This thesis has been read and certified by:

Signature : .....

Names : SOO YEW GUAN

Date : 5/5/06

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TWO-WHEELED BALANCING ROBOT LOCOMOTION

NOOR AZAM BIN ALIAS

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Fakulti Kejuruteraan Elektronik dan Kejuruteraan Komputer
Kolej Universiti Teknikal Kebangsaan Malaysia

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DECLARATION

"I hereby declare that the following thesis is own except for commentaries and summaries for which I have detailed each of their sources"

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ABSTRAK

Kajian berkenaan keseimbangan pergerakkan robot dua roda telah menigkat sejak kebelakangan ini oleh makmal-makmal kajiselidik robotik. Ini adalah disebabkan keunikan ketidakstabilan system yang ada pada robot tersebut. Robot-robot seperti ini dikategorikan sebagai robot yang berkeupayaan untuk menyeimbangi struktur badan sendiri dengan hanya dilegkapi dua roda dan melakukan gerakkn putaran pada satah dan titik yang sama. Kelebihan kebolehgerakan robot ini memudahkanya untuk bergerak pada selekoh tajam, bergerak pada tangga kecil atau di kawasan yang terhalang laluanya. Kebolehan ini membuatkanya berpotensi memberi penyelesaian kepada masalah dalam bidang industri atau pada masyarakat. Sebagai contoh, kerusi roda bermotor yang dilengkapi teknologi ini akan memudahkan pergerakkan penggunanya dan membolehkan beliau melalui kawasan yang sukar dilauinya sebelum ini. Kenderaan kecil yang dibina berdasarkan teknologi ini membolehkan penggunanya bergerak pada jarak dekat di ruang kecil atau kawasan kilang yang menghadkan penggunaan kereta yang memerlukan ruang yang besar untuk beroperasi.

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ABSTRACT

The research on two-wheeled balancing robot has increase over the last decade in a number of robotics laboratories around the world. This is due to the inherent unstable dynamics of the system. Such robots are characterized by the ability to balance on its two wheels and spin on the spot. This additional maneuverability allows easy navigation on various terrains, turn sharp corners and traverse small steps or curbs. These capabilities have the potential to solve a number of challenges in industry and society. As example, a motorized wheelchair utilizing this technology would give the operator greater maneuverability and thus access to places most able-bodied people take for granted. Small carts / cycles built utilizing this technology allows humans to travel short distances in a small area or factories as opposed to using cars or buggies that need more space required to operate.

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LIST OF ABBREVIATION

CPU	Control Processing Unit
EEPROM	Electrically Erasable Programmable Read-Only Memory
LED	Light Emitting Diode
PCB	Printed Circuit Board
PIC	Programmable Interface Controller
GUI	Grafic User Interface
EEPROM	Electrically Eraseable Programmable Read-Only Memory

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LIST OF ATTACHMENT

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CHAPTER I

INTRODUCTION

1.1 PROJECT INTRODUCTION

The research on balancing robot has gained an interest among researchers over the last decade in a number of robotics laboratories around the world. This is due to the unstable dynamics of the robot. This type of robots are characterised by the ability to balance on its two wheels and spin on the spot. This additional manoeuvrability allows easy navigation on various terrains, turn sharp corners and traverse small steps or curbs. These capabilities have the potential to solve a number of challenges in industry and society. For example, a motorised wheelchair utilising this technology would give the operator greater manoeuvrability and thus access to places most able-bodied people take for granted. Small carts built utilising this technology allows humans to travel short distances in a small area or factories as opposed to using cars or buggies that is more polluting.

The basic concept of two-wheeled balancing robot locomotion is a dynamic balancing. This type of balancing is easy to describe with human such an example. To keep humans standing, the brains constantly sense whether the body are standing

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upright. If an outside force pushes human body off-balance, the brains will move the muscles to counteract that force. This is how the robot is going to react. A feedback sensors like a tilt sensor or angle sensor is required to maintain the robot stability. These sensors will measure the tilt of the robot with respect to the gravity and wheel encoder is to measure the position of the base of the robot. The measurement will be summed and feedback to the platform as a motor voltage, which is proportional to the torque and will result to the robot balancing.

1.2 PROJECT OBJECTIVE

The objective of this project is to design a robot that only equip with two wheels in order to counter most robot disadvantages. This robot will be able to balance itself with just only two wheels and perform a movement and manoeuver in the human environment condition and counter the obstacles occur perfectly

i. Understanding the concept and theory of two-wheeled balancing robot.
ii. To understand the working mechanism of two-wheeled robot.
iii. To construct a two-wheeld robot and operate by only this two wheels as its locomotion system.
iv. To develop a two-wheeled robot that has a self-balancing mechanism.
v. To develop a robot that can counter obstacle that a most probably occur in human environment.

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1.3 PROBLEM STATEMENT

There are a few problems in the robot system that may occur. These problems are:

i. To build the robot, a full requirement of maintaining the desire robot chassis in order to maintain its balancing. Otherwise the robot may lose its stability that will result a failure to the development.

ii. Circuit must be built as compact as can. This is to insure there are not to mush area will be taken by the circuit in the robot chassis in order to maintain its weight and its stability.

iii. The robot may have a problem when moving in the tilt surface. This may occur because of the usage of the IR range sensor

1.4 SCOPE OF WORK

In building this two-wheeled balancing robot locomotion the work will be divided into two parts:

Part 1:

Assembles of the mechanical and electrical part of the robot. This include the listing and identifying the robot component such as motors, wheel, body part, steel part, actuator, circuit design, PIC implementing, sensors and others.

Part 2:

The development of the robot programming using PIC Microcontroller and the full testing of the robot functionality.

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1.5 THESIS STRUCTURE

CHAPTER I

INTORDUCTION

Chapters that will intruduce about the thesis and what is the project are all about. In this chapter also, others researcher finding abaout the related topics will be include. The executibe summary og this thesis will be shown here.

CHAPTER II

LITERITURE REVIEW

Conducting literature review is important, as this will provide needed information on the technology available and methodologies used by other researchers on this related topic. This chapter provides a summary of literature reviews on key topics related to two-wheeled balancing robot locomotion.

CHAPTER III

PROJECT METHODOLOGY

Chapters where the procedure or the project implementation will be discuss. This chapter will be discussing in details all the working and researh that had been done in completion of the two-wheeled balancing robot.

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CHAPTER IV

TWO-WHEELED BALANCING ROBOT LOCOMOTION CONSTRUCTION

In this chapter, all the process in developing the two-wheeled robot will be showed. All the circuit construction process and the robot chassis construction process are determined in this chapter.

CHAPTER V

PROJECT RESULT

In this chapter, the analysis and the produced result are documented.

CHAPTER VI

CONCLUSION & SUGGESTION

Discussin and conclusion about the project and this thesis is including in here. In this cahpter also the rpoblem and the solution is state for the project enhastment

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CHAPTER II

LITERATURE REVIEW

2.1 THE BALANCING ROBOT SYSTEM

The inverted pendulum is not an uncommon factor in the field of robotic engineering. The uniqueness and the wide application of the technologies that comes from this unstable factor have gained an interest among many robotics researches around the world. In recent years, researchers have applied the idea of a mobile inverted pendulum model to various problems like designing walking gaits for humanoid robots, robotic wheelchairs and personal transport systems.

A similar and commercially available system is a balancing scooter 'SEGWAY HT'. Dean Kamen who holds more than 150 U.S. and foreign patents related to medical devices, climate control systems, and helicopter design has invented this scooter. The 'SEGWAY HT' is able to balance a human standing on its platform while the user traverses the terrain with it.

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Figure 2.1: SEGWAY.

The design of the robot is kept as simple as possible but still not affects the objective of the robot building.

Two-wheeled balancing robot is capable to balance itself with only two wheels. The basic idea for two wheeled balancing robot locomotion is very simple: drive the robot wheels in the direction that the upper part of the robot is falling. If the wheels can be driven in such a way as to stay under the robot's center gravity, the robots will remains balanced. The robot is in balance when the top of the robot is directly over the base of the robot. When the robot tilts (forward or backward), the robot need to drive the motors in the proper direction to bring the top of the robot back up over center of the base. The robot should capable to react fast enough to stay upright or else it will fall over

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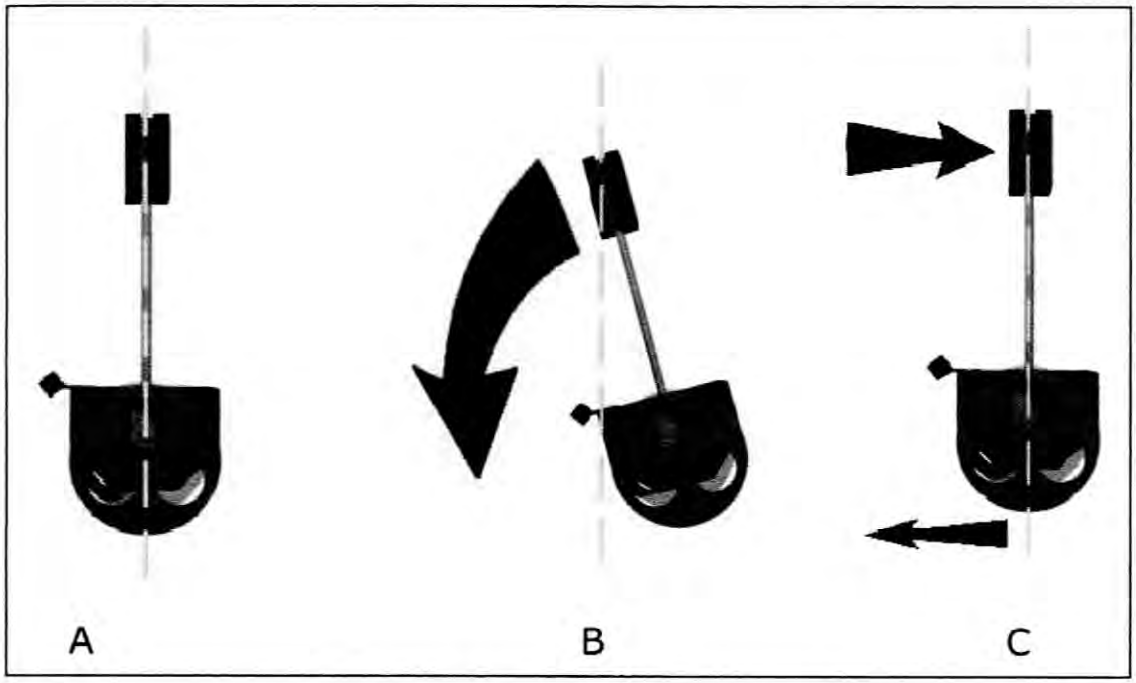

Figure 2.2: The balancing robot system

As shown in Figure 2.2 the robot is in balance when the top of the robot is directly over the base of the robot (A). If the robot tilts (B), its need to drive the motors in the proper direction to bring the top of the robot backs up over center (C). If the robot makes many small corrections, the robot will stay upright. If the corrections isn't make fast enough, the robot will fall over.

2.2 CONTROL SYSTEM

Control system development is the most important part in order to guarantee the success in balancing the robot; the main aim is to control the system effectively without ignoring the objective of the robot controller. The difference in balance control

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algorithm implemented depends mostly on how the system is modeled and how the tilt information is obtained.

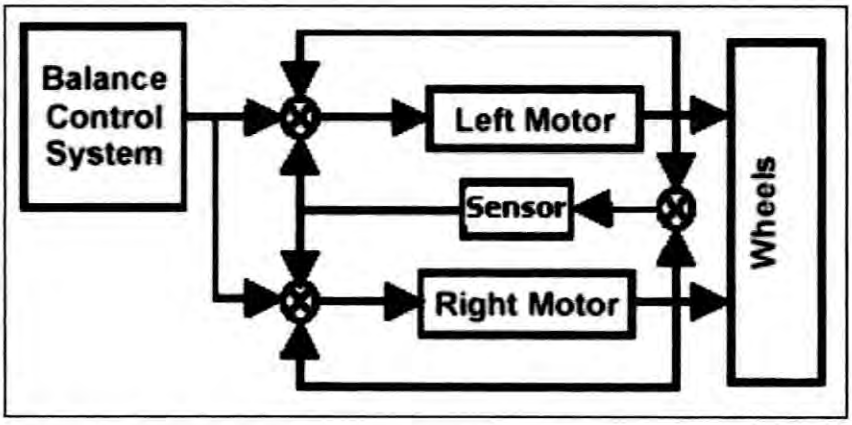

Figure 2.3: Functional block diagram of the balancing robot

2.3 ROBOT CHASIS

The robot's chassis design is based on a stack board with the components placed in between the spacing of each plate and the upper part of the plate. This simple design enables quick installation of component and the height of the robot can be increased or lowered when desired. The drive train of the robot resembles a two-wheeled differential drive robot, but the balancing robot balances the load with its wheels instead dragging the weight around on a pivot in a regular differential drive robot. The motors are fitted into the wheels socket. This provides a stronger grip on the motors apart from the three screw holes on the motor to avoid misalignment of the motors. The plates are stacked apart from each other. The whole structure is held together with nuts and screw or by gluing each part of them.

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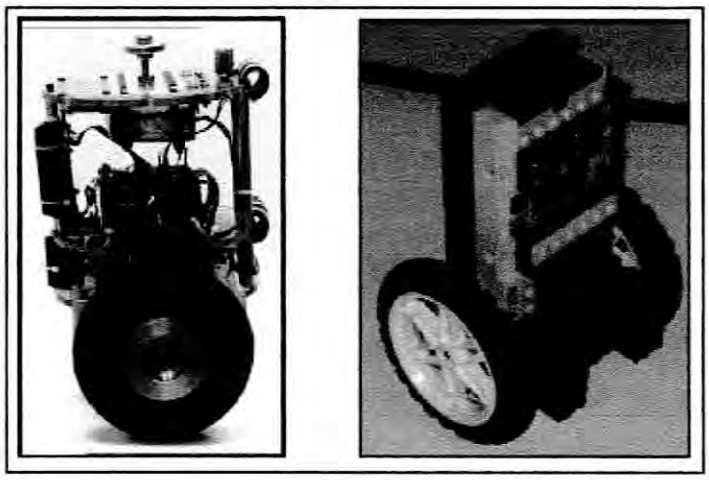

Figure 2.4: Nbot [left] Legway [right] is an examples of two-wheeled balancing robot

2.4 CONTROLLER

There are lot types of controller that can be use as a control a system. Tree main controller type have been commonly used today is programmable logic controller (PLC), microprocessor and microcontroller.

PLC applications are widely used in electrical device control system. PLC usually used in factory as production line control system. This type of controller infrequently used for electronic control system. To implement this PIC for a robotic system is not efficient due to the price of PLC. Currently the price for one unit PLC controller is more then RM500. This price is really high compare to the price of one microprocessor or microcontroller.

Microprocessor is usually implemented in electronic control system. It is widely used in mobile phone, personal digital assistance (PDA), VCD player and robotic control

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