SMART KART: AN ESSENTIALS LINE FOLLOWER ROBOT

BAN SHU WEN

This report is submitted in partial fulfillment of requirements for the award of Bachelor of Electronic Engineering (Industrial Electronic) with honours

Faculty of Electronic and Computer Engineering

University Teknikal Malaysia Melaka

APRIL 2008

UNIVERSTI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : SMART KART

Sesi Pengajian : 2007 / 2008

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FAUZIYAH BT SALEHUDDIN
Pensyarah
Fakulti Kej Elektronik dan Kej Komputer (FKEKK),
Universiti Teknikal Malaysia Melaka (UTeM),
Karung Berkunci 1200
Ayer Keroh, 75450 Melaka

Tarikh: 8 MEI 2008

"I hereby declare that this report is the result of my own work except for quotes as cited in the references."

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Author : BAN SHU WEN

Date : 08/05/2008

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Signature :.....

Supervisor's Name : PAUZIYAH BTE SALEHUDDIN

Date : 8 MEI 2008

DEDICATION

To my beloved father, mother, sister and boyfriend. Also to all my friends.

ACKNOWLEDGEMENTS

Firstly, I would like to express my gratitude to my supervisor, Pn. Fauziyah Bt. Salehhudin, for his endless encouragement, support, trust and guidance throughout this project.

Secondly, I would also like to express my heartfelt appreciation to all my fellow friends for his/her for sharing the opinions and helps during completes on this project.

Last but not least, deepest thanks you and appreciation to my lovely family especially my parents and my boy friend, whose have been there to support and encourage me. Without the mentioned parties, I would not walk through the hard time during this period.

ABSTRACT

A Smart Kart is a small autonomous microcontroller base mobile robot which is able to navigate its way through four different modes of behaviors. The robot is essentially a line following robot that follow a black line drawn on a white background. Generally, the Smart Kart consists of four main parts which are microcontroller board, drive system, sensor system and effect indicator system. By using a pair of infrared sensors, the robot can detect the black lines for its line following function. Differential steering will be applied to the robot and each wheel is drive by a dc gear motor. PIC microcontroller is used as the brain of the robot, the onboard PIC microcontroller receives the data from sensors and logic switches (S1 and S2) to execute the task according the programming have been programmed on it, and exhibit the indicator. There are four manoeuvres that can be programmed to perform the Smart Kart including line runner, line runner with station, playpen and maze solver.

ABSTRAK

Smart Kart merupakan sebuah robot bergerak sendiri yang mampu bergerak dalam empat jenis cara pergerakan. Robot ini mempunyai fungsi yang serupa dengan robot yang bergerak mendasarkan garisan hitam yang dilukiskan diatas lantai. Umumnya, robot ini dibina daripada empat bahagian yang utama, iaitu bahagian pengawal mikro PIC, bahagian pengerakkan, bahagian pengesan infra merah, dan bahagian pengawal keluaran. Robot ini menggunakan sepasang pengesan infra merah untuk mengikut garisan hitam atau perjalanlan yang hendak diikuti. Robot ini menggunakan motor arus terus bersama degan nisbah gear yang sesuai untuk pergerakan. Disamping itu, robot ini juga menggunakan pengawal mikro PIC sebagai otaknya untuk menlaksanakan kesemua tugasnya. Pengawal mikro PIC yang menerima data daripada pengesan infra merah dan suis logik (S1 dan S2) akan melaksanakan tugasnya berdasarkan programming yang dituliskan. Empat cara pergerakkan yang mampu dilakukan oleh robot ini ialah pengikut garis, pengikut garisan yang berstesen, pergerakan dalam kawasan tertutup dan penyelesaian jalan sesat.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Autonomous Mobile Robot is a microprocessor based, programmable mobile robot, which can sense and react to perform desired tasks in unstructured environments without continuous human guidance [16]. Different robots can be autonomous particularly desirable in different fields, it is capable to perform almost all kind of tasks that the designers want it to do. Throughout the programming written to the robot, the robot is definitely capable of performing the desired task. Hence, robots are used in all kind of sectors due to their capabilities and their near limitless possibilities.

Autonomous mobile robots are used most in the industrial sector. Since, robots can perform task with more precision and accuracy compared to human counterparts. Robots are considered useful due to their ability to perform tasks without stopping and not needing rest unlike humans. Their main attribute is robot can perform repetitive tasks without any complains and they do not go on strike like humans do when they are not satisfied. In some sector, some manufacturing operation may be designed with flexibility manufacturing system due to this a type of flexible robot is desired for use in such industry sector.

The aim of this final year project is to design and develop an autonomous mobile robot which is having multi-navigation modes. It is actually to replace with presented line follower robot which is just able to comply with single line following function. To achieve with this, a study will be conducted into current line follower robot in order to evaluate their effectiveness. The most effective system will be selected from a criterion and combined with a logic control to create an autonomous deterrent in different path ways. Once a design has been finalized, a prototype will be constructed and limited preliminary tests of movement and functional of the robot will be conducted.

A smart kart with different modes of line following functions, its autonomous behavior can be applied into the real life to perform a various physical tasks. It can be changing on their navigations thought input setting on it. So, such robot is also suitable for biomedical engineering, chemical laboratories and automation task in hazardous place which are unsuitable and dangerous for humans to entry besides its application on industrials.

1.2 Problem Statements

In the natural and unknown environments, to perform the activity such as inspection, detection and exploring in potentially dangerous or hazardous place, where human beings dangerous or otherwise impossible to go or enter, an autonomous navigation robot is ideally to replace such operation. In certain indoor environment motion, each task maybe consists of collecting, delivery, moving and manipulating objects repeat or continuously. A smart kart is one of the solutions for such situations that can be complete the task to desire locations, while not colliding into obstacles on its way.

1.3 Objective

The objectives of this project are:

i. To design and develop a smart kart with PIC Microcontroller and will be manipulate into four modes of behavior.

ii. To design and construct the typical maps according to the action of the modes behavior.

iii. To create a program using assembly language as the programming language for PIC microcontroller to perform the smart kart.

1.4 Scope of Work

The scopes of work of this project are to design and develop an autonomous mobile robot which is able to navigate in four modes of behaviors according to the switches setting and infrared sensor as the input signal. The project is involved with utilizing of microcontroller design and to create a programming using assembly language. After simulation, the program will generate from assembly language into hex files by MPLAB programmer to run the robot with desire output.

1.5 Thesis Overview

This thesis is a documentary delivering the idea generated, concepts applied, activities done, and finally the final year project product itself. The thesis consists of five chapters. The following paragraphs are the description of each chapter in this thesis.

In chapter 1, the overview of autonomous robot, its capability and application is presented. The problem statements, objective, scope of work of this project also presented within this chapter.

Chapter 2 introduced the literature review on the theoretical concept applied in constructing a line follower robot. This chapter also discusses the various types of devices and component that can be used to construct a robot includes the concept and fundamental of PIC microcontroller, motor and sensors.

Chapter 3 will discuss the methodology that had been used to complete for this projects. It is consists of two parts which are hardware development and software development. The hardware development is design and construction of robot's physical structure which is including microcontroller circuit, drive system and sensors. In the software developments, the suitable program language was choosing to output solving presented in flowchart.

In chapter 4 covered all the designing, testing and troubleshooting process. It contains overall of robot's hardware construction included the PIC microcontroller board, sensor board, effect board and driving system for the robot. The analysis results from the hardware and software experiments are also included in this chapter. The problem during the whole designing and construction process and solution were also discussed.

The last chapter 5 will be the summary of this final year project. It is discuss about the application of the project and the conclusion, which can be drawn from this project and the recommendations for future improvements, will also be disclosed.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Literature review has been done to gain some ideas before conducting this project. In this chapter the writer will discuss about the previews work done by other researcher. Technical paper series and thesis from other research are referred. Furthermore, the various types of microcontroller, motor and sensors is done as a guide line to choose for most suitable components to be used in this project.

2.2 Autonomous Robot

Creating autonomous mobile robots is the first step towards the creation of artificial intelligence robots such as the ones from science fiction. Robots are like animals, require continuous input to correctly and dynamically understand what they are doing and what they should do next [1]. Autonomous vehicles have been designed and implemented to perform a wide variety of tasks, from delivering medical sample in a hospital to sweeping and clearing unexploded ordnance from a mine-field. One way to simplify this is to define a task based on a simple environmental stimulus, in this project a black line surrounded by white paper. The primary goal is to create sensors and logic hardware to control a robot to follow a black line and stop on a field of black.

James Cronmiller had designed a simple line following robot began with the control system. The project consisted of steering and drives control circuit, which is able controlled by the PIC Microcontroller. An H-bridge circuit was designed to enable the steering. Two pair of visible light emitter detector pairs was positioned at the front of the robot to sensing the black area. Software was written to the PIC to control the robot [1].

Jaseung Ku has been designed a line follower robot 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 of wheels' rotation. The control is done in such a way that when a sensor senses a black line, the motor slows down or even stops [2].

Erik Albert had been implemented the line follower robot on every programming environment that currently use. The robot follows a dark line on a light surface. It's been calibrated that >50 is the surface, and < 40 is the line on a scale of 0-100. The robot has been implemented two different ways, one as a treaded vehicle and one as a tricycle type design. Structurally they are basically the same, two motors in the back to drive, and a light sensor in the front that controls them. If the sensor is over the line, the robot will turn so that it isn't over the line, if the sensor is over the surrounding area, the robot will turn until it is over the line [3].

2.3 Microcontroller

A microcontroller is a computer-on-a-chip. It is an inexpensive single-chip computer and sometimes referred to as one-chip microcomputers, used to control a wide range of electrical and mechanical appliances. The microcontroller existing on the encapsulated silver of silicon has features and similarities to our standard personal computers. Primarily, the microcontroller is capable of storing and running a program, its most important feature [5].

A microcontroller differs from a microprocessor in many ways. The microcontroller is design to be all in one. It is a general-purpose chip that is used to create a multi-function computer or device and requires multiple chips to handle various tasks. No other external components are needed for its application because all necessary peripherals are already built into it. While, in order for a microprocessor to be used, other components such as memory, or components for receiving and sending data must be added to it.

The great advantage of microcontrollers compare to using larger microprocessor is that the part-count and design costs of the item being controlled can be kept to a minimum. They are typically designed using complementary metal oxide semiconductor CMOS technology, an efficient fabrication technique that uses less power and is more immune to power spikes than other techniques. Primarily, the microcontroller is capable of storing and running a program, its most important feature.

The microcontroller contains a central processing unit (CPU), random-access memory (RAM), read-only memory (ROM), electrically erasable programmable read-only memory (EEPROM), input/ output (I/O) lines, serial and parallel ports, timers, and other built-in peripherals, such as analog to digital (A/D) and digital to analog (D/A) converters [21]. Figure 2.1 shown for the microcontroller based system.

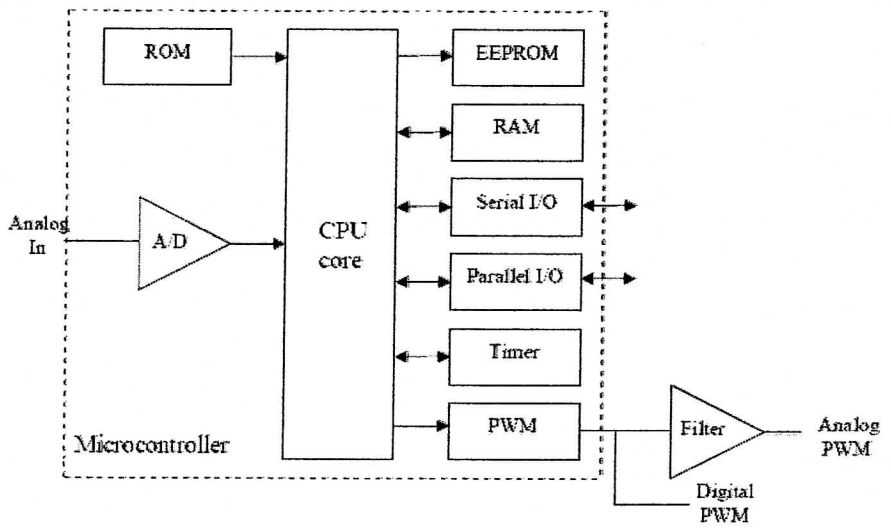

Figure 2.1: Microcontroller based-system [6].

2.3.1 Central Processing Unit (CPU)

The CPU is the internal core of the microcontroller [4]. CPU is used to accept the input data, execute the programs, and output the results. Generally, the CPU will add data, move and compare data, execute loops, read and store data, read and modify internal status registers, and increment counters. Figure 2.2 shown for simplified central processing unit with three registers.

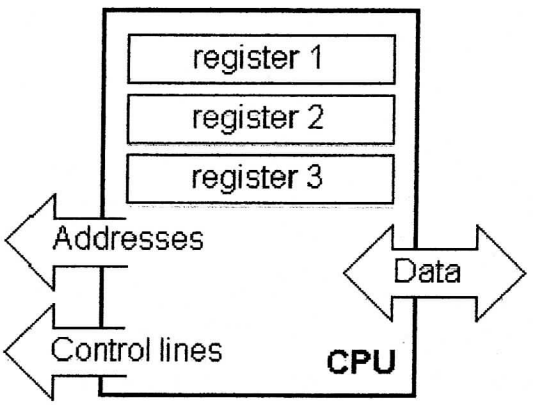

Figure 2.2: Simplified central processing unit with three registers [4].

2.3.2 Memory Unit

Memory is part of the microcontroller whose function is to store data. [4] The EEPROM is where the programs and permanent data are stored. The RAM is where all of the temporary data that the microcontroller uses is stored. The amount of RAM of microcontroller will limits the number of variables that user can use in programs meanwhile the amount of EEPROM sets the limit on how large a program that user can use. Figure 2.3 shown for simplified model of a memory unit.

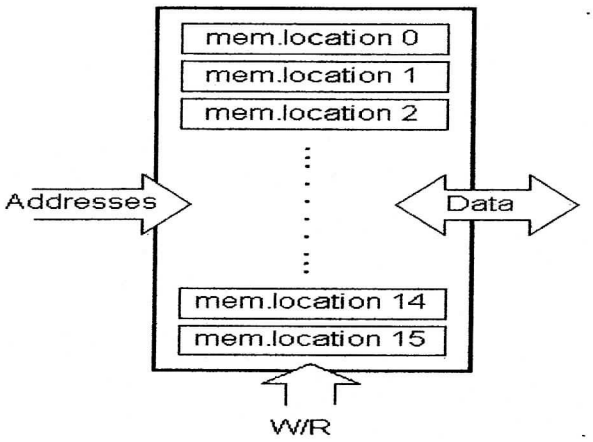

Figure 2.3: Simplified model of a memory unit [4].

2.3.3 Input Output Unit

All microcontrollers have a certain number of I/O pins. Depending on the microcontroller, some I/O pins are input only or output only and some have the special-purpose I/O for such thins as analog-to-digital conversion. Most microcontrollers have bidirectional I/O pins. Figure 2.4 shown for simplified input-output unit.

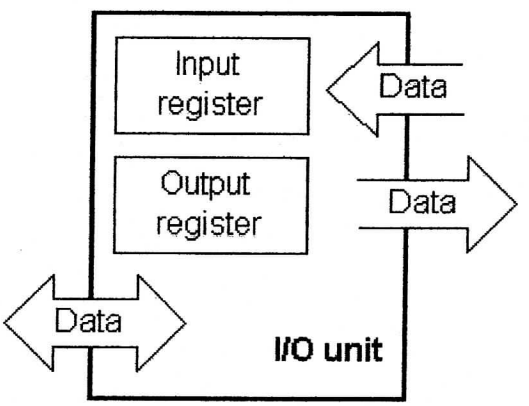

Figure 2.4: Simplified input-output unit [4].