LECTURERS STUDENTS FRIENDLY ATTENDANCE ROBOT

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DEGREE OF MECHATRONICS ENGINEERING

MAY 2009

"I hereby declared that I have read through this report and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Mechatronics)"

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"I hereby declared that this report is a result of my own work except for the excerpts that have been cited clearly in the references"

Signature 

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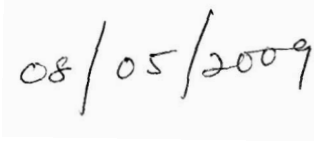
Date 

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BISMILLAHIR RAHMAN NIR RAHIM

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ABSTRACT

Nowadays in this modern technology era, human use robots to help them and making their job to be easier. In fact usage of robot system could give human a bunch of advantages in completing the job even in the hazardous and dangerous place. Robots are widely used in the industry, automation, medical and manufacturing etc. Building and programming a robot is a combination of mechanics, electronics and problem solving.

The 'Lecturers Students Friendly Attendance Robot' is a line following robot to deliver an attendance sheet in UTeM lecture classes. The robot is consisted with two core elements which are DC motors as a mechanical/hardware development part and PIC microcontroller system as a software/language development part. The DC motors will be jointed with pulse width modulation, PWM as speed controller and H-bridge mechanism as DC motors mechanical sequences controller as ordered to follow the path line.

This robot is controlled by the PIC microcontroller software which is using 'C' language as command program and connected to proximity sensors as robot's eyes. The microcontroller is used to execute the program that will be loaded to its program memory. Thus, the direction of robot will refer to command program that already installed in the PIC 16F877A after the proximity sensors send signal and navigate the robot to follow the path line as well as programmed.

ABSTRAK

Dalam teknologi moden pada hari ini, robot kebanyakannya digunakan untuk membantu manusia dan menjadikan sesuatu tugasan menjadi lebih mudah. Malahan penggunaan sistem robot memberi banyak kelebihan kepada menusia dalam menyelesaikan sesuatu kerja walaupun dalam persekitaran yang sukar dan berbahaya. Robot digunakan secara meluas di dalam bidang industri, automasi, perkilangan, perubatan dan sebagainya. Membina dan memprogram sesebuah robot adalah kombinasi antara mekanikal, elektrikal dan penyelesaian masalah.

'Robot Kehadiran Mesra Pensyarah-Pelajar' adalah robot yang diprogram untuk menghantar kertas kehadiran kepada pelajar di bilik-bilik kuliah UTeM. Robot ini terbahagi kepada dua bahagian utama iaitu motor DC sebagai bahagian pembangunan mekanikal dan peralatan dan PIC mikrokawalan sebagai bahagian pembangunan perisian/bahasa. Motor DC akan digabungkan bersama penyesuaian kelebaran nadi, PWM yang bertidak mengawal kelajuan motor dan mekanisma 'H-Bridge' sebagai kawalan aturan mekanikal seperti mana yang dikehendaki adalah untuk mengikut garisan laluan.

Selain daripada itu, robot ini dikawal menggunakan perisian PIC mikrokawalan yang menggunakan bahasa 'C' sebagai bahasa arahan disambungkan kepada sensor berhampiran yang bertindak sebagai mata robot. Mikrokawalan digunakan untuk menghimpun program yang akan dimasukkan ke dalam memori program. Jadi, haluan robot adalah berpandu kepada arahan program yang mana telah sedia dimasukkan ke dalam PIC 16F877A selepas pengesan berhampiran menghantar isyarat dan memandu robot mengikut garisan laluan seperti mana yang telah diprogramkan.

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List of Abbreviations

CMOS	Complementary Metal Oxide Semiconductor
PWM	Pulse Width Modulation
PIC	Peripheral Interface Circuit
DC	Direct Current
I/O	Input / Output
IC	Integrated Circuit
IR	Infra-Red
3D	3 Dimensions
RAM	Random Access Memory
ROM	Read-Only Memory
IDE	Integrated Development Environment
ANSI	American National Standard Institute
CAD	Computer Aided Design
LDR	Light Dependant Resistor
ICD	In-Circuit Debugger
UART	Universal Asynchronous Receiver Transmitter
PSP	Parallel Slave Function
RF	Radio Frequency

CHAPTER I

INTRODUCTION

1.0 Introduction

Functionally, a robot is a physical agent which is capable of executing motion to achieve given tasks. A robot motion and drive depends on its ability to perform the ordered sequence of perception, making decision and action. A robot is a programmable, multi-functional manipulator designed to move materials, parts or specialized devices through variable programmed motions for the performances of a variety of tasks[2]. A line following robot is a machine that can follow a path. The path can be visible like a black line on white surface or white line on black surface or it can be invisible like a magnetic field as line.

Today, the line following robot is gaining its own popularity in various sectors such as in the manufacturing industry and public services. Tasks or processes which could typically be accomplished by using line following robots includes as a carrier to deliver products faster and more efficient from one department to another department and as a transporter to drive and fetch people to desired destination.

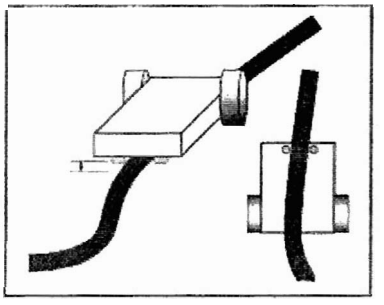

Figure 1.0: Line Following Robot Concept

1.1 Problem Statements

Nowadays, robots are used to help people doing their job. Based on many factors that increasing a demand for a robot to be able to reduce human job that was manually and repeatedly done[4].

Apparently in UTeM, there is no effective attendance marking system applied yet. The system used now seems not to be working well. Distributing attendance system will distract student's concentration on lectures and retard the learning process. Besides the system is wasting much time and make a lecture class so noisy like in a battlefield.

The student's ID card scanning system is not working well and students face a lot of problems. Students have to queue up outside the class to scan their card as well to mark their attendance. For a relief class there will be a problem because the scanning system is not declared for a relief class. Then students have to write down their name on a paper as an attendance sheet.

Thus, the robot is built to prevent students from being distracted during lessons and the applications of attendance robot in UTeM will certainly give positive impacts as well as:

- Saving Time: Students just wait for robot to bring the attendance sheet.
  Avoid Cheating: System will eliminate cheating problems on attendance.
- Interest: With a robot in class, it would help to stimulate interest among students to explore robot technology.

1.2 Project Objectives

Robotic systems are found in all major local factories and the industrial robot is part of many of these systems. Exploration of robotic field would be an advantage for students to move forward and achieving excellence of technology[3].

The construction, programming and operation of the line following robot is identical as a basic to explore robotic field and with a great understanding of this system will prepare students to work with industrial robot and automation system that applied in modern manufacturing factory. Besides, the objectives of this project are:

i. To study and learn the line following robot mechanism construction and it's design.
ii. To design and build a line following robot.
iii. To study and understand microcontroller program language.
iv. To explore and design the command program that can be used as a controller for the line following robot.
v. To execute hardware and software development successfully.
vi. To expose students with robotic technology.

1.3 Project Scope

To study and explore the systems involved in robot development with the basic of line following robot system using command language includes the following elements like DC motors, PIC microcontroller, H-Bridge mechanism and power source.

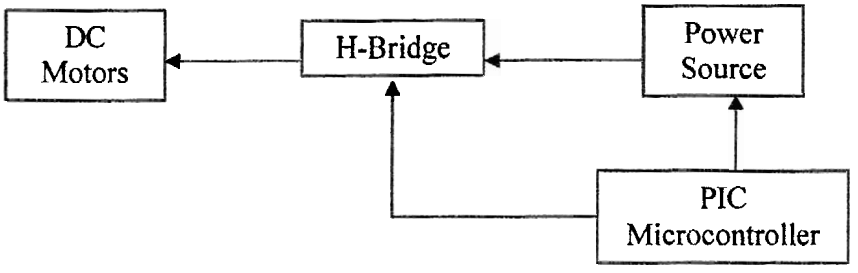

Figure 1.3.: A Genealogy of Project Scope

CHAPTER II

LITERATURE REVIEW

2.0 Literature Review

2.1 Theory of Robot

In this theory discuss some of issue involved in the design of the motor controller. In general, methods of design and even the evaluation of a finished design are partially subjective topics. The elements of a robot system fall roughly into four categories:

1. DC motor controller
2. Pulse width modulation (PWM)
3. H-Bridge
4. PIC microcontroller

In developing a motor controller design, it will starts by examining the factors likely to have the great overall effect on the design and then consider more detailed questions. However, designing a motor controller is an iterative process and more often than problems may arise in the solving of a design detail that will force rethinking for design decisions[7].

2.2 The Design on Task Requirement

Although robots are nominally universal programmable machines capable of performing a wide variety of tasks, economics, and practicalities dictate those different motor controller to be designed for particular type of tasks. For example, large robots capable of handling payloads of hundreds of pound do not generally have the capabilities to insert electronics components into circuit boards.

Based on the phenomenon, the size is not a main factor for robots ability but the hardware joints arrangement and the types of actuation, sensing and control will all vary greatly with the sort of task to be performed[9].

2.3 A Line Follower Robot

A simple robot is designed to be able to follow a black line on the ground without getting off the line too much. The robot has two sensors installed underneath the front part of the body, and two DC motors drive wheels moving forward. A circuit inside takes an input signal from two sensors and controls the speed wheel's rotation. The control is done in such way that when a sensor senses a black line, the motor slows down or even stops. Then the difference of rotation speed makes it possible to make turns. For instance, if the sensor somehow senses a black line, the wheel on that side slows down and the robot will make a right turn.

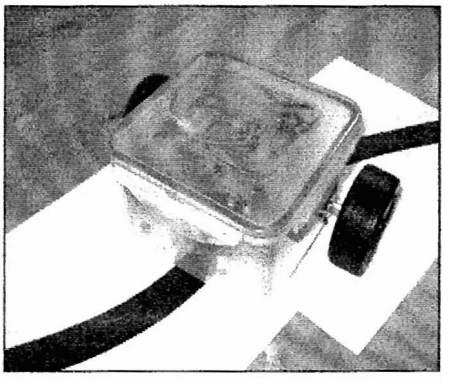

Figure 2.3.: A Line Follower Robot

The sensors are Reflective Object Sensors (ROS), 0PB710F as a single sensor consists of an infrared emitting diode and a NPN Darlington phototransistor. When a light emitted from the diode is reflected off an object and back into phototransistor, output current is produced depends on the amount of infrared light which triggers the base current of phototransistor. The amount of light reflected off a black line much less than the white background and detects the black line somehow measuring the current.

Switching of robot is repeatedly with fixed voltage applied to motors. The signal connected with PWM (pulse width modulation) pulses to power MOSFET in order to turn it on and off. Then the motor sees the average voltage while it depends on duty cycle of PWM pulses. The speed of rotation is proportion to this average voltage. With PWM method, it is easier to control the DC motor than directly controlling the voltage across it[5].

2.4 Lego-Cybermaster Based Line Following Robot

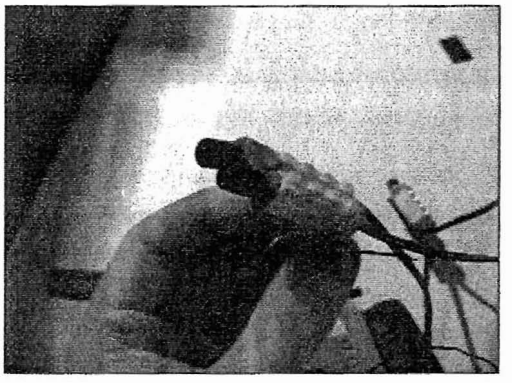

Figure 2.4: Sensor

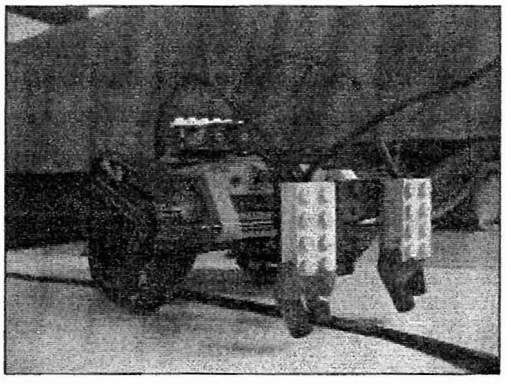

Figure 2.4.1: Robot Operation

Mechanism of Lego-Cybermaster Based Line Following Robot when red light is reflects to LDR (light dependant resistor) from the surfaces. As the colour of the surface changes a lot like from white to black the resistance of LDR changes enough to be observed. Movement of robot is based on the change in resistance. The LDR and LED (light emitter diode) are installed together as a light sensor.

The program controls the robot reads start values when started and endless loop starts. Every cycle of loop reads both, right and left values of both sensors. The difference between the value that has just been read and starts value is large enough to change the colour to give a difference value to the opposite track will turns on until none of the sensors is giving a larger reading. The robot operation is tested with a line of code and black flat Lego blocks. During test mechanism the maximum difference is defined and the better base is made from black tape and piece of white plastic mat. Mechanical base of robot are traces plugged straight to the motors. System is easy to build and it operates as desired[1].

2.5 Towing the Line

Following lines is an essential part of robot navigation. However, programming a robot to follow a line is not an easy task. This project compares several algorithms that robots can use for line following. Hypothesized the robots that were programmed to stay closer to the line and stop less for corrections would be faster and more accurate. A robot which used six different algorithms to follow a winding black line, and robot's speed and accuracy on each run were recorded and hypothesis proved to be incorrect when the result showed that algorithms programmed to continuously search for the line were accurate than that those that tried not to lose the line. It was also found that the faster algorithms sacrificed accuracy for speed.

Which one of six specific algorithms will allow one or two light sensors to follow a winding black line on a white background most accurately and most quickly. A light sensor outputs a number from 0 to 100 depending on how much light enters the lens. In this way, the light sensor can 'see' a small area on the floor. When the sensor is over a black line, it reads a lower number than when it is over a white background. If it 'sees' an area that is part of black and white, it registers an in between, or 'gray' value. The six algorithms tested in the experiment use one or two light sensors. Algorithms 1-5 starts centered over the line, with the back of the robot flush with the beginning of the line. Algorithm 6 begins on the side of the line, with the back light sensor flush with the beginning of the line. Algorithms 1, 3 and 6 follow the side of the line, and although they are described as following only the left side of the line, they are tested on both sides.

#	Name	Sensors	Description
1	FOLLOW GRAY	1 sensor in front	The robot follows the edge of the line: if the sensor detects "gray" the robot goes straight; if it detects black it turns towards the left, and if it detects white it turns towards the right.
2	ONE INSIDE	1 sensor in front	The robot zigzags inside the line: it turns toward the left until it detects white, then turns toward the right until it detects black and then white, then left until black and white, and so on.
3	ONE BOUNCE	1 sensor in front	The robot bounces off the side of the line: it turns left until it detects white, then right until black, then left until white, and so on.
4	STRADDLE	2 sensors in front	The light sensors are positioned on either side of the line: the robot goes straight while both sensors detect white, left when the left sensor detects black, and right when the right sensor detects black.
5	TWO INSIDE	2 sensors in front	The light sensors are positioned side-by-side inside the line: while both sensors detect black, the robot goes straight; when the left light sensor detects white, the robot turns right, and when the right sensor detects white, the robot turns left.
6	TWO BOUNCE	2 sensors: one in front and one in back	The robot bounces off the side of the line, with one light sensor in front and one in back: it turns toward the right until the front sensor detects white, then turns left in place until the rear sensor detects black, then turns toward the right until the front sensor detects black, and so on.

Table I: Table of Experiment

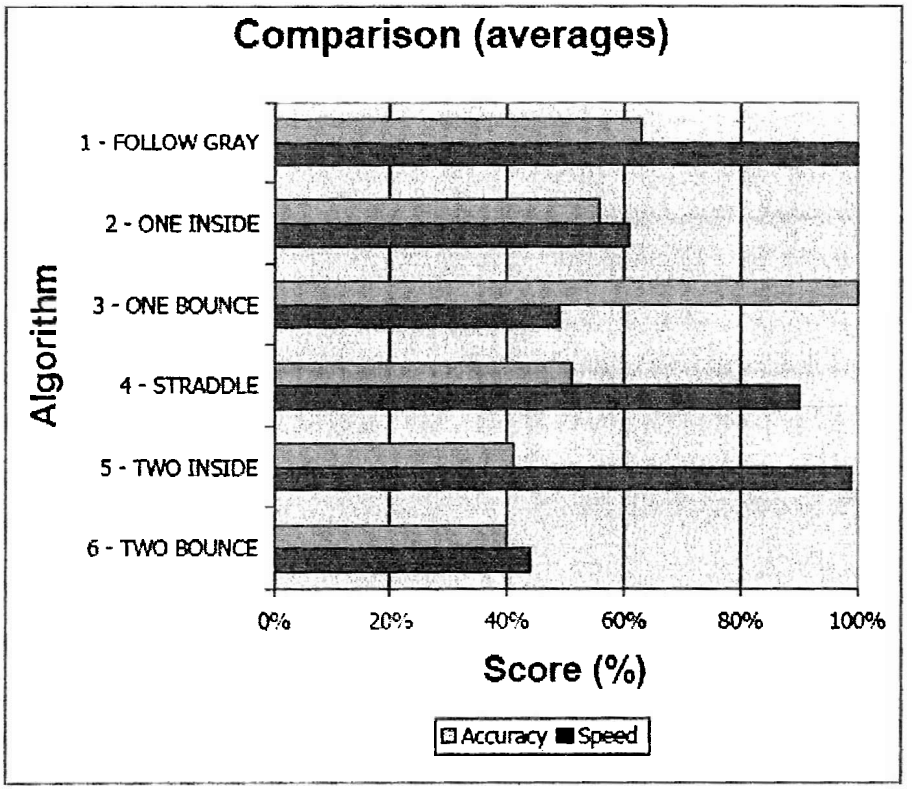

Figure 2.5: Comparison Vertical Chart

As a result the hypothesis is incorrect. The algorithms with one light sensor are more accurate than those with two. Perhaps this is a result of the way the robot follow the line. The algorithms with one light sensor continuously search for the line, so if they lose their way and get a little off track and keep looking and eventually to find the line. When the robot with two light sensors overshoots the line on a sharp turn, it sees the other side of the line and thinking it has turned successfully straightens its course, bringing it away from the line and completely off the track. Two sensors or more recommended to be used in line following robot[9].

2.6 The Hardware Design

The first step in the design of mobile line following robot is to select the right equipment. The design can be divided into several units or modules which first can be tested or implemented independently and then combined together. The components are:

1. Processing unit
2. Mobility unit

2.6.1 Processing Unit

Build a robot consisted with hardware and software development. Microcontroller has all the capabilities needed for an application such as a line following robot. The 'Lecturers Students Friendly Attendance Robot' design is using the PIC 16F877A microcontroller. The command program for robot ought to be built as to achieve desired behaviour for robot completing its tasks. Since PIC microcontrollers use RISC CPUs, the instruction set is reduced and the development with assembly environment is not difficult.