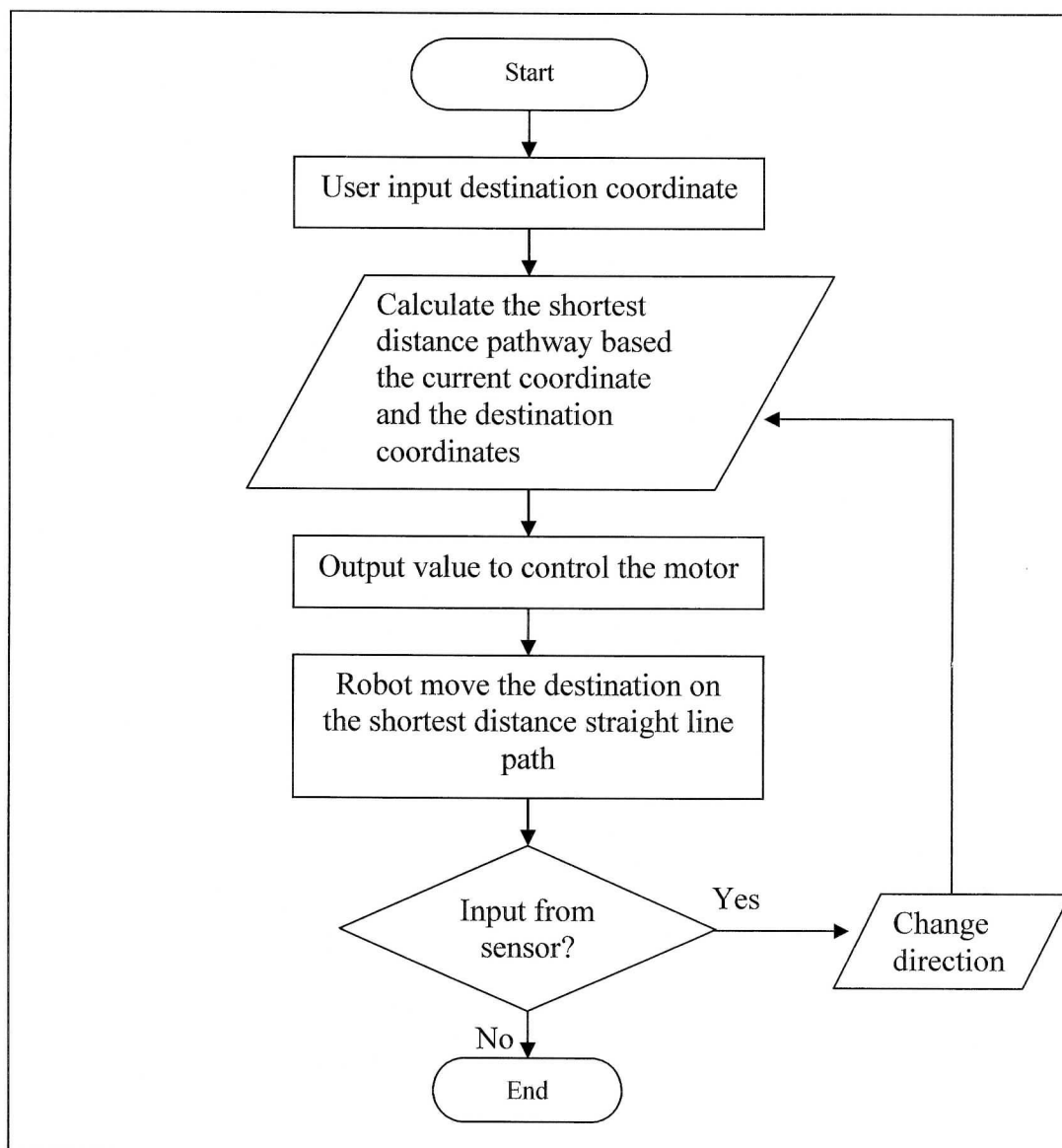


Figure 1.1: New program process flow

## 1.1 Problem Statement

A soccer robot is being modified to become an autonomous mobile robot which will follow human by adding a wireless camera on it as a sensor to track the human position. The modification of hardware just adds on a wireless camera on top on the soccer robot only, while the new program will be divided into two parts. That is vision and robot control, since vision program will be written using Matlab, for the ease of combine the both program, the robot control program will be written using Matlab too.

Since the soccer robot with the wireless camera add on, then we will called it as the mobile robot, is used for a purpose of follow a human, thus the program to control the mobile robot has to be rewrite because the soccer robot program to control the robot was written for the purpose of soccer competition only. The program to control the mobile robot is consists of two parts, the control program on computer and the program on microcontroller of the mobile robot. But this project will only focus the rewrite control program of the mobile robot on the computer only using Matlab to allow the mobile robot follow the human automatically.

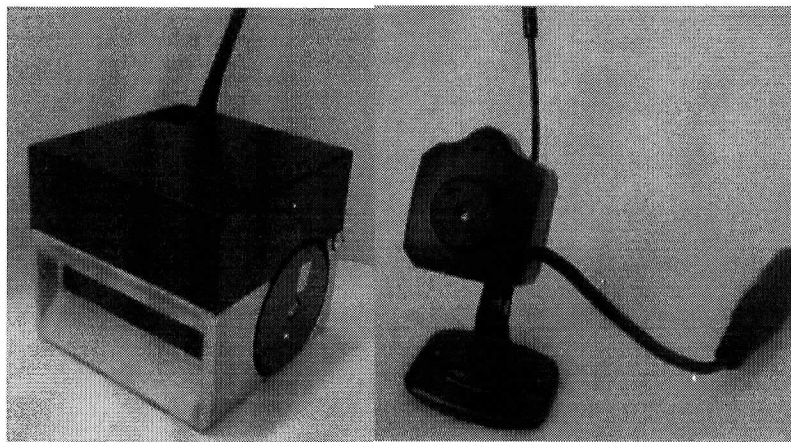


Figure 1.2: Soccer robot and wireless camera

## 1.2 Project Objectives

The main objective of this project is used Matlab to write a program on computer to control a mobile robot to follow a human based on the data output from the vision program. In order to achieve the main objective, there are some goal is being set to ensure the project objective can be achieved as plan. The goals are as below:-

- i. To output commands to computer serial port using Matlab:  
This goal is to verify the Matlab code to control the serial port and confirm the serial port on computer is working properly.
- ii. To design a user friendly GUI (General User Interface) program:

This goal is for ease of testing purpose. After the control program is used for testing, a GUI is needed for the convenient to input command to control the mobile robot.

- iii. To find out the communication protocol setting between all the hardware being used and configure serial port protocol setting in Matlab:  
Since the hardware consists of serial port on computer, RF transceiver, RF receiver and the motor driver, hence a set standard communication protocol setting is needed in order for all hardware to transmit data.
- iv. To send commands to control the mobile robot movement from a computer:  
To verify the communication protocol setting; the mobile robot must move according to the command given and does not perform any unexpected movement through the testing process.
- v. To interface the control program with the vision program:  
To read the inputs from vision program and use that value to control the mobile robot movement.
- vi. To give instruction to the mobile robot follow the human after the human coordinated is determined:  
Final stage testing with all the hardware installed.

### **1.3 Project Scope**

Generally every project must have their scope to avoid the project from running away from the right track. The scope for “Autonomous mobile robot following human – software movement part” is as below:-

- i. The COM Port that being used will be different for each computer, user has to determine which is the correct COM Port to use to control the robot:  
Due to the COM Port register for each new device is vary from one computer to another. Although the COM Port can be determine manually by user but for the



ease of user, the program will provide the option to check the availability of the COM Port to be used because choosing a wrong COM Port to use may lead to unexpected error occurs.

- ii. The working range of the RF communication between the mobile robot and the computer is 30 meter in a building and 120 meter in open area.

This is the recommend working range written in user manual <sup>[2]</sup> of the soccer robot, where by the transceiver and receiver is one of the components of the soccer robot.

- iii. The program is designed to control a mobile robot at a time:

Since only a mobile robot is provided for the project; hence all the research and test will be only done based on a mobile robot.

- iv. The mobile robot will not avoid from any obstacle while moving to the targeted human position:

The camera is the only sensor that installed that soccer robot, while the only data that will be get from the vision program the targeted human position, hence if there is an obstacle, the mobile robot cannot identified and avoid from it.

#### 1.4 Literature Review

The article <sup>[1]</sup> of “Development of Software for Mobile Robot Control over a Radio Frequency Communication Link” is focus on the methods the overcome the error bits problem on receiver site. That paper suggested using software to correct errors that may develop in RF communication. This error most probably is come from the nearby RF devices.

The article <sup>[1]</sup> is actually given a great impact on project of autonomous mobile robot following human. By ignoring the statement come from that article, may be by the end of the project, the mobile robot is able to follow the human automatically but this does not guarantee there will be no error occur when the robot executing the command, the error occurs may lead the robot move to somewhere which is away from the destination.

Anyway this project is only focus on create a control program that allow the mobile robot to follow human only, all the computation is done on computer only, while the command that send the mobile robot is simply the PWM value only. Compare with article mentioned above, the output is data is much more complicated, which consists of speed of motor, direction to move, distance to travel and angle to turn, meaning the computation is done on the mobile robot instead of computer, hence an error occur may give them a significant impact, hence error handling is very important to that project.

In article <sup>[4]</sup> mentioned that the movement to the robot is control with reference to the compass sensor and rotation of the wheel to recognize its current position; the control of the robot movement based on these two inputs. Although, the robot has a camera attached on it but it only serve for the purpose to visualize the surrounding. According to Firmansyah <sup>[4]</sup>, the camera is not used as input to control the robot movement because it required complicated algorithm to interpret the data, hence wasting resources on doing image processing. But in this project, the movement of robot only based on the input from the camera. The weakness of only depend on the input from camera to detect the surrounding required an complex algorithm and high processing speed processor, where the accuracy of the robot movement will low compare with those robot that using other sensor such as encoder, compass sensor and obstacle sensor. In this project, the robot is only design to automatic follow the targeted human but it cannot avoid from obstacle, that is the limitation of this project due to lack of other sensor as support.

## **1.5 Project Background**

Every project is developed based on some background theory, in order to let the user understand the project in depth; here is some background theory to be introduced.

### **1.5.1 Serial Communication Link**

In serial transmission<sup>[3]</sup>, one bit is sent follow by another, hence the advantages of using serial transmission as the communication link between two devices can reduces cost of transmission. In general, serial transmission divided in three ways: asynchronous, synchronous and isochronous.

Asynchronous transmission is a transmission that ignores the timing signal. Data is received and sent by agreed upon the pattern. As long as the patterns are followed, the receiver can receive the information. Normally, patterns are based on grouping the bit stream into bytes, where each group usually eight bits and sent as a unit. In asynchronous transmission, the receiver cannot use timing to predict when the next group of data will arrive. Hence an extra zero bit is added as the start bit and one or more bits is added as stop bits, usually is one bit. By using this method, each byte of data is increased to at least ten bits, where eight bits is the data information and two bits is the signal for receiver. This is the serial transmission that use in this project.

While synchronous transmission is a transmission of unbroken string with one and zero, no start bit, no stop bits. It all depends on the receiver timing to receive and separate those data bits into group and translate it into readable information. Typically this transmission is used in high speed internet transmission, where time and speed is critical. Isochronous transmission is used for real time video and audio broadcast transmission, where it always sent a fixed rate of data with no delay.

One byte of data is equivalent with eight bits data. Typically, serial data is send out at least one byte of data. In this project, the transmitter is sent out eight bytes of data at a time, where the 1<sup>st</sup> byte and the 8<sup>th</sup> byte is start byte and end byte, while the six bytes of data in between is the data byte. Each byte is equivalent of eight bits, hence it can carry a set of data range from 0-255 in term of decimal.

### **1.5.2 Soccer Robot**

The soccer robot<sup>[2]</sup> that in used for this project is developed Yujin Robotics Co.Ltd, Korea. The robot is come in a box with separated part to be assembly. In the box consists of:-

- i. A soccer robot with a RF receiver
- ii. A RF transceiver with serial port
- iii. A testing program code written in Visual C++
- iv. A testing program which is compile into EXE file



- v. A user manual <sup>[2]</sup> of the soccer robot

Initially this robot is received command from computer during the soccer competition. The control program that installed on computer was written in Visual C++. There are two type of software to control the soccer robot. In this project, the software (firmware) on the soccer robot will be remained unchanged, while the software on the computer will be a new program which written in Matlab.

### 1.5.3 Pulse width modulation

The Pulse width modulation (PWM) is a typical method used to control the motor speed. According to the user manual<sup>[2]</sup>, PWM is the method used to control the speed and the direction of the motor of the YSR\_A soccer robot. PWM is actually the ratio of the high voltage and low voltage that being apply to a motor in duration of one cycle time, as shown in Figure 1.3. Normally, the PWM value is range from 0 to 255, if the PWM value is 127, meaning it is the high voltage will on for half of the period of one duty cycle and continue with the low voltage (which is equivalent of zero voltage). The cycle time is depended on the frequency of the PWM, where the frequency of PWM is depended on the combination micro controller and the frequency of the clock that used by the micro controller.

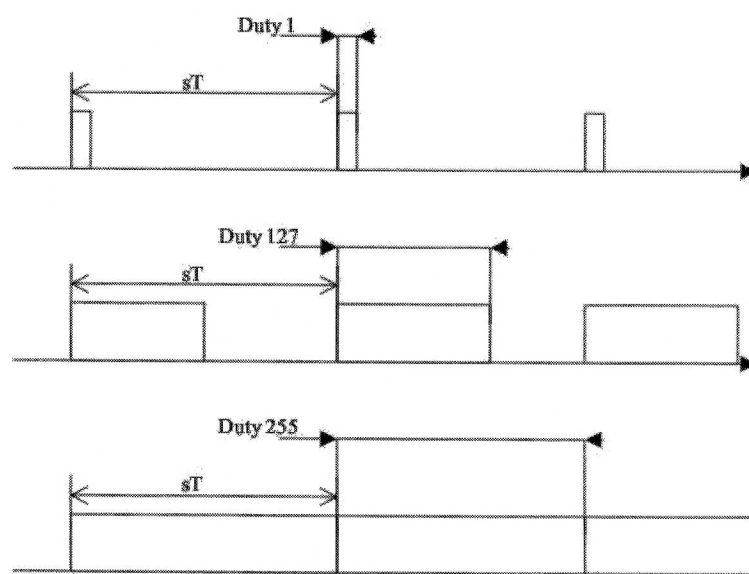


Figure 1.3: Pulse Width Modulation (PWM)