



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**DESIGN AND DEVELOPMENT OF
AUTONOMOUS LINE TRACKING ROBOT
USING MICROCONTROLLER**

Thesis submitted in accordance with the requirements of the
Universiti Teknikal Malaysia Melaka for the Degree of
Bachelor of Engineering Manufacturing (Robotic & Automation)
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By

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ABSTRACT

This project is about the design and development of an autonomous line tracking robot using microcontroller. Basically, this type of robot is used as a global planning method for their navigation system in order to perform a required task. This project highlighted three objectives which are to design and develop a suitable mechanical structure of an autonomous mobile robot, to develop electronics hardware that is able to integrate both sensors and electrical motor with the micro controller and to develop a complete program for the microcontroller to achieve the required task of line tracking. The project flow started by conducting a literature review regarding to the project topic using books, internet articles, thesis, journals and other sources in order to get the valuable information to guide in the project development. Acrylics and aluminum are the main materials used to build the structure of the robot. To support robot navigation, infrared (IR) sensor has been installed on the robot. Microcontroller PIC16F877A was used to process the input from sensor and than execute the program to control two geared DC motors. Three main tests were developed in this project in order to observe the capability of the robot to track the printed line. They are the straight line, curve line and junction test. This project has successfully achieved the aims of this project with some technical aspects still can be improved in the future

ABSTRAK

Projek ini berkenaan dengan merekabentuk dan membangunkan automatik robot yang memiliki kemampuan untuk mengesan garisan menggunakan pemprosesan mikro. Kebiasaanya, jenis robot ini menggunakan kaedah perancangan global dalam menyokong perjalanannya dalam melakukan sesuatu tugas yang diperlukan. Projek ini mengariskan tiga objektif iaitu, merekabentuk dan membangunkan rangka mekanikal robot yang sesuai, membangunkan pekakasan elektronik yang boleh berinteraksi antara sistem penderiaan dan motor elektrik kepada pemprosesan mikro, membangunkan satu program yang lengkap untuk pemprosesan mikro. Projek ini bermula dengan melakukan kajian ilmiah berkenaan dengan tajuk projek, dimana buku, artikel dari internet, tesis, jurnal atau sumber yang lain telah digunakan bagi mendapatkan maklumat yang bernilai bagi membimbing pembangunan projek. “Acrylics” dan aluminium merupakan bahan utama yang digunakan bagi membangunkan struktur mekanikal bagi projek ini. Bagi menyokong perjalanan robot, penderiaan infra merah (IR) telah dipasang kepada robot. Pemprosesan mikro PIC16F877A telah digunakan bagi mengolah data dari penderia dan kemudiannya melaksana pengatucaraan yang bersesuaian bagi mengawal dua motor arus terus bergear. Terdapat 3 jenis ujian telah dilakukan didalam projek ini bagi melihat sejauh mana kebolehpayaan robot menjejak dan mengikuti garisan, ujian garis lurus, ujian garisan bengkok dan ujian persimpangan. Projek ini telah berjaya mencapai objektif yang di tetapkan namun masih terdapat ruang dari segi teknikal yang boleh ditingkatkan di masa hadapan

DEDICATION

For my beloved parents:

Othman bin Mohamad

Kalsum bt Chayos

And for my adored brother and sisters:

Nurehan bt Othman

Muhammad Yazid bin Othman

Nurhafizah Bt Othman

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SIGN AND SYMBOLS

AGVs	-	automated guided vehicles
ψ	-	Yaw
γ	-	Roll
ϕ	-	Pitch
2D	-	Two Dimensional
3D	-	Three Dimensional
PLC	-	Programmable Logic Circuit
PC	-	Personal Computer
DC	-	Direct current
SCARA	-	Selective Compliant Articulated Robot Arm
BLDC	-	Brussless Direct Current
PSM	-	Projek Sarjana Muda
MCU	-	Microcontroller unit
RAM	-	Random Access memory
SRAM	-	Static random access memory
ROM	-	Read only memory
PROM	-	Programmable read-only memory
EPROM	-	Erasable programmable read-only memory
EEPROM	-	Electrically erasable programmable read-only
RTC	-	Real time counter
PWM	-	Pulse-width modulation
I/O	-	Input and output
IR	-	Infrared
RISC	-	Reduced Instruction Set Computer
CPU	-	Central computer unit
CMOS	-	Complementary metal-oxide semiconductor
ADC	-	Analog to digital converter

CHAPTER 1

INTRODUCTION

1.1 Back ground

In the modern life system, manufacturing takes place under all types of economic system. Manufacturing comes from Latin word “*manu factura*” that means making by hand. The term refer to the human activity to produce something that useful and have a commercials value, whether it’s in a small scale activity in such handicraft until to high technology activity [1]. In the simplest word, manufacturing is an activity that related to process added material value. Typically, manufacturing is directed toward the mass production of products for sale to consumers and it’s become very important to us. When look around us; we can saw there are many types of manufacturing products with variety purpose. .Modern manufacturing includes all intermediate processes required for the production and integration of a product's components.

Robotics is a new technology that largely used in the manufacturing field. This new technology has found entrance to many industries. Besides that, robots are also employed in the nuclear industry, civil engineering, marine work, orbital space missions, ship building, agriculture and security super vision [2].

When we talk about applied robotics technology in manufacturing system, we cannot escape from descript or talk about an industrial robots or robotics arm. Industrial robot is a programmable machine designed to increase productivity, improve quality and also

reduce direct labor (human) cost. Industrial robots are very familiar to most type of industries because the capability to provide services or perform their job that human cannot make it such as in hazardous environment, heavy or dangerous [3].

The new type of robot is concern about strategic. Autonomous mobile robots are the electromechanical systems that have capability to perform their task in an unknown environment [2]. In the industrial environment, autonomous mobile robots work in conjunction with material conveyors, part buffers, stationary robots and production machine. This autonomous mobile robot, also called automated guided vehicles (AGVs). Mostly AGVs task is to transport workpieces, parts and tools for machining. AGVs navigations can be guided using line printed on the floor or self localization with their environment.

1.2 Problem Statement

The design and development of an autonomous line tracking robot is a very complicated task. There are many aspects that should be considered such as mechanical system, electrical circuit and microprocessor programming. All these aspects need to be fully integrated between each other. So that, the autonomous robot can be perfectly functional to achieve the tasks provided.

In order to make sure this autonomous robot system fully integrate, the challenges are to decide and choose the best device should be implemented in this autonomous robot system. Furthermore, there are many types of microcontroller, sensor device and driven motor in the market. Each of them has difference specifications, capability and functions.

The biggest obstacle is to program the microcontroller based on the information gathered from the robot's line sensors. Basically each sensor provides the information

to controller based on the signal that they got and the controller will decide what to do base on the programming loaded.

For line sensor case, its information based on the rate of reflected light that have been detected by detector. In different environment or brightness of area, the rate of light detected by detector is fully different. So, the strong programming languages knowledge are needed to synchronize environment changes with the execute program in the microcontroller.

1.3 Objectives

The main aim of this project is to design and develop an autonomous line tracking robot using microcontroller. This is achieved through these objectives:

1. To design and develop a suitable mechanical structure of an autonomous mobile robot.
2. To develop electronics hardware that is able to integrate sensor and electrical motor with the micro controller.
3. To develop a complete program for the microcontroller to achieve the required task of line tracking.

1.4 Scopes

In order to design and development an autonomous line tracking robot using microcontroller, project scopes need to be defined for assist and guide the development of the project. The main scopes for this project are:

(a) Data collection:

Collect necessary data through literature review on existing autonomous line tracking robots, microcontroller, line sensor, driven motor and circuit design.

(b) Design electronics and mechanical system:

Create a circuit diagram for electronics part and design robot structure.

(c) Integration:

Build a complete set of autonomous robot by integrate the mechanical structure and electronics device.

(d) Programming and Testing

Build the complete set of program for microcontroller unit and run the testing for the complete autonomous robot

1.5 Project Schedule

1.5.1 PSM 1 Gantt chart

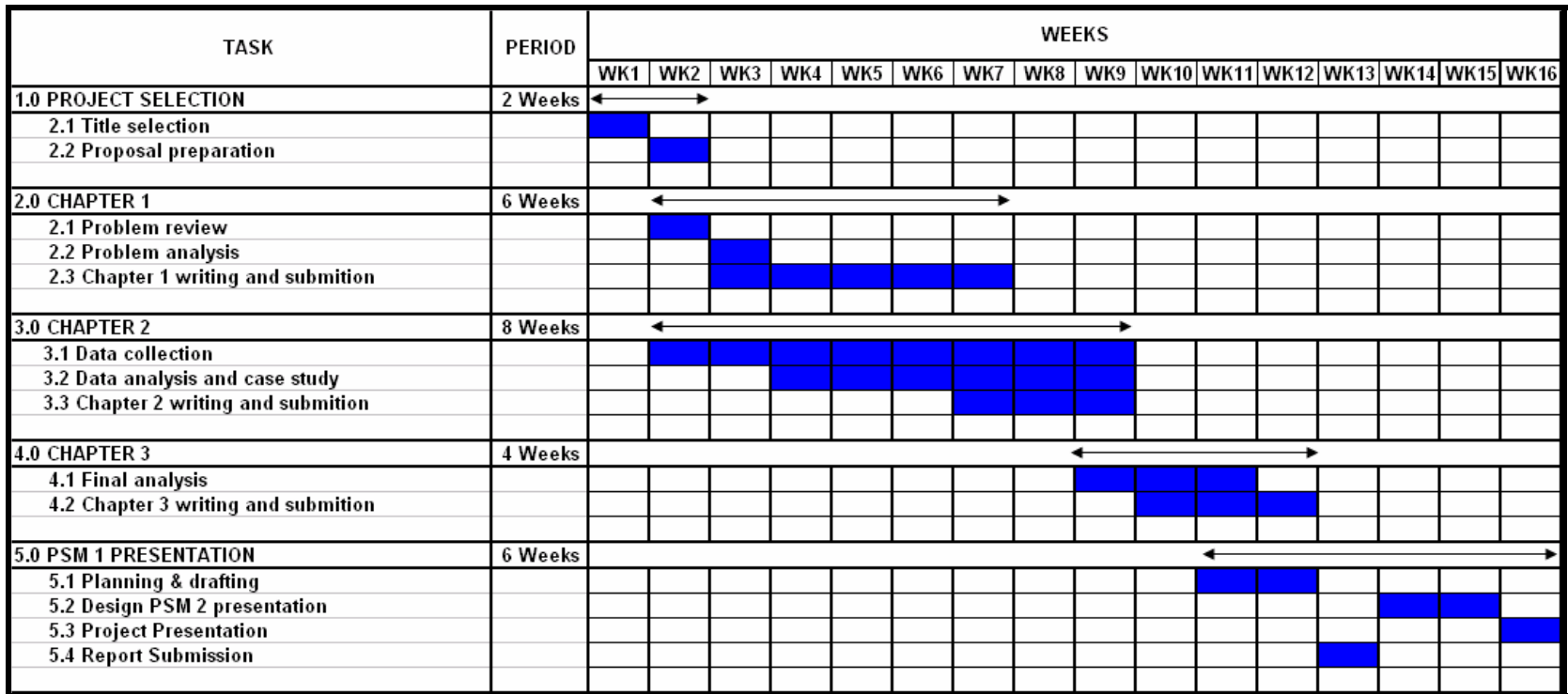


Figure 1.1: PSM 1 Gantt chart

1.5.2 PSM 2 Gantt chart

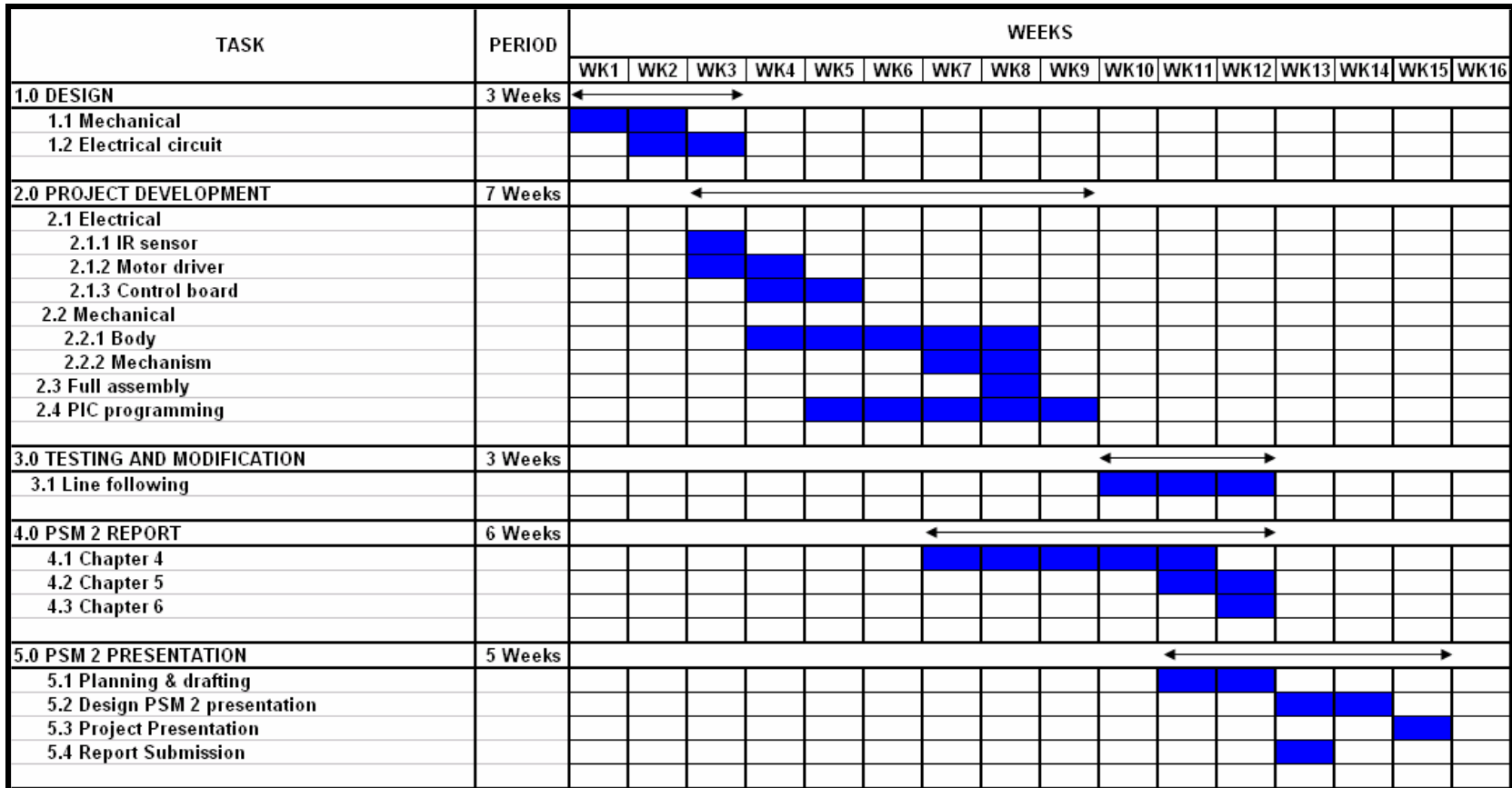


Figure 1.2: PSM 2 Gantt chart

Gantt chart above describe about the planning and flow of Projek Sarjana Muda (PSM). This Gantt chart shows the required topics, action and time needed in order to fulfill the PSM scope and objectives.

1.5.3 Schedule details

The detail of each element that stated in the Gantt chart was explained more clearly below.

1.5.3.1 Title Selection

Title selection have been done in the first week of 2007/2008 academics weeks. During this time, students need to find the PSM title and the supervisor that will in charge and supervise their project until finish. Students can come out with their own title or pick PSM title that publishes in Faculty of Manufacturing Engineering, Universiti Teknikal Malaysia Melaka website. If student interest to select one of the titles has been published, they need to meet the owner of the title and discuss requirement and the detail about the title. If student need propose their own title, they need to find the lecture that interest with their project and consenting to be their PSM supervisor.

1.5.3.2 Proposal

Proposal is a first documentation that student need to submit to their supervisor. This documentation show the rate of student understanding about the project that their chosen. Proposal contains the background of the project, objective project, problem statement and scope. All the information from the proposal such as problem statement and scope show the basic element should be covered in the project. And, the objective represented the main element should be achieved in the end of the project.

1.5.3.3 Problem review

Problem review is a hypothesis method used to predict all the problem will come out during this project being progress until its finish. It more to basics movement of the project by observe and view the project from the different type of angle.

1.5.3.4 Problem analysis

The entire problem that counted in problem review will be analyzed during this section.

The main purpose of problem analysis is to categories the problem in the subgroup based on their features and significances. So, the process to collect all data and information needed for solve all the outgoing problem can plan. The side purpose is to measure student understanding about all the element in their project.

1.5.3.5 Data collection

Where all the information and data needed to support the developing of the project is listed based on the problem has been analyze before. Journals, books, articles, thesis or conference paper that related with this project is collected.

1.5.3.6 Data analysis

Data analysis is the process to read and analysis all the data has been collected before. Journals and thesis are the main source of the data and information need to analyze. It's because journals and thesis are publish based on the previous research has been done a years before. So, it can be categories as a new technology has been founded in the world.

Beside that, other kind of documentation or information also important to support the developing knowledge to solve the problem that counted before. All the data being analysis is used to find the best solution to solve the problem.

1.5.3.7 Final analysis

All the data and solution gather from the data analysis have been analyzing secondly in this time. Final analysis used to make sure that solution is the best among the existing data and solution. Thus, the autonomous robot can achieve the objective successfully without huge technical problem.

1.5.3.8 Design

At this stage, design process has been occurred. The design process was included the whole system of the robot that divided into 2 main portion which is mechanical and electrical aspects. In designing mechanical aspects, there are two main elements had been considered that are robot body structure and mechanism. Whereas for electrical aspects, the designing process was focusing to 3 main element which is sensor, main board and motor driver circuit.

1.5.3.8 Project development

The development process of an autonomous line tracking robot was divided into 3 phase. At the first phase, the development process is more focusing on the body structure and mechanism. Then followed by electrical circuit development at the second phase and microcontroller programming at the last phase of development.