

AUTONOMOUS LAWNMOWER

SITI MARIAM BINTI RAJAB

**This report is submitted in partial fulfillments of the requirements for the award of
Bachelor of Electronics Engineering (Industrial Electronics) With Honours**

**Faculty of Electronics and Computer Engineering
Universiti Teknikal Malaysia Melaka**

April, 2009



UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : AUTONOMOUS LAWNMOWER
Sesi : 2008/2009
Pengajian :

Saya SITI MARIAM BINTI RAJAB

(HURUF BESAR)

mengaku membenarkan Laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan () :

SULIT*

(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)

TERHAD*

(Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

TIDAK TERHAD

Disahkan oleh:


(TANDATANGAN PENULIS)


(COP DAN TANDATANGAN PENYELIA)

Alamat Tetap: NO. 1228 JALAN MERBOK

FELDA ULU PENGGELI

86000 KLUANG JOHOR

Tarikh: 28 APRIL 2009

SITI HUZAIMAH BINTI HUSIN
Ketua Jabatan (Elektronik Industri)
Fakulti Kejuruteraan Elektronik Dan Kejuruteraan Komputer
Universiti Teknikal Malaysia Melaka (UTeM)
Karung Berkunci No 1752
Pejabat Pos Durian Tunggal
76109 Durian Tunggal, Melaka

Tarikh: 30 April 2009

“I hereby declare that this thesis entitled “*Autonomous Lawnmower*” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature

: 

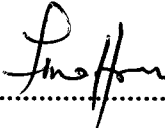
Author

: **SITI MARIAM BINTI RAJAB**

Date

: **28 APRIL 2009**

"I hereby declare that I have read this thesis entitled "*Autonomous Lawnmower*" and in my opinion this report is sufficient in terms and the scope and quality for the award of Bachelor of Electronics Engineering (Industrial Electronics) With Honours.

Signature : 

Author : **PUAN SITI HUZAIMAH BINTI HUSIN**

Date : **28 APRIL 2009**

Specially dedicated to;

My beloved parents, Rajab Othman and Sumini Jemiran, brothers Norizam, Hairunizam, Mohd Faizal, Misrizal, sisters Norhayati, Siti Suriana, Anasuhana, nephews Nabil Hakim, Danish, Addyn, Ariq Irfan, Asrar Al Ariffin, Nur Aliff and to my special friend, Mohd Zulhilmi.

Who have encouraged, guided and inspired me throughout my journey of education.

ACKNOWLEDGEMENT

Praise to be Allah S.W.T the most Gracious, the most Merciful. There is no power no strength save in Allah, the Highest, the Greatest.

First of all, I would like to take this opportunity to express my deepest gratitude to my beloved family who have give me encouragement, support and the strength to keep moving on no matter what the odds and obstacles is ahead. All of your support rather in there, physically and mentally indeed giving me lot of joy.

Secondly, to my beloved project supervisor, Puan Siti Huzaimah Binti Husin for her guidance, motivation, encouragement and endurance during the whole course of this project. It is indeed my pleasure for her undivided support; invaluable inspirational ideas have very much contributed to the success of this undergraduate project.

To all my friends especially my course mates, for their technical advice and material aid that have helped and supported me along the way, I thank you from the bottom of my heart. I wish you all the best in life and hope that our friendship will last forever.

Last but not least. I would also like to thank those who had helped me directly and indirectly. Unfortunately, it is not possible to list all of them in this limited space. Thank you.

ABSTRACT

The objective of this project is to design a mobile robot that capable to cut and trim a flat grass area by itself. This small **Autonomous Lawnmower** is built with hardware and software interfaces. The robot will follow the specific path or trail as programmed. The mobile robot is using microcontroller PIC16F877 as the brain of the robot. Besides that, limit switches will acts as sensors, and battery-powered electric motors are used to build the robot. Generally, the robot control algorithm is designed so that the robot is able to move forward by using the dc motors. While walking along the path of the robot moves, it will cut the grass. Then it will check if there are any obstacles around it by using the limit switches sensors. When the sensors hit any barrier such as tree trunks, vases it will alert the controller to change the direction of the robot. This robot is very useful in the gardening maintenance purpose. It also environmentally friendly, high quality of mowing, no need to collect the clippings, no emissions, safe time and money.

ABSTRAK

Objektif utama projek ini adalah merekabentuk sebuah prototaip robot bergerak yang boleh memotong rumput di kawasan yang rata dengan sendirinya. Robot ini akan mengikut laluan dan corak yang telah ditentukan oleh program selepas suis pemotongan ditekan dengan menggunakan mikro pengawal PIC16F877 sebagai otak kepada robot ini. Selain itu suis penghad digunakan sebagai pengesan objek halangan, tiga buah motor arus terus digunakan untuk menggerakkan robot ini. Secara umumnya algoritma robot ini direka, untuk membolehkannya bergerak ke depan dengan keupayaan dua buah motor. Sepanjang perjalanan yang ditentukan robot ini akan memotong rumput seperti yang dikehendaki. Robot ini akan mengesan sebarang objek pegun yang berada dihadapannya dengan menggunakan mekanisma suis penghad. Bila suis penghad mengesan objek seperti pokok dan pasu bunga, ia akan mengelak dengan mengikut arahan dari mikropengawal. Robot ini sangat berguna untuk menyelenggarakan taman-taman kecil. Robot ini juga dilengkapi dengan ciri-ciri mesra alam, kualiti pemotongan yang tinggi, tiada pencemaran udara, serta menjimatkan masa serta wang ringgit.

TABLE OF CONTENTS

CHAPTER	CONTENT	PAGE
	PROJECT TITLE	i
	RECOGNITION	ii
	SUPERVISOR RECOGNITION	iii
	DEDICATION	iv
	ACKNOWLEDGEMENT	v
	ABSTRACT	vi
	ABSTRAK	vii
	TABLE OF CONTENTS	viii
	LIST OF TABLES	xiii
	LIST OF FIGURES	xiv
	LIST OF APPENDICES	xviii
	GLOSSARY	xixi
I	INTRODUCTION	
	1.1 Introduction of the Project	1
	1.2 Definition of Robot	2
	1.3 Problem Statement	3
	1.4 Objectives	4
	1.5 Scopes of Work	5

1.6	Project Methodology	6
1.7	Thesis Layout	7

II LITERATURE REVIEW

2.1	Introduction	8
2.2	Studying from Lawnmower System	10
2.2.1	BigMow	10
2.2.1.1	Mowing Modes	12
2.2.2	LawnBott	13
2.2.2.1	The LawnBott Works	14
2.2.2.2	Mowing Modes	15
2.2.3	RoboMower	16
2.3	Currently Lawnmower	17
2.4	Conclusion and Finding	18

III HARDWARE IMPLEMENTATION

3.1	Introduction	19
3.2	Motor Selection	19
3.2.1	DC Motor	20
3.3	IC Motor Driver (L293D)	21
3.4	Microchip PIC16F877	23

3.5	Electronic Circuit Fabrication	27
3.5.1	PIC Basic Stamp	27
3.5.2	Power Supply	28
3.5.3	Motor Driver Design	29
3.5.4	RF Module	30
3.5.5	IR Sensor	33
3.5.5	Circuit Integration	34

IV SOFTWARE IMPLEMENTATION

4.1	Introduction	35
4.2	PIC Microcontroller	35
4.3	CCS C Compiler	36
4.3.1	File Format	38
4.3.2	Overall Structure	40
4.4	PROTEUS VSM	41
4.4.1	ISIS and Simulation	42
4.4.2	General Points about Libraries	45
4.5	How to Compile a Program	46
4.6	Boot Loader	50

V PROJECT METHODOLOGY

5.1	Introduction	51
5.2	Project Flow Chart	52
5.2.1	Hardware Development	53
5.2.2	Software Development	55
5.2.3	Combining Software and Hardware	57

VI RESULT AND DISCUSSION

6.1	Introduction	58
6.2	Project Design	58
6.3	Hardware Description	62
6.3.1	Buggy Assembly	63
6.3.2	Buggy Dimension	64
6.4	Schematic Circuit	66
6.4.1	The Programming Code of Autonomous Lawnmower	67
6.4.2	Download the Programming to the PIC.	68
6.5	Cutting Ability	72
6.6	Discussion	75

VII**CONCLUSION AND RECOMMENDATION**

7.1	Introduction	78
7.2	Conclusion	79
7.3	Recommendation	80

REFERENCES	81
-------------------	-----------

APPENDIX A	83
APPENDIX B	85
APPENDIX C	87
APPENDIX D	89
APPENDIX E	92
APPENDIX F	94
APPENDIX G	96

LIST OF TABLES

NO	TITLE	PAGE
3.1	The Control Pin Function	23
3.2	PIC16F877 Device Features	25
4.1	Standard Code for File Format	39

LIST OF FIGURES

NO	TITLE	PAGE
1.1	Autonomous Lawnmower	7
2.1	Tractor Lawn Mowing Vehicle Autonomously Cutting Long Grass	9
2.2	BigMow	10
2.3	Controller Console	11
2.4	BigMow Blades	11
2.5	BigMow Cutting Model	12
2.6	Various Type of LawnBott	13
2.7	LawnBott and Rain Sensor	13
2.8	LawnBott Working Route	14
2.9	LawnBott Control Display	15
2.10	RoboMower	16
2.11	Currently Lawnmower	17
3.1	DC Motor	21
3.2	IC L293D	21
3.3	The circuit connection for driver motor	22
3.4	Microchip PIC16F877	24
3.5	Pin Diagram for PIC16F877 Microcontroller	24
3.6	Block Diagram for PIC16F877 Microcontroller	26
3.7	Main Circuit PIC	27
3.8	PIC16F877	27
3.9	Power Supply Units	28
3.10	Connection from ICL293D to DC motor	29

3.11	Motor Driver and IC L293D	30
3.12	Transmitter and Receiver Block Diagram	31
3.13	RF Module Used	32
3.14	Schematic IR Sensor	33
3.15	IR Sensor Circuit	33
3.15	Circuit Integration	34
4.1	Single Chip PIC	36
4.2	CCS C Compiler developed by Custom Computer Services	37
4.3	Architecture for PROTEUS VSM	41
4.4	Library Browser	45
4.5	Opening a New File to Compose Source Codes	46
4.6	Saving the Source Codes as C Source File	47
4.7	Selecting “Build all” to Compile the Project	47
4.8	File Successfully Compiled	48
4.9	Capture Screen of CCS C	49
5.1	Project Flow Chart	52
5.2	Hardware Flow Chart	54
5.3	Software Flow Chart	55
5.4	Combining Software and Hardware Flow Chart	57
6.1	Design of Prototype Autonomous Lawnmower	59
6.2	Block Diagram of Autonomous Lawnmower using PIC Controller	60
6.3	Block Diagram of Autonomous Lawnmower using RF Module	60
6.4	Top View of Prototype Autonomous Lawnmower	61
6.5	Side View of Prototype Autonomous Lawnmower	61
6.6	Prototype of Autonomous Lawnmower	62
6.7	Buggy Assembly Flow	63
6.8	Top View	64
6.9	Side View	64
6.10	Front View	65
6.11	Perspective View	65

6.12	Schematic Diagram of the motor movement	66
6.13	Hardware to Download the Programming	68
6.14	Connecting to the Computer	68
6.15	The Programmer detect the PIC	69
6.16	The Programmer Read the Data	69
6.17	Import the Hex file	70
6.18	The Programmer Write the Source Code from Hex File	70
6.19	The Programming is Successful	71
6.20	Before the Mowing	72
6.21	During the Mowing	73
6.22	Grass after the Mowing	73
6.23	Grass Result Zoom Out	73
6.24	The Motor of the Blade	74
6.25	The Stainless Steel Blade	74
6.26	RE-260RA DC motor	76
6.27	Motor and Gearing Layout	76

LIST OF APPENDIXES

NO	TITLE	PAGE
A	Gantt chart	83
B	Poster	85
C	Schematic Diagram for Motor Movement and IR Sensor	87
D	Programming Code	89
E	Schematic Diagram Of The IR Sensor	92

GLOSSARY

DC	-	Direct Current
IC	-	Integrated Circuit
MCU	-	Microcontroller
PCB	-	Printed Circuit Board
PCD	-	Printed Circuit Design
PIC	-	Programmable Interface Controller
PWM	-	Pulse Width Modulation

CHAPTER I

INTRODUCTION

1.1 Introduction of the Project

An autonomous robot is a machine that operates in a partially unknown and unpredictable environment. In contrast to robots used in manufacturing plants, where the environment is highly controlled, an autonomous robot cannot always be programmed to execute predefined actions because one does not know in advance what will be the universe of transformations required by the various situations that the robot might encounter. Furthermore, the environment might have dynamic characteristics that require modifications in the robot behavior. For these reasons, in the last ten years several researchers have looked at novel methods for setting up autonomous mobile robots.

The mobile robot is using microcontroller PIC (Programmable Interface Controller) as the brain of the Autonomous Lawnmower. Microcontroller PIC16F877 will be used to control the robot's system and supported by integrated circuits as driver and other electronic components. The robot will be equipped with several sensors to make it "intelligence". The sensor will help the movement of the robot, send the signals to PIC and the PIC will send signals to output. The output will be the motion of the robot and the hardware. The Autonomous Lawnmower runs on clean and quiet electricity.

1.2 Definition of Robot

In general, robot carries many definitions. Therefore, it is hard to define robot accurately. There are few of definitions to describe the word “robot”. It is difficult to suggest an accurate meaning for the word robot, because there are various definitions of this word, different to each other according to the points of view. Some of the definition emphasize on the aspect of re-programmability while others more concern to the manipulation of the robot, behavior, intelligence and the ability to carry out a complex series of action automatically.

The Robotic Institute of America defines the robot as: “Reprogrammable multifunctional manipulator designed to move material, parts, tools or specialized devices through variable programmed motion for the performance of a variety of tasks.” [Fuet, 87].

The British Robot Association (BRA) defines robot as: "A programmable device with a minimum of four degrees of freedom designed to both manipulate and transport parts, tools or specialized manufacturing implements through variable programmed motion for the performance of the specific manufacturing task" [Wikipedia, 2000].

The world famous encyclopedia Wikipedia defines robot as a mechanical device which performs its tasks either according to direct human control, partial control with human supervision, or completely autonomously. In any capacity, robots can be useful, but need to be programmed and controlled. Robotics is an interdisciplinary subject that benefits from mechanical engineering, electrical and electronic engineering, computers implementation and environmental observation.

Robots are typically used to do tasks that are too dull, dirty, or dangerous for humans. Industrial robots used in manufacturing lines used to be the most common form of robots, but that has recently been replaced by consumer robots cleaning floors and mowing lawns.

Based on the definition of robot given by those institutes, it can be concluded that a robot must be an automatic machine and be able to deal with the rapid changes of information received from the environment.

1.3 Problem Statement

By referring to the previous research done by other researcher, several difficulty can be noticed. Nowadays, the problem occurs when we face to cutting the grass. It is because:

1. Currently lawn mowers consumed a lot of time since we need to push it manually.
2. Small engines found in lawn mowers are actually a significant source of smog causing air pollution.
3. Traditional lawn mower requires gas, oil, tune-ups or spark plugs, making them a bargain to maintain and there is emission.

1.5 Scopes of Work

The scope of this project is divided into five major parts, the Mechanical design for the robot structures, the Electronic Circuit Fabrication, the Motor Drives & Controller Design, the Sensor integration and to program the Micro-Controller from Microchip. The combination of the five elements become as an Autonomous Lawnmower. The scope of the project for the mechanical part is to design a mechanical structure and motor placement at the right locations to ensure the functionality of the robot in its movement. The design of cutting blade and make it real for cutting task.

The controller which consists of a PIC16F877 microcontroller and appropriate electronic circuitry will be feed with input from sensors and drive the motors base on specific command. Finally, this project is focusing on the programming aspect to control the robot's movement. The suitable program arrangement needs to be programmed to ensure smooth movement of the robot and able to respond sensitively to the sensor.

1.6 Project Methodology

Methodology is important part of the whole project because it shows out on how the project's activity develops. So, in this project it is divided in two parts, which is hardware development and software development. In this section, the discussion on hardware development appears which involves the overview of fabrication robot structure for the cutting purpose.

The discussion also contains some of reason why the hardware had chosen approaches used in this project. For the other part, we discuss about software development. The software development using CCS C Compiler using C language.