

raf

TJ211.45 .K66 2005



0000010418


Micro-controller implementation of a line following mobile robot / Kong Mun Fun.

**MICRO-CONTROLLER IMPLEMENTATION OF A LINE
FOLLOWING MOBILE ROBOT**

KONG MUN FUN

MARCH 2005

This report has been read and certified by:

Signature : 

Name of Supervisor : MS. CHONG SHIN HORNG

Date : 11 MARCH 2005

**MICRO-CONTROLLER IMPLEMENTATION OF A LINE FOLLOWING
MOBILE ROBOT**


KONG MUN FUN

**This Report Is Submitted In Partial Fulfillment Of Requirements For The
Degree of Bachelor In Electrical Engineering (Industrial Power)**

**Fakulti Kejuruteraan Elektrik
Kolej Universiti Teknikal Kebangsaan Malaysia**

March 2005

“I hereby certified that this report is of my own work except for the extracts and summaries, in which the sources have clearly noted.”

Signature : 

Name : KONG MUN FUN

Date : 11 MARCH 2005

To My Beloved
Father, Mother, Brother & Sister

ACKNOWLEDGEMENT

First of all, I would like to thank you my superior, Ms Chong Shin Horng, who is the PSM I and PSM II (Projek Sarjana Muda) supervisor of this project. Under her supervision, I had learned many kinds of the literature review about the line following mobile robot.

1

Secondly, I would like to thank you my lecturer, Dr. Ir Alita Devi and Mr Gan Chin Kim. Between these period, they advices and opinions give me a chance about how to do, to start, to continue my project. Their suggestions have given many ideas for me to implement my project.

Thirdly, I would to thank you Mr Omar, the technician who help to buy the components; Mr Subki and Mr Jasmani, the technician who help me to do my project in the laboratory.

Last but not least, I also would to thank you the person who is directly or indirectly helping me to finish my project during this period, because without their help, suggestion, advice and comment, I cannot finish my project in the duration of this semester.

ASBTRACT

Robot is a machine which, able to extract information from its environment and use knowledge about its world to move safely in a meaningful and purposive manner. Meanwhile, robotics has become a very popular hobby with computer and electronics enthusiasts worldwide. Following lines is an essential part of robot navigation in a First LEGO League robotics competition. Line following robot is a fantastic and small-uncomplicated robot. There have three main parts to develop a line-following robot; they are controller (human brain), sensors (human eyes) and actuators (human legs). Line-following mobile robots is using micro-controller as the brain to control the movement of the robot. The robot captures the line position by using optical sensors likes infrared sensor, which mounted at front of the robot. The robots will detect black line on the white surface. When the movement the robot is out of path, the controller will give the signal to the motor to move its back to the line. The wheels of the line-following robot will use the toy wheels, which is inexpensive and controlled by DC motor. The programming to program the line-following robot will use the Assembly Language.

ABSTRAK

Robot ialah satu mesin di mana ia dapat menghasilkan informasi daripada dunianya dan menggunakan pengetahuan yang diperolehinya untuk bergerak dalam keadaan selamat dengan tujuan yang tertentu. Pada ketika ini, robotik telah menjadi satu hobi yang popular oleh peminat robotik dengan menggunakan komputer dan bahan elektronik di seluruh dunia. Bergerak mengikut garis ialah suatu bahagian terawal dan terutama sekali dalam pengemudian robot dalam “*First LEGO League*” pertandingan robotik. Robot bergerak mengikut garis adalah satu robot yang fantastik dan bersaiz kecil dengan tidak rumit. Terdapat tiga bahagian utama dalam memperuntuk satu robot bergerak mengikut garis, iaitu pengawalan (otak manusia), pengesanan (mata manusia) dan pergerakan (kaki manusia). Robot bergerak mengikut garis menggunakan “*micro-controller*” sebagai pengawalan fikiran untuk mengawal pergerakannya. Robot itu dapat mengesan garis dengan menggunakan pengesan, di mana pengesan itu terletak di bahagian depan robot tersebut, contohnya “*pengesan infrared*”. Robot itu dapat mengesan garis yang berwarna hitam. Jika pergerakannya telah lari daripada garis dan dikesan oleh pengesan, pengawalan itu dapat memberi isyarat kepada motor supaya bergerak dan balik semula ke arah garis tersebut. Motor yang digunakan oleh robot bergerak mengikut garis ialah motor arus terus (DC) dan tayar yang digunakan adalah daripada alat mainan kereta. Pengaturcaraan bagi robot itu adalah menggunakan bahasa “*Assembly*”.

CONTENTS

CHAPTER	TITLES	PAGE
	CONTENTS	vii
1	INTRODUCTION	1
	1.1 Overview	1
	1.2 Project Objectives	2
	1.3 Scope	2
	1.4 Problem Statement	3
	1.4.1 Lack Of Knowledge About The Theoretical	3
	1.4.2 Time Management	3
	1.4.3 Broken Of The Hardware Parts	4
	1.4.4 Failure Of The Software	4
	1.4.5 Path Encoding Difficulties	5
	1.4.6 Problem Of The Combination	5
2	LITERATURE REVIEW	6
	2.1 Background	6
	2.2 History Of Robot	7
	2.3 Definition Of A Robot	14
	2.3.1 First Use Of The Word “Robot”	14
	2.3.2 First Use Of The Word “Robotics”	15
	2.4 Line Following Mobile Robot	16
	2.5 Who Might Use A Line Follower	17
	2.6 PIC Micro-controller	19

2.6.1	Types Of PIC's	19
2.6.2	PIC Specifics – PIC16F84A	20
2.6.3	Applications Of PIC16F84A	23
2.7	Sensors	24
2.7.1	Overview	24
2.7.2	Applications	25
2.7.2.1	Infrared Reflectance Sensor	25
2.8	Electrical Motor Control	26
2.8.1	General Information	26
2.8.2	DC Motors	26
2.9	Software MPLAB	27
3	METHODOLOGY	29
3.1	Procedure	30
3.2	Hardware Development	31
3.2.1	Method 1 – Study PIC From Datasheet Before Start the Project	31
3.2.2	Method 2 – Work of Soldering	32
3.2.3	Method 3 – Connecting Circuit Using Wire Wrap	33
3.2.4	Method 4 – Find the Suitable Motor And Wheels	33
3.2.5	Method 5 – Project Testing	33
3.3	Software Development	34
3.3.1	Compilation	34
3.3.2	Program Algorithm	41
3.4	Experiment	45
3.5	Analysis Data	46
4	RESULTS AND FUTURE WORK	48
4.1	Results	48
4.2	Future Work	49
5	CONCLUSION	50

BIBLIOGRAPHY

52

APPENDIX A-G

55 - 115

LIST OF TABLE

TABLE	TITILE	PAGE
1	Algorithm Of The Sensor	41

LIST OF FIGURES

NO	TITLES	PAGE
2.1	Robotic Workers – “Mechanical Men”	8
2.2	“Shakey”, The First Mobile Robot Controlled By Artificial Intelligence	10
2.3	“Robot III” Six-Legged Robotic Insect	12
2.4	“Asimo” The Next Generation Of The Series Of Humanoid Robots By Honda	13
2.5	“Aibo” The Robot Dog	13
2.6	Pins Of The PIC16F84A	22
2.7	Diagrams Of IR Emitter And IR Phototransistor	24
2.8	Circuit Diagram Of An Infrared Reflectance Sensor	25
2.9	Logo of Microchip MPLAB IDE	28
3.1	Flow Chart Of Methodology Procedure	30

3.2	Procedure To Get The Hex Code By Using MPLAB	34
3.3	Sample Circuit Diagram Of The Line Following Mobile Robot	35
3.4	Circuit Diagram Of The PIC16F84A Connect With The H-Bridge Circuit	36
3.5	Simple Circuit Diagram For Running Light	37
3.6	Micro-Controller Part	38
3.7	The Circuit Of Mini Follower 1281	38
3.8	The Frame Work Of The Procedure Of The Combination Of Hardware And Software	39
3.9	The Flow Chart Of The Function Of Mini Follower 1281	40
3.10	The Distance Of The Range Between Two Sensors	46
3.11	The Distance Between The Sensor And The Surface Of The Range	47

LIST OF APPENDIX

APPENDIX	TITILE	PAGE
A	Mini Follower 1281 (Photograph)	55
B	Linefollowing	59
C	It's Time To Make Mobile Robots Programmable	62
D	Mobile Ultrasonic Sensing In Mobile Robot	69
E	Following A Wall By An Autonomous Mobile Robot With A Sonar-Ring	76
F	Improved Learning For A Simple Mobile Robot	85
G	Example Of Programming	92

CHAPTER 1

INTRODUCTION

1.1 Overview

The purpose of this project was to apply principles of robotics to a real-world application. When developing a mobile robot, it becomes apparent just how complex it is to navigate freely and dynamically in space. With each new environment, or task comes the need for new sensors or manipulators, the human body which is the ultimate mobile robot has an incredible number of sensors.

Line following mobile robot is a simple and useful task for a robot is to follow the line. However this task is not really simple things to produce. The methods of this line following mobile robot are edge following, which stay on the edge of the line and also keep the line between sensors.

By developing the sensors, hardware, and software from scratch; the project enabled to get a deeper understanding of what is required in the design of a mobile robot. The mechanical part of the robot is using a casing, which is designed by myself. The logic was performed by using a PIC micro-controller, which is an

inexpensive single-chip computer. The sensor part is using infrared sensor, which is in pairs of transmitter and receiver, and motor control was performed with DC (Direct Current) motor. The wiring was done using wire wrap.

1.2 Project Objectives

The objective of this report is to design and implement a line following mobile robot. The report details the various phases of the project, from literature review in progress planning through to the finished of the prototype produced.

To achieve this objective, study the literature review about the line following mobile robot and the PIC16F84A micro-controller has been done.

Besides that, learn how to use the basic command and code language into the programming to control the PIC to be function.

1.3 Scope

My project is searching around the development of the robotics to interface the device, which can autonomous moving by following a line with the combination of the hardware (components) and software (programming) development for a line following mobile robot. A mobile robot to follow a line marked in black along the floor, which is in white surface. The hardware and software still have in study but will have lots of room for improvement in future works.

1.4 Problem Statement

Robotics systems are effective tools for the automation necessary for industrial modernization, improved international competitiveness, and economic integration. Increases in productivity and flexibility and the continuous assurance of high quality are closely to the level of intelligence and autonomy required of robots and robotics systems.

However, to build and develop the line-following robot this problem may be occurred and must take more attention.

1.4.1 Lack of Knowledge About the Theoretical:

This is the mistake that always happen around the students. They always lack to find the information in details about the project their handle. Before start any projects, literature review and study are very important to make the fundamental strong. Lack of the knowledge and information will stuck the project running smooth.

1.4.2 Time Management

Management time is one of the important paths that must carefully and get the full attention to develop. Each of the parts for develop the project is very taken time. Lack of time management will affect the progress of the project. One-way have a well-done job is using a Gantt chart to plan the progress of the project, follow the procedure that have plan in the Gantt chart will help to save the time from wasting.

1.4.3 Broken of the Hardware Parts:

This is misestimated matter that the logic like micro-controller will damage or not function. Most of the components are very hard to detect that is in the good condition or not. Normally this matter cannot to avoid because the chips inside the component is cannot direct see on our eyes. Testing and checking the components are the way for prevent the component from not function. But hope that all the components are in good conditions and sometime it also depends on our luck.

1.4.4 Failure of the Software:

The most common kind of robot failure is not mechanical or electronic failure but rather failure of the software that controls the robot. For example, if a robot was to run into a wall, and its front touch sensor did not trigger, the robot would become stuck (unless the robot is a tank), trying to drive through the wall. This robot is not physically stuck, but it is “mentally stuck”: its control program does not account for this situation and does not provide a way for the robot to get free. Many robots fail in this way.

1.4.5 Path Encoding Difficulties:

Irregularities in the environment and sensor inaccuracies may make it difficult to encode the path accurately and follow the line without veering. Small deviations may multiply over the course of the path, resulting in large cumulative errors. Hopefully, the error correction algorithms in the robot will eliminate this issue.

1.4.6 Problem of the Combination

After the circuit complete builds up and the programming can success in compiling but when these two developments are combines, many errors will occur. For example, after the programming burn into the micro-controller then put into testing, there have no any outputs or function. The misunderstanding between the micro-controller and the programming will make the project failure to function. Hopefully this problem can be solved and the projects can successful function.

CHAPTER 2

LITERATURE REVIEW

2.1 Background

In industrial, robots become very important characters for help in dangerous and complex field. These automated machines can outperform people in many ways, work in hazardous environments, and do the most strenuous and repetitive tasks without getting tired or making mistakes.

On TV and in films, robots are mechanical people with computers for brains. Some are massive, metallic and menacing. They carry laser guns and try to conquer the Universe. Others are cute and cuddly like R2D2 of *Star Wars*. Some looks like human, but we cannot tell the difference because they are known as androids.

In the real world, robot ‘people’ have also been developed as waiters and butlers, but it is in industry that robots have made the biggest impact. In just a few decades they have completely changed the way industries go about their business.

Robot comes in a huge range of shapes, sizes and uses, but they all have one thing common – they are machines designed to operate automatically.

2.2 History of Robot

In 270 Before Century, an ancient Greek engineer also is an inventor, named Ctesibus made organs and water clocks with movable figures. From this invention, the designing of the robot have begun [15].

Follow by 1774; the Swiss inventors named Pierre and Henri-Louis Jacquet-Droz created some of the most complicated automatons which, are lifelike figure of a boy could draw and write any message up to 40 characters long and a robot woman playing a piano [15].

In 1801, an inventor names Joseph Jacquard invents a textile machine, which is operated by punch cards. This machine is called a programmable loom and goes into mass production.

Follow by 1818; Mary Shelley wrote "Frankenstein" which was about a frightening artificial life form created by Dr. Frankenstein and in 1830 and 1892; American Christopher Spencer designs a cam-operated lathe and Seward Babbitt creates a motorised crane with gripper to remove ingots from a furnace.

In 1921; the first reference to the word "robot" appears in a play staged in London, called "R.U.R." or "Rossum's Universal Robots" written by the Czech writer Karel Čapek. This play introduces the word robot from the Czech roSbota, which

means a serf or one in subservient labour or forced labour, the concept of a robot takes hold in this beginning. The plot was simple: robotic workers - "mechanical men" - rebel against their masters and assume control of the world after slaughtering them, i.e. man makes robot then robot kills man (Figure 2.1).

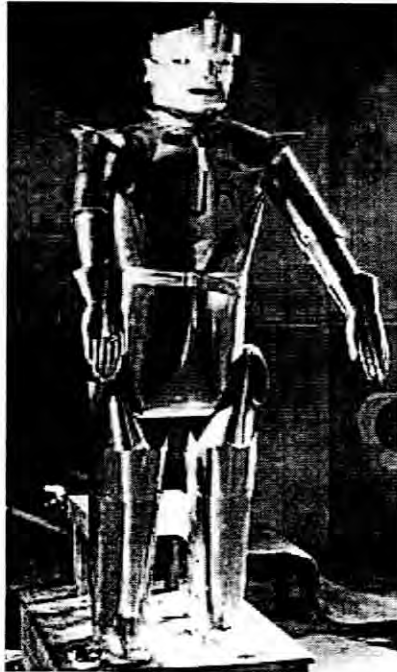


Figure 2.1: Robotic workers - "Mechanical Men".

In 1941, science fiction writer Isaac Asimov first used the word "robotics" to describe the technology of robots and predicted the rise of a powerful robot industry. Asimov wrote "Runaround", a story about robots; which contained the "Three Laws of Robotics". Asimov had proposed his three "Laws of Robotics" [18].

- A robot may not injure a human, or, through inaction, allow a human being to come to harm.
- A robot must obey the orders it by human beings except where such orders would conflict with the First Law.

- A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

In 1946; George Devol patents a general-purpose playback device for controlling machines. The device uses a magnetic process recorder. In the same year the computer emerges for the first time. American scientists J. Presper Eckert and John Mauchly build the first large electronic computer called the Eniac at the University of Pennsylvania. A second computer, the first general-purpose digital computer, dubbed Whirlwind, solves its first problem at M.I.T [15].

In 1948; "Cybernetics", an influence on artificial intelligence research was published by Norbert Wiener, where he is a professor at M.I.T. It describes the concept of communications and control in electronic, mechanical, and biological systems. And in 1951, 1954 and 1956; A teleoperator-equipped articulated arm is designed by Raymond Goertz for the Atomic Energy Commission, the first programmable robot is designed by George Devol, who coins the term Universal Automation. Later he shortens this to Unimation, which becomes the name of the first robot company in 1956, George Devol and Joseph Engelberger formed the world's first robot company [15].

In 1959, computer-assisted manufacturing was demonstrated at the Servomechanisms Lab at MIT. Planet Corporation markets also are the first commercially available robots. In 1961, the first industrial robot was on a production line a General Motors automobile factory in New Jersey and it was called UNIMATE.

In 1963, the first artificial robotic arm to be controlled by a computer was designed. The Rancho Arm was designed as a tool for the handicapped and it is six joints gave it the flexibility of a human arm. In 1964, artificial intelligence research laboratories are opened at M.I.T., Stanford Research Institute (SRI), Stanford