UNIVERSITI PUTRA MALAYSIA

DESIGN AND FABRICATION OF AUTONOMOUS ENTERTAINMENT MOBILE ROBOT

ASNOR JURAIZA BINTI DATO' HJ. ISHAK

DESIGN AND FABRICATION OF AUTONOMOUS ENTERTAINMENT MOBILE ROBOT

By

ASNOR JURAIZA BINTI DATO' HJ. ISHAK

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of Requirements for the Degree of Master of Science

September 2003

Dedicated to my parents,
Dato' Hj. Ishak Idris and Datin Hjh. Asmah Md Rashid,

my husband and daughter,
Aziz Kamal and Anis Amalina Aziz,

and
my dearest brothers and sister…..

……With Love……

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

DESIGN AND FABRICATION OF AUTONOMOUS ENTERTAINMENT MOBILE ROBOT

By

ASNOR JURAIZA BINTI DATO' HJ. ISHAK

September 2003

Chairman : Associate Professor Ishak bin Aris, PhD.

Faculty : Engineering

Mobile robots are already widely used for surveillance, inspection and transportation tasks. An emerging technology with enormous potential is the entertainment mobile robot. Sony Corporation has developed a Sony dog known as Sony's Aibo that cannot speak but can chase a ball, lie down, sit and wag its tail. The robot must operate in a safe and friendly manner, avoiding obstacles and posing no risk to human in its vicinity. The scenario in Malaysia is that not many entertainment mobile robot has been developed because generally, Malaysians are content with their role as a user rather than a developer.. In order to achieve the objectives of the "Vision 2020", Malaysia should produce more scientists and developers in various areas. The best and most effective way of learning and stimulating interest in entertainment robot is through contests. Therefore, Sirim Berhad and the Ministry of Education have organized the Robot Games Festival or Robofest 2002 to encourage researchers, lecturers and students to design and develop robotic systems.

The main objective of this project is to design and develop an entertainment mobile robot that can place as many beach balls as possible into the cylinder tubes within 3

minutes. In the festival, the robot can be manual and/or automatic. The manual robot must not touch Kinabalu Zone (Appendix B1) and starts only at 'Start Zone A'. Meanwhile, the automatic robot can touch and enter the entire area of the game field and starts at 'Start Zone B' in the Kinabalu Zone.

The development of the entertainment mobile robot consists of hardware and software development. The hardware development is divided into two parts namely, mechanical design and electrical design. The mechanical design involves a platform module, a storage module and an arm manipulator module. While, electrical design includes a power supply module, a sensing system, a control panel, a DC motor driver and a programming logic controller. The software development is required to develop the programming of this robot and the software used is FPWIN GR PLC.

The design of the proposed robot is based on the Cylindrical coordinate concept known as Y-Z-θ coordinate. In the contest, two strategies plan of motion are applied that are the I motion and the L motion. Therefore, the strategy should be selected before the match starts. The I motion only involves Y-axis motion or straight motion while L motion requires Y-axis, Z-axis (turn left or right) and θ-axis motion (rotation).

Based on the result testing and the contest that took place, the entertainment mobile robot is found to be operating according to its contest motion plan.

Abstrak tesis dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Master Sains

REKABENTUK DAN FABRIKASI ROBOT HIBURAN

Oleh

ASNOR JURAIZA BINTI DATO' HJ. ISHAK

September 2003

Pengerusi : Profesor Madya Ishak bin Aris, PhD.

Fakulti : Kejuruteraan

Robot hiburan secara meluasnya telah digunakan dalam bidang pengawasan, pemeriksaan dan pengangkutan. Robot hiburan mempunyai pontensi yang tinggi dalam bidang teknologi. Syarikat Sony telah membina sebuah robot anjing Sony yang dikenali sebagai Sony Aibo dimana robot ini tidak boleh bercakap tetapi mempunyai keupayaan memegang bola, baring dan duduk serta menggerakan ekornya. Robot harus dikendalikan secara selamat dan berkeadaan baik bagi mengelakkan halangan dan risiko pada persekitaran manusia. Senario di Malaysia secara umumnya memperlihatkan bahawa tidak banyak pembinaan robot hiburan keranan dasar dan peraturan kerajaan yang hanya bertindak sebagai pengguna daripada bertindak sebagai pengusaha. Sebagai panduan untuk mencapai sasaran "Wawasan 2020", Malaysia seharusnya melahirkan lebih ramai saintis dan pengusaha dalam pelbagai bidang. Jalan terbaik dan berkesan untuk mempelajari dan menaruh minat dalam bidang robot hiburan adalah melalui pertandingan. Untuk yang demikian, Sirim Berhad dan Kementerian Pendidikan telah menganjurkan satu kejohanan Pesta Pertandingan Robot 2002 untuk menggalakkan penyelidik, pensyarah dan pelajar merebentuk dan membina sistem robotik.

Objektif utama projek ini ialah untuk merekabentuk dan membina sebuah robot hiburan yang membolehkan ianya memasukkan bola pantai sebanyak mungkin ke dalam tiub silinder dalam masa 3 minit. Dalam pertandingan ini, robot ini boleh dikawal samada secara manual ataupun automatik. Robot manual tidak boleh memasuki dan menyentuh Zon Kinabalu (Apendik B1) dan perlu bermula di 'Zon Permulaan A'. Manakala, robot yang dikawal secara automatik dibolehkan memasuki dan menyentuh kawasan pertandingan dan bermula di 'Zon Permulaan B' dalam kawasan Zon Kinabalu.

Pembinaan robot hiburan ini melibatkan pembinaan perkakasan dan perisian. Pembinaan perkakasan dibahagikan kepada dua kategori iaitu rekabentuk mekanikal dan rekabentuk elektrik. Rekabentuk mekanikal melibatkan rekabentuk modul planta, modul simpanan dan modul lengan robot. Manakala rekabentuk elektrik merangkumi modul bekalan kuasa, sistem pengesan, panel kawalan, motor arus terus dan kawalan pengaturcara logik. Pembinaan perisian dalam robot ini diperlukan dengan membina satu sistem pengaturcara menggunakan perisian FPWIN GR PLC.

Rekabentuk robot yang diperlukan ini adalah berdasarkan kepada konsep kordinat berbentuk silinder yang dikenali sebagai kordinat Y-Z-θ. Dalam pertandingan ini, dua rancangan strategi pergerakan diaplikasikan iaitu pergerakan I dan pergerakan L. Walaubagaimanapun, strategi harus ditentukan sebelum pertandingan bermula. Pergerakan I hanya melibatkan pergerakan paksi Y atau pergerakan lurus manakala pergerakan L melibatkan paksi Y, paksi Z (pusing kekiri dan kekanan) dan paksi θ (putaran).

Berdasarkan kepada keputusan ujian dan keputusan ketika pertandingan, robot hiburan ini dapat beroperasi seperti keperluan dalam pertandingan tersebut.

ACKNOWLEDGEMENTS

I could not have accomplished this project without the help of Allah S.W.T. Thanks to Allah S.W.T that I can complete my project successfully.

First and foremost, I would like to express my gratitude to my project supervisor, Associate Professor Dr. Ishak Aris for his valuable advice, guidance and willingness to share his expertise knowledge.

I would also like to thanks my project co-supervisor, Dr. Samsul Bahari Mohd Noor and Associate Professor Dr. Napsiah Ismail for their valuable opinions and guidance and checking the accuracy of my entire project.

I have also indebted to the help of Hj. Noorfaizal Dato' Hj. Yidris and Mr. Danny Lim of Intellogic Technology Sdn Bhd for their various ideas, suggestions and valuable aid to carry out this project.

Special thanks to my loves ones, Dato' Hj. Ishak Idris and Datin Hjh. Asmah Md Rashid, my beloved husband and daughter, Aziz Kamal and Anis Amalina Aziz, my dearest brothers and sister, my dearest friends, Mashida Sakrani, Huda Rameli, Izadora Mustafa, Siti Fatimah Sadikon and anyone for their patience, encouragement and continuous support.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AC	Alternative current
BISMARC	Biologically Inspired System for Map-based Autonomous Rover Control
CARL	Construction Automation and Robotics Laboratory
CPU	Centre processing unit
DC	Direct current
EEROM	Erasable programmable read-only memory
I/O	Input and output
LED	Light-emitting diode
MCSM	Mobile Camera Space Manipulation
NCSU	North Carolina State University
PLC	Programmable Logic Controller
RBMS	Robotic Bridge Maintenance System
ROBOCON	Robot Festival Contest
SIRIM	Standards and Industrial Research Institute of Malaysia
TISOFT	Texas Instruments software
VA	Volt amperes

LIST OF SYMBOLS

T	Torque
J	Inertia
t	Time
ω	Angular velocity
g	Gravity constant
W_L	Weight of the load
W_G	Weight of the gear
R_L	Radius of load wheel
R_G	Radius of gear
N_G	Number of teeth gear
r	Radius of gear
rpm	Revolutions per minute
d	Diameter of gear
m	Meter

CHAPTER 1

INTRODUCTION

1.1 Introduction

Robots are very useful in the manufacturing industry to perform tasks like welding, grinding and part assembly. Nowadays, mobile robots have begun to achieve the dreams of researchers. Mobile robots make our life easier and safer in many ways such as sea exploration, planet discovery, dangerous military and police missions, as well as being a new type of entertainment (Jones, et al., 1999).

In Malaysia, many industrial companies are not interested to participate in the research and development of robots. Lack of financial support and involvement by researchers and students worse the situation. However, the recent success by Honda's Asimo and Sony's Aibo has changed people's perception. They make use of the development of robots in the world of entertainment.

Sirim Berhad believes that the best and most effective way of learning and stimulating interest in robotics is through contests. The proposed project was designed and fabricated to participate in the first Malaysia Robot Games Festival or Robofest 2002. It is an annual event to promote robotic and artificial intelligent fields and hold activities such as robot contests, exhibitions, demonstration, forum and seminar.

The contest (Robofest 2002) was held on 5th of May 2002 with SIRIM Berhad as the organizer. In the contest, only two types of machines were allowed; the automatic and manual machines. The participants were among university and polytechnic students. Each team had 4 members that were made up of 3 students and 1 instructor or lecturer. The layout of the game field is attached in Appendix B1.

1.2 Objectives

The main objective of this project is to develop an entertainment mobile robot that can place as many beach balls as possible into the cylinder tubes within 3 minutes.

In order to achieve the main objective, the following works must be carried out. They involve the development of:

- the platform module
- the storage module
- the robot arm manipulator module
- the DC motor driver
- the sensing system
- the power supply module
- the controller
- the programming design.

1.3 Project Overview

The development process of the proposed robot is based on the block diagram as shown in Figure 1.1. The first step of the development process is discussed in detail in the game rules and a strategy is done based on the rules.

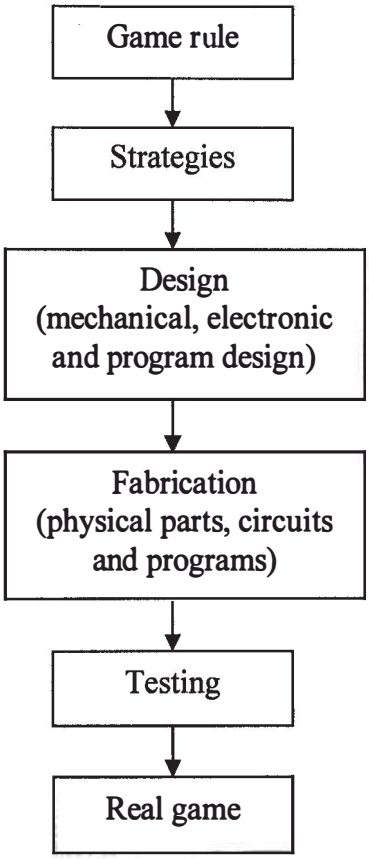

Figure 1.1: Development Process of the Proposed Robot

In the contest, each team can construct either or both the manual machines or the automatic machines, or both. There is no restriction on the number of machines. The machines must mount beach balls at the start of the game, and the number of balls is not restricted. The total weight of all machines must be less than 40 kg.