MICROMOUSE: AN AUTONOMOUS MAZE SOLVING ROBOT

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

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DEDICATION

To my beloved father, mother and twin sisters

ABSTRACT

Micromouse – An Autonomous Maze Solving Robot is a small autonomous microcontroller-controlled mobile robot which is able to navigate its way through an unknown maze in the shortest time. Micromouse also able to explore different maze configurations and to maps the optimum route for the shortest travel distance. Generally, the Micromouse consists of four main parts which are microcontroller board, drive system, sensor system and power supply system. By using infrared sensors, Micromouse can detect the obstacle and distance between walls around it. Differential steering will be applied to the robot and each wheel is drive by a stepper motor. By applying the maze solving algorithm, the onboard PIC microcontroller receives the data from sensors and then calculate the current position of robot. The algorithm also functions as to discover the shortest path to the targeted destination which normally located in the center of the maze.

ABSTRAK

Micromouse – Robot penyelesaian pagar sesat berautonomi ialah robot mobil kecil berautonomi yang dikawal oleh mikropengawal dimana ia berkemampuan menyelesaikan pagar sesat yang tidak dikenali dalam masa yang paling singkat. Micromouse juga berkemampuan untuk meneroka konfigurasi pagar sesat yang berbeza dan memetakan laluan yang paling optimum untuk jarak perjalanan yang paling pendek dalam pagar sesat. Secara amnya, Micromouse terdiri daripada empat bahagian utama iaitu papan mikropengawal, sistem pemacu, sistem pengesan dan sistem bekalan kuasa. Dengan menggunakan pengesan inframerah, Micromouse dapat mengesan halangan dan jarak antara Micromouse dengan dinding di persekitarannya. Dalam projek ini, stereng bezaan akan digunakan oleh robot ini dimana setiap roda akan digerakkan oleh motor berlangkah. Dengan menggunakan algoritma penyelesaian pagar sesat, mikropengawal PIC pada papan mikropengawal akan menerima data dari pengesan untuk mengira kedudukan semasa robot untuk mendapat tahu laluan yang paling pendek untuk sampai ke destinasi sasaran yang kebiasaannya ditempatkan pada bahagian tengah pagar sesat.

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INTRODUCTION

1.1 Introduction

Micromouse – An Autonomous Maze Solving Robot is a small autonomous microcontroller-controlled mobile robot which is able navigates its way through an unknown maze in the shortest time. Micromouse also able to explore different maze configurations and to maps the optimum route for the shortest travel distance in that maze.

Autonomous robots are robots which can perform desired tasks in unstructured environments without continuous human guidance. A high degree of autonomy is particularly desirable in fields such as space exploration, where communication and delays and interruptions are unavoidable. A fully autonomous robot in the real world has the ability to:

a) Gain information about the environment.
b) Work for months or years without human inventions.
c) Travel from one location to other location without human navigation assistance.
d) Avoid situation that are harmful to human, property or itself.
e) Repair without outside assistance.

The research on Micromouse can be applied in the real life activity, which including biomedical engineering, automation of tasks unsuitable for human beings in rescue operations. Besides that, the Micromouse can be modified into a mapping robot to explore and map the area that humans are unable to reach.

1.2 Problem Statements

In the real life activity such as search and rescue or exploring hazardous area which humans are unsuitable to be, an autonomous navigation robot is required in such operation. In certain situation, humans always try to look for the shortest path to the destination to perform task such as looking for emergency exit in unknown area. A Micromouse is one of the solutions for such situation to solving an unknown area in an efficient manner.

1.3 Objective

The objective of this project is to design and develop an autonomous Micromouse which is able navigate its way through an unknown maze and to negotiate this path for the shortest navigation time by utilizing microcontroller design with infrared sensor as inputs.

1.4 Scopes of Work

The scopes of work for this project are stated as below:

- The microcontroller board, stepper motor driver board and sensors are constructed.

- The Micromouse is designed and developed according to the rules of IEEE Micromouse competition.
- The 8x8 unit maze is designed and constructed according to the dimensions set by IEEE Micromouse competition.
- The flood-filled maze solving algorithm is designed and developed.
- The CCS C compiler is used to develop the Micromouse program in C language.

1.5 Methodology Briefing

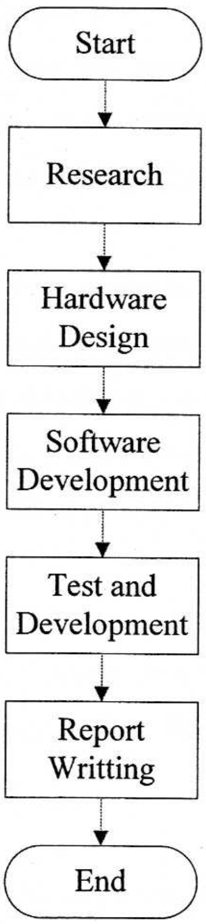

Figure 1.1: Methodology flowchart

1.6 Structure of Thesis

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

In chapter 1, the brief introduction to Micromouse, 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 history of Micromouse contest, the concept of Micromouse and the rules and standard of Micromouse contest. This chapter also includes the concept and fundamental of PIC microcontroller, motor, sensors and maze solving algorithms.

Chapter 3 is regarding the project methodology that consists of two parts which are hardware development and software development. The hardware development as stated in project methodology which include the design and construction of robot's platform, microcontroller circuit, drive system and sensors. In the software developments, the suitable maze solving algorithm is presented in flowchart.

In chapter 4, all the analysis result from the hardware and software experiments is included in this chapter in the form of table, discussions, and improvements done.

Finally, the chapter 5 will be the summary of this final year project. The conclusion, suggestions or recommendations for improvements and application are discussed within this chapter.

CHAPTER II

LITERATURE REVIEW

2.1 Micromouse History

The first Micromouse was mechanical. In 1972, the "Machine Design" magazine sponsored a contest in which spring-powered mice pitted their stamina against one another to see which could travel the longest distance down a racetrack. The first-placed "mousemobile" was one which traveled 825.3 feet.

In 1977, the IEEE Spectrum magazine came up with the concept of a Micromouse - a small microprocessor-controlled robot vehicle imbued with the intelligence and capability to decipher and navigate a complicated maze. In May 1977, Spectrum announced the first US Amazing Micromouse Maze Contest to be held in June 1979, New York. Only 15 Micromouse competed out of 6,000 entries received. Some reported "brain failure" and others claimed mouse "blow-up". While interest was high, evidently, the design and construction of an intelligent Micromouse proved to be tougher than most has imagined.

In 1980, the European version of the contest was launched at the Euromice '80 in London but none of the 18 Micromouse managed to solve the maze. Among the spectators were delegates from the Japan Science Foundation who took the rules back to Tokyo and subsequently organized the first All-Japan Micromouse Contest.

In August 1985, Tsukuba, Japan, was the site of the First World Micromouse Contest Micromouse came from all over Europe and the USA, employing sensors ranging from infra-red to ultrasonic to CCD, and driving mechanisms from stepper motors to DC servo-motors. All the top prizes were clinched by the Micromouse from Japan with Noriko-1 emerging as the world champion.

At the 1987 World Micromouse Championship, hosted by the Institution of Electrical Engineers in London, 13 Micromouse competed for top honours. David Otten from the Massachussetts Institution of Technology (MIT), USA, captured the first and second prizes with his two entries, Mitee Mouse I and Mitee Mouse II. A new system of scoring was also adopted, designed to reward intelligence, efficiency of maze-solving and self-reliance of the Micromouse. This was also the year of the first Singapore contest. the winner of this contest was MIR3+ from the Nanyang Technological Institute. This mouse came third in the 1988 IEE UK competition in London.

In 1989, The IEE UK Championship held during July in London was won by members of a Singapore team that took 6 of the top 8 prizes. Dave Woodfield's Enterprise came in 5th while Dave Otten's Mitee Mouse III was placed second. All three of the top mice were within a half second of each other. Later that year, in October, came Singapore's first International Micromouse competition. Local mice from Singapore took five of the top seven places.

In 1992, the seventh annual IEE micromouse competition was held in London. Nine mice ran. The winner was Mitee Mouse III with the best overall score although the runner up, Mouse Mobile II by Louis Geoffrey from Canada, made the fastest run. Third prize went to Enterprise. Derek Hall's Motor Mouse 2 managed a good best run but picked up some penalty points as did Andrew Gattell's Mars 1.

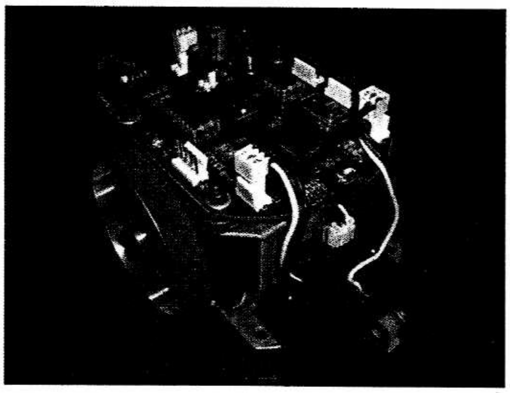

Figure 2.1: The Micromouse "SOMA ZERO"

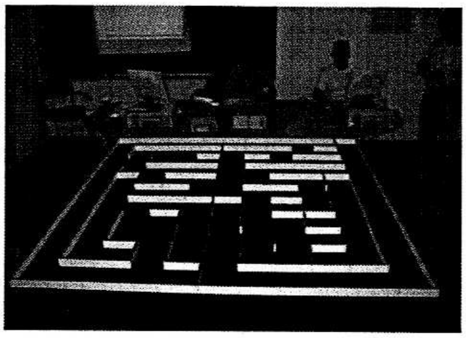

Figure 2.2: The Micromouse competition

2.2 Microcontroller

A microcontroller is a computer-on-chip that accepts inputs from one electrical device, conducts some operation on signals, and then outputs the results to control other electronic devices.

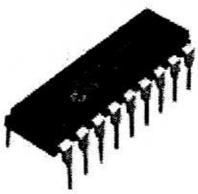

Figure 2.3: Microcontroller

2.2.1 Basic Microcontroller Features

The basic microcontroller features contains the number of input/output (I/O) pins, the amount of electrically erasable programmable read-only memory (EEPROM), the amount of random access memory (RAM), a central processing unit (CPU) and clock speed.

2.2.1.1 CPU (Central Processing Unit)

The CPU is the internal core of the microcontroller. 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.

2.2.1.2 I/O Pins

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.

2.2.1.3 EEPROM and RAM

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.