DESIGN & DEVELOPMENT MICROMOUSE FOR ROBOT COMPETITION

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Robotics and Automation) with Honours

by

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APPENDIX E

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **Design & Development Micromouse For Robot Competition**

SESI PENGAJIAN: 2008/09 Semester 2

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I hereby, declared this report entitled "Design & Development Micromouse for Robot competition" is the results of my own research except as cited in references.

Signature : .....

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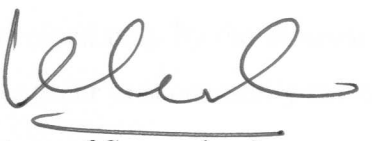
APPROVAL

This report is submitted to the Faculty of Manufactuing Enginering of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Manufacturing Engineering (Robotics And Automation) with Honours. The member of supervisory committee is as follow :



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ABSTRACT

A micromouse is an autonomous robot which has to navigate through a maze. The aim is to reach the center of the maze as fast as possible. To achieve that, it will need several different components such as sensors, motors and a microcontroller. Sensors are used to obtain data of its surroundings. A microcontroller will then process that data and provide output to the motors. A chassis will accommodate all the components, and its size will be restrained only by the dimensions of the maze cell. Algorithms will have to be devised in order to successfully solve mazes.

ABSTRAK

Objektif Projek Sarjana Muda ini mereka satu robot kecil dipanggil MicroMouse yang berupaya mencari jalan keluar sendiri apabila diletakkan di dalam sebuah maze, secara perantaramukaan "hardware" dan "software". PIC18F4620 akan digunakan. Secara keseluruhan, MicroMouse beroperasi tanpa sebarang pertolongan and membawa bekalan kuasa sendiri. Motor stepper dan sensor peka cahaya akan digunakan. Konsep MicroMouse. Mouse dibahagikan kepada 3 bahagian utama iaitu mikropengawal, sensor dan motor stepper. Sejurus itu, litar skematik bagi sensor dan motor direka. Penderia yang sesuai digunakan ialah IR transmitter yang diletak di hadapan ,kanan, dan kiri mouse. Penderia ini akan memancarkan cahaya inframerah yang akan dipantul kembali sekiranya ada mengena dinding maze. Mikropengawal membacaa isyarat daripada sensor dan mentafsir arah pergerakan yang selanjutnya dengan menghidupkan motor yang sesuai. Jangkaaan akhir projek ini adalah mouse akan dapat bergerak mencari jalan keluarnya secara automatik dan sempurna.

DEDICATION

I would like to dedicate this report to my beloved mother Stella Tay Shew Kiau , my late father Raymond Edward Aw for giving me the best guidance . Not to mention my second brother Amos Aw Teik Onn and the youngest Andre Aw Teik Tsen for supporting me as their big brother . I love all of you . Thank you very much God for this blessed family .

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I would also like to thank my beloved parents, and brothers. Mom , thank you for almost everything in guiding me and giving your utmost support in time of hardships and difficulties . You are such a strong woman I had ever known . To my brothers thank you so much for motivating me when I need help . Not forgetting my late dad may his soul rest in peace. Thank you for being my father .

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Furthermore, I would like to express my heartfelt appreciation to my best friend Aaron Pereira for giving me various ideas and suggestion . Last but not least , I would like to say thank you to my UTeM friends especially my housemate Song Chien Shyen and Parameswara for their help in need . Thank you guys .

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LIST OF ABBREVIATIONS

Vref	-	Voltage Reference
PWM	-	Pulse Width Modulation
mA	-	Mili ampere
LED	-	Light Emitting Diode
VLOAD	-	Load Voltage
OCXO	-	Oven Controlled Crystal Oscillators
TCXO	-	Temperature Compensated Crystal Oscillators
IR	-	Infra Red
NiMH	-	Nickel Metal Hydride
NiCd	-	Nickel-Cadmium
EEPROM	-	Electrically Erasable Programmable Read-Only Memory
RAM	-	Random Access Memory
CPU	-	Central Processing Unit
PLL	-	Phase Lock Loop
Mhz	-	Mega Hertz
Khz	-	Khz
LDO	-	Low Drop Output
EMF	-	Electromotive Force
MIPS	-	Microprocessor without Interlocked Pipeline Stages
ADC	-	Analog-Digital-Converter

CHAPTER 1
INTRODUCTION

1.1 THE COMPETITION

A micromouse is a robot with maze solving capabilities. The micromouse competition has been a worldwide event since the late 70's. In this competition, contestants are given a set amount of time to get their robots to find the center of a maze. The robot which manages to find the reach the center in the shortest possible time is the winner.

The maze is made out of wood. It has 256 cells, or more specifically, a 16 by 16 grid of cells. These cells are sized at 180mm square and have walls with a thickness of 12mm and a height of 50mm. Figure 1 is an example of how a maze looks like.

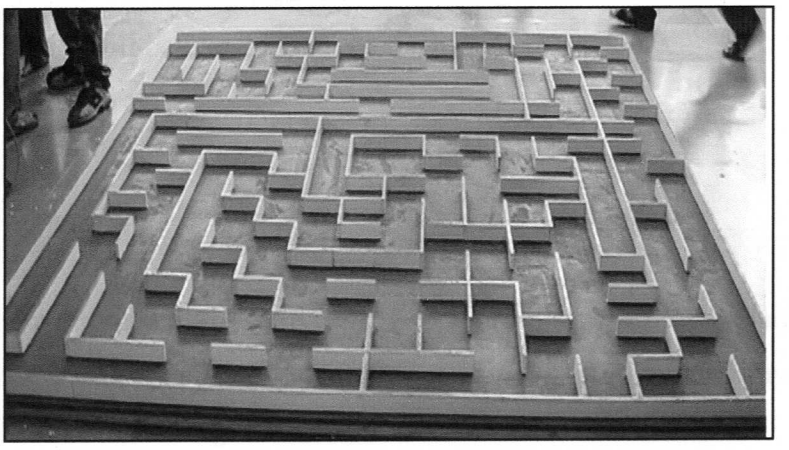

Figure 1: Micromouse Maze

Building the micromouse utilizes knowledge from many branches of robotics such as electrical circuit design, microcontroller programming and mechanical design. Many

different types of hardware can be used in building a mouse, therefore there is a huge variety of mice normally at these events.

These hardware ranges from motors to integrated circuits. The selected hardware will have to work together to make a functional micromouse.

1.2 THE EDUCATIONAL AIM OF THIS PROJECT

Since the competition was created in 1979, the Micromouse as a project was part of the project offer from universities. In most universities the Micromouse project is given to a group of student to increase the chance of completion and success. In Universiti Teknikal Malaysia Melaka , each student has a different project and if two peoples have the same project they should not work on the same Mouse. This project has the advantage to demonstrate the student abilities in many fields such as electronics design, mechanical design, program design and how the student approach complex engineering problems.

1.3 OBJECTIVE

The objective of this project is to design a MicroMouse, a small robot that can find its way through and out of a constructed maze using hardware and software interface. A maze of 20 cells will be constructed for the mouse to navigate.

1.4 SCOPE OF PROJECT

The size of a constructed maze is 36 cells, a reduction from IEEE standard maze which comprising 256 cells. The demonstration is to perform indoor to avoid excessive infrared from sunlight.

1.5 APPLICATION

Although the designs of this Micromouse seem simple at first, its application can be applied in a search and rescue situation where this small robot can navigate and search for victim trapped inside a collapsed building or any situation which the use of rescue dogs in not advisable. With a few sophisticated gadgets added on the robot, it can transmit a clear digital picture to the search party above so that they can locate and save the survivors.

The design can be upgraded to be an automatic vacuum cleaner with the abilities to sense and avoid obstacles when cleaning the floor. Whenever the battery level drop to a minimum state, it can recharge itself by plugging its' socket to the power supply without any external help.

1.6 MAIN IDEA OF THE PROJECT

The main idea of this design is to design a two wheel robot which can interact with its surrounding through IR sensors and a microcontroller.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

Literature review can be defined as a background study about the knowledge and information needed to develop a project . In order to develop a complete and functional project in reality , a literature review is necessary to go through before the start to analysis and design the project .

Literature review for this particular project starts from the early project planning phase . Information and knowledge gathered from various sources via the internet and other relevant journals eased the process .

Apart from that , this can also be done by referring to theories and concepts that had been published and declared but expertise in their respected fields. Besides , case study on the existing similar projects is one of the effective methods for literature reviews too.

The key advantages and significant of this literature review helps to determine the project scopes and features that are necessary in the intended development for this project. Furthermore, case study helps to avoid system weakness that may be found in similar review's projects. On the other hand , enhancement of the similar projects can be done to overcome the existed weakness .

The importance of this case study on existing projects that are quite similar with the Micromouse maze solving development is obvious because it helps determine the intended features and how it should suppose to be .

By doing literature review before starting to analyze the project would result in a higher success rate in the design and development of the micromouse robot competition.

2.2 Current Micromouse Competition

The current micromouse competition is conducted on a maze as specified in Fig. 2.1. A typical micromouse built to manoeuvre the maze is shown in Fig. 2.2.The first difficulty is the maze itself. The specifications require a large wood floor of 3 m 3 m that is expensive and difficult to build. At CSUF we tried to build one, but after spending $1700, it still did not fully comply with the specifications. To utilize the maze is another problem. A special room needs to be set aside permanently for the maze. Most of the testing of the micromouse requires the maze and it is virtually impossible for students to test their vehicles at home (P. Louzon , 2002).

The construction of the micromouse also presents difficulty. The main reason is that the maze square is very small. No off the- shelf toy cars with steering mechanism can fit in the square.

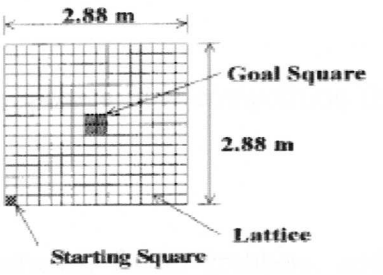

Fig 2.1 : Micromouse maze specification

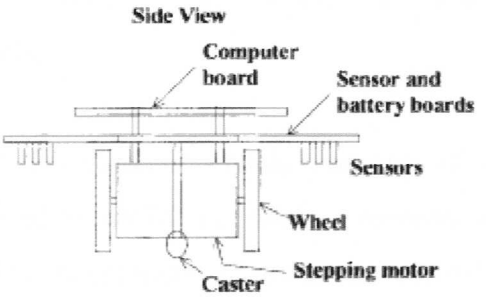

Fig 2.2 : A micromouse example

The on-board computer typically is a single board computer built from scratch using the wire-wrap prototyping technique. Microcontrollers used include the 68HC11 and 80C188EB. To increase reliability and to reduce power consumption, micromouse builders usually try to reduce the number of components used. As a result, the on-board computer is usually barely able to handle the computation. The software program is written from scratch and stored in EPROM's. According to N. Chen et al (2004), there is no floppy or hard drive and the on-board computer does not provide any programming environment making debugging an extremely time consuming process . The sensor system is made of eight or more reflective infrared sensors. These discrete sensors can only take in limited amount of information. The sensor system is made of eight or more reflective infrared sensors. These discrete sensors can only take in limited amount of information.

2.3 Proposed Vision Guided Autonomous Vehicle Competition

Y. K. Kwon et al (2004) propose a new competition that takes advantages of the following.

1) The use of CCD cameras, frame grabbers, and related products that are becoming widespread due to the explosion of the multimedia market. These products are inexpensive and readily available.

2) The fact that many students own powerful computers with excellent programming environment and many of whom possess excellent programming skills.

A vision-guided autonomous vehicle consists of a CCD camera and a transmitter mounted on an RC car while a receiver and a frame grabber are connected to a PC. A competition arena that consists of a white floor with black dashed line serving as tracks hosts the game. The participants run their software program on a PC. The program processes the image seen by the vehicle and issues drive commands back to the vehicle. Participants' merit is judged by how fast the vehicle finishes the loop or by how intelligently the vehicle solves a maze. Major components of the project proposed are as below:

2.3.1 Vehicle

The vehicle used is a popular radio-controlled toy car called "little R/C buggy." This toy car has a good steering mechanism and has a changeable gear train. During testing and debugging, the low gear feature is very handy. With three C batteries, it can run almost 6 h without recharging. This also makes the testing less painful.

2.3.1 Camera

We used an inexpensive black and white CCD camera with a built-in wide angle lens costing about $130. It outputs a standard RS-170 video signal and accepts a dc input from 8 to 14 V.

2.3.2 Transmitter/Receiver Pair

The transmitter/receiver pair is an off-the-shelf product costing about $100 per pair. It can deliver quality video signal at 900 MHz with a range of 125 ft.

2.3.3 Frequency Demodulator

The off-the-shelf receiver outputs a signal intended for TV channel 4 which needs to be demodulated back to the RS-170 video signal. Instead of buying or building a frequency demodulator, we simply run the receiver output to a VCR. The VCR's VHF input takes in TV channel 4 signal and produces an RS-170 video signal on its VIDEO OUT connector.

2.3.4 Video Frame Grabber

At CSUF we built a low-cost video frame grabber from scratch.

2.3.5 Interface to the Hand-Held Controller

All RC toy cars are equipped with hand-held controller that issues drive commands at 27 or 49 MHz. All control buttons on the hand-held controller are on/off type mechanical switches. Using n-p-n transistors (e.g., 2N3904) we easily constructed electronic switches that accepted commands from the PC.

2.3.6 Race Track/Maze

The race track/maze on which the vehicle operates consists of a white base dotted with black dashed lines as the track. Fig The white base can be easily constructed by taping white poster sheets on the floor. The black dashed lines are made of non-reflecting black paper cut into 1 cm by 2 cm rectangular blocks. One can arrange the dashed black lines into a race track or a maze. The cost and time for the construction is minimal.