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DEVELOPMENT OF A WIRELESS PC-CONTROLLED MOBILE ROBOT SYSTEM AND MULTIMEDIA BASED LEARNING MODULE

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DEVELOPMENT OF A WIRELESS PC-CONTROLLED MOBILE ROBOT SYSTEM AND MULTIMEDIA BASED LEARNING MODULE

By

TARIQ SAAD MUJBER

Thesis Submitted in Fulfilment of the Requirement for the Degree of Master of Science in the Faculty of Engineering Universiti Putra Malaysia

April 2001

UPM

This work is dedicated to my beloved parents and wife

Abstract of thesis presented to the senate of Universiti Putra Malaysia in fulfilment of the requirement of the degree of Master of Science.

DEVELOPMENT OF A WIRELESS PC-CONTROLLED MOBILE ROBOT SYSTEM AND MULTIMEDIA BASED LEARNING MODULE

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April 2001

Chairman: Associate Professor Abdel Magid Hamouda, Ph.D.

Faculty: Engineering

Autonomous mobile robots, which are required to operate safely in ill-defined, complex and time varying environments, are essential elements in achieving improved performance and flexibility in manufacturing.

In this thesis, a mobile robot system was designed and fabricated. The system consists of two main sections; namely; system hardware and system software. The system hardware includes motion system, receiver and transmitter, and video camera, all these components are controlled wireless using personal computer. The main purpose of the video camera is to enable the user to monitor the movement of the mobile robot system.

The system software includes the development of a user-friendly and flexible interface control code named PC-Mobile Robot Control (PC-MRC). The code has been developed using Object-Oriented Programming Language and Graphic User Interface. The developed control algorithms enable the user to control the mobile robot manually, automatically or by voice recognition commands. There are three ways to control the mobile robot manually (Manual Run, Path Run and Paths Run). For automatic-run, the mobile robot can be controlled using two ways (Run File and Timer). Voice recognition control is also installed and commissioned in the developed robot system.

The developed control software has been tested by running experimental movements of the robot in two different directions (forward and backward) and the time and the velocity were recorded. Three different types of motion systems (tracks, legs, wheels) were tested. It has been found that in all motion system types, the backward movement is faster than the forward movement by a range of 2% to 5.5%. It has also been found that in both movements (forward and backward) the wheels motion system is faster than the tracks and legs motion systems.

Multimedia technology provides a valuable resource to enhance the teaching and learning experience. The ability to combine practical applications and visualization is among the advantages of technology based training and teaching. In this study a multimedia module for robot teaching and training was developed and implemented using Macromedia Director 7 as authoring tool. The multimedia

module is divided into three main sections, which are automation, robotics and mobile robot systems. The mobile robot section shows the fabrication of the mobile robot, construction of gripper arm and some video of the movement of the mobile robot system.

The implementation of this multimedia-based learning for robot technology will help to enhance the learning abilities of the engineering students. Hence, it will help to complement the subject and its understanding.

Abstrak tesis yang dikeumukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Master Sains

PEMBANGUNAN SISTEM KAWALAN KOMPUTER PERIBADI ROBOT BERGERAK TANPA WAYAR DAN MODUL PEMBELAJARAN BERASASKAN MULTIMEDIA

Oleh

Tariq Saad Mujber

April 2001

Pengerusi: **Professor Madaya Dr. Abdel Magid Hamouda, Ph.D.**

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Robot Bergerak peka dikehendaki untuk beroperasi dengan selamat, komplek dan dalam pelbagai keadaan persekitaran adalah merupakan unsure yang penting dalam meningkatkan prestasi dan kesesuaian dalam bidang pembuatan

Dalam tesis ini, satu system robot bergerak telah direka dan dihasilkan. Sistem tersebut terdiri daripada dua bahagian iaitu sistem perkakasan dan sistem perisian. Sistem perkakasan terdiri daripada sistem pergerakan, penerimaan, penghantaran dan kamera video. Komponen-komponen tersebut dikawal tanpa wayar melalui komputer peribadi. Penggunaan kamera video adalah untuk membolehkan pengguna mengawal pergerakan sistem robot bergerak.

Sistem perisian terdiri daripada pembangunan kod antara muka pengguna dan mudah lentur yang dikenali sebagai Komputer Peribadi-Kawalan Robot Bergerak. Kod tersebut dibangunkan menggunakan bahasa pengaturcaraan berorientasikan objek dan antara muka pengguna Grafik. Pembangunan algoritma terkawal membolehkan pengguna mengawal robot bergerak secara manual, automatik atau melalui arahan pengecaman suara. Terdapat tiga cara untuk mengawal robot bergerak secara manual (Manual Berlari, Lorong Berlari, dan Lorong Berjalan). Bagi automatik berlari, robot bergerak boleh dikawal dengan dua cara iaitu (Fail Berlari dan Masa). Kwalan Pengecaman Suara dimasukkan dalam membangunkan sistem robot.

Pembangunan perisian terkawal telah diuji secara eksperimen terhadap pergerakan robot dalam dua arah yang berbeza iaitu (ke hadapan dan belakang) dan masa serta halajunya direkodkan. Tiga jenis sistem pergerakan yang berbeza (jejakan, kaki dan roda) telah diuji. Hasilnya menunjukkan kesemua sistem pergerakan ke belakang adalah lebih laju berbanding dengan pergerakan ke hadapan sekitar 2% hingga 5.5%. Bagi pergerakan ke hadapan dan ke belakang, sistem pergerakan beroda lebih laju berbanding dengan sistem pergerakan jejakan dan kaki.

Teknologi Multimedia merupakan satu sumber yang berguna untuk meningkatkan pengalaman pengajaran dan pembelajaran. Kebolehan untuk menggabungkan aplikasi praktikal dan penglihatan adalah satu kelebihan bagi teknologi berasaskan latihan dan pengajaran. Satu modul multimedia untuk pengajaran dan latihan robot

telah dihasilkan menggunakan Macromedia Director 7. Modul multimedia itu terbahagi kepada bahagian iaitu automasi, robotik dan sistem robot bergerak. Sistem Robot bergerak menunjukkan penghasilan robot bergerak, pembinaan lengan pemegangan dan beberapa video daripada pergerakan sistem Robot Bergerak.

Implementasi Asas Pembelajaran Multimedia untuk teknologi robot telah membantu meningkatkan keupayaan pembelajaran di kalangan pelajar Kejuruteraan. Ini membantu melengkapkan pemahaman dalam subjek tersebut.

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I certify that an Examination Committee met on 28th April 2001 to conduct the final examination of Tariq Saad Mujber on his Master of Science thesis entitled "Development of a Wireless PC-Controlled Mobile Robot System and Multimedia Based Learning Module" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work expect for the quotations and citations, which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

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CHAPTER 1

INTRODUCTION

1.1 Importance of Study and Justification

Robots in general and mobile robots in particular have long been a fascinating subject. Making progress toward autonomous robots is of major practical interest in a wide variety of application domains, including: factory automation, where mobile robots carry out transportation tasks; operations in hazardous environments, including deployment of mobile robots in mine excavation, for inspection purposes inside nuclear or chemical facilities; planetary and space exploration; deep-sea surveying; military applications etc. It is also of great technical interest in various fields of computer science and AI, computer vision, process control etc. because it raises challenging and rich computational issues from which new concepts of broad usefulness are likely to emerge.

As a class of robotics system, autonomous mobile robots constitute one of the important steps in the evaluation of robotic intelligence and structure. The property of "autonomy" is understood as the ability to independently make intelligent decisions as the situation changes. Such ability is possible if intelligence allows a creation level of independence i.e. if the general goal of motion is formulated by human-operator, the specificities of the particular motion are taken care of by the robot with no direct involvement of human. Autonomous mobile vehicles can be

considered as the ultimate goal for the joint area of automatic control and artificial intelligence, which is now called "intelligent control". [1]

Robot technology is offered as a core subject to students pursuing their Bachelors in Manufacturing Engineering. For many years, student have found it difficult to "enjoy" this subject due to its passive delivery and lecturers have been unable to "liven" the subject due to its dry contents. This may has a detrimental effect on engineering students, as robot technology is fundamental in engineering. Being an important, it is ironic that students tend to neglect the importance of mastering its basic principles due to its nature. This was one of the motivating factors behind this work.

Recently, robot technology undergraduate courses throughout the world are experiencing much pressure to be both more efficient and effective. Also there are moves in education to encourage learning as opposed to teaching, in an attempt to make the educational process more active rather than passive. Many of these difficulties may be overcome by the use of Computer-Based tutorial programs, which use Multimedia techniques. Multimedia Technology provides a valuable resource to enhance the teaching and learning experience. The ability to combine practical applications, visualization of complete mathematical and abstract subject, visual labs is among the advantages of technology-based education.

In this work an overview of some of the basic consideration of multimedia courseware are discussed and presented. This includes description of the common types of digital media and their formats. Methods of course distribution are also discussed with emphasis on dissemination on CD-ROM. This work also describes the main features of several multimedia tutorials for robot technology education. The Robot Technology CD-ROM includes lessons on automation, robot definition and historical perspective, robot applications and characterization. Several virtual robot kinematics and movement are also developed using virtual reality software. Also, in this work, a mobile robot system was designed and fabricated. The system consists of two main sections; namely; system hardware and system software. The mobile system has been integrated within the Multimedia module to enhance the student learning process, make the subject more interesting and appealing, and encourage the students to be more innovative. It is hoped that the implementation of this multimedia-based learning for robot technology will help to enhance the learning abilities of the engineering students. Hence, it will help to complement the subject and its understanding.

1.2 Objectives

The objectives of the present study can be summarized as follows:

(i) To design and fabricate a Wireless PC Controiled Mobile Robot.

(ii) To develop and implement a user-friendly interface for the Mobile Robot Control (PC-MRC).

(iii) To develop a multimedia module for Robotics teaching and training.

1.3 Thesis Layout

This thesis is divided into five chapters. Chapter one gives the importance of study, the aims and objectives of the project. Chapter two gives a comprehensive and critical background about robot technology, robot characteristic, applications, control languages, sensors and navigation system. Chapter three is divided into two main sections, first section is devoted to the development of a wireless PC controlled mobile robot, while the second section discusses the development stages of the multimedia module for robotics teaching and training. Chapter four is devoted to the analysis and discussion of results. Finally in chapter five, conclusions are drawn and recommendations for future work are suggested based on the present study.