UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF WIRELESS VOICE ACTIVATED ROBOT SYSTEM

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

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ABSTRAK

Tujuan projek ini adalah untuk membangunkan satu sistem suara robot diaktifkan tanpa wayar. Teknik panduan yang dicadangkan adalah sistem kawalan robot mudah alih tanpa wayar yang menggunakan sistem pengenalan suara untuk mencetuskan dan mengawal pergerakannya. Robot mudah alih bertindak balas kepada arahan suara dari pengguna untuk melaksanakan apa-apa fungsi pergerakan. Sistem kawalan suara tanpa wayar yang diaktifkan berkomunikasi dengan menggunakan dua peranti tanpa wayar yang dibahagikan kepada unit pemancar tanpa wayar dan unit penerima tanpa wayar. Dengan melaksanakan sistem itu, pengguna boleh mengendalikan robot mudah alih dengan hanya bercakap melalui mikrofon tanpa wayar. Fungsi pergerakan robot mudah alih termasuk depan dan belakang, belok kiri dan ke kanan, dan berhenti. Pengguna perlu melatih perkataan yang dituturkan bagi memastikan pemproses pengenalan boleh mengenali perkataan yang dituturkan. Perlaksanaan unit pengenalan suara untuk mencetuskan dan mengawal pergerakan robot dapat menggantikan kaedah navigasi konvensional. Robot dapat melakukan pergerakan yang dikehendaki ketika menjawab arahan suara dari pengguna melalui mikrofon yang mengurangkan keperluan aktiviti tangan. Sistem pengecaman suara telah direka sebagai perseorangan dan boleh digunakan oleh seorang pengguna sahaja. Keputusan daripada satu siri ujian telah membuat kesimpulan bahawa sistem pengawal suara diaktifkan tanpa wayar adalah kaedah navigasi yang boleh dipercayai. Analisis fungsi keseluruhan menunjukkan prestasi sistem pengawal apabila mengemudi robot bergerak melalui laluan yang ditetapkan.

ABSTRACT

The purpose of this project is to develop a wireless voice activated robot system. The proposed guidance technique is a wireless mobile robot control system which employs a voice recognition system for triggering and controlling all its movements. The mobile robot responds to the voice command from its user to perform any movements functions. The wireless voice activated controller system is communicating using two wireless devices which are divided into wireless transmitter unit and wireless receiver unit. The wireless transmitter unit was a combination between a microphone, a voice recognition unit, a microcontroller unit and a wireless module; while the wireless receiver unit was a combination between another one microcontroller unit and a wireless module. By implementing the system, the users are able to operate the mobile robot by simply speak through the wireless microphone. The movement functions of the mobile robot includes forward and reverse, turn left and turn right, and stop. The user need to trained the word spoken out in order to make sure the recognition processor can recognize the spoken words. The implementations of voice recognition unit for triggering and controlling the mobile robot movement can replace the conventional navigation method. The mobile robot can perform the desired movement when responding to the voice command from its user through a microphone that reduces the need of hand activities. The voice recognition system was designed to be dependent and can be used by one user only. The results from a series of testing have concluded that the wireless voice activated controller system is a reliable method of navigation. The overall function analysis shows the performance of the controller system when navigating the mobile robot through a path line.

DEDICATION

This report is lovingly dedicated to my respective parent, Othman Bin Burhan and Chek Gayah Binti Nuri. An appreciation to my Supervisor, Dr. Fairul Azni Bin Jafar, lecturers and friends that have been my constant source of inspiration. They have given me the drive and discipline to tackle any task with enthusiasm and determination. Without their love and support this project would not have been made possible.

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AGV	-	Automated Guided Vehicle
LED	-	Light Emitting Diode
3G	-	Three Generation
FM	-	Frequency Modulation
RF	-	Radio Frequency
LGV	-	Laser Guided Vehicle
AGC	-	Automated guided carts
IEEE	-	Institute of Electrical and Electronics Engineers
WLAN	-	Wireless local area network
PC	-	Personal computer
PDA	-	Personal digital assistant
OS	-	Operating system
MBM	-	Map based mode
DDM	-	Direct drive mode

GPS	-	Global Positioning System
GIS	-	Geography Information System
IR	-	Infrared
RFID	-	Radio-frequency identification
PWM	-	Pulse-width modulation

CHAPTER 1
INTRODUCTION

This report presents the development and performance analysis of the wireless voice activated controller system for mobile robot, which is the main project proposed in this report.

1.1 Background

Figure 1.1: An example of mobile robot or Automated Guided Vehicle (AGV) (www.wheelomania.com, 2013).

A mobile robot is manually or automatically controlled by programming the robot to follow wires in the floor, markers, uses vision or laser as a navigation device for the robot. They are widely used in industrial applications for transporting materials around a warehouse or a manufacturing facility.

A mobile robot have many advantages compared to other types of material handling systems, including reliable, flexibility to changes in the material handling requirements, automatic operation, improved positioning accuracy, easily expandable layout and system capacity, reduced handling damage, and automated interfaces with other systems.

The first mobile robot was carried out to market in the 1950s, by Barrett Electronics of Northbrook, Illinois, where at that time it was simply a tow truck that navigating to follow a wire in the floor. The technology is now has become more sophisticated and today automated vehicles are mainly laser navigated, LGV (Laser Guided Vehicle) (Sharma M., 2012).

A mobile robot uses vehicle guidance technology to define path ways and to control it movement to follow the pathway. Based on latest technology, there are some example of guidance technology such as laser guidance system (LGVs), wire guidance, magnetic guidance, tape guidance or line follower, and etc. The example of a mobile robot is shown in Figure 1.1.

1.2 Motivation

The rapid growth of technology has introduced the voice recognition system that has been implemented in many applications. Nowadays, the voice recognition system became more popular in use as voice based remote control to control various mobile robot and home appliances.

The wireless voice activated controller system is a new vehicle guidance technology that has been proposes to improve the mobile robot control. Before this, a mobile robot uses laser guidance system (LGVs), wire guidance, magnetic guidance, tape guidance or line follower, and etc. to control its own movement. However, this guidance system has some disadvantages. For example, the use of line follower guidance system to follow the tape or paint strips have weaknesses where the tape or paint strips can easily get dirty or damage when being embedded in high traffic areas. This problem will affect the accuracy and efficiency of the mobile robot movement.

Based on the problem, a new controller system which employs a voice recognition system is to be designed for triggering and controlling all the mobile robot movements. The mobile robot responds to the voice command from its user through a wireless transmission to perform any movement functions. This control system integrates a microcontroller, voice recognition processor, wireless communication unit and microphone to control the mobile robot according to the user command. The user can simply speak to the microphone to operate the mobile robot from a distance.

1.3 Problem Statement

The first problem is the use of line follower to control the mobile robot by navigating the mobile robot to follow a tape or paint strips that have a draw back where the tape or paint strips may become damaged or dirty when the mobile robot is being embedded in high traffic areas. This may affect the sensitivity of the line follower sensor to follow the line accurately and may resulting lost track. The line need to be clean or repaint frequently to maintain the mobile robot movement. With the presence of the wireless voice activated controller system, the mobile robot can be control by simply using voice command wirelessly without following any line or paint strips. The user can choose any available route to navigate the mobile robot to any location.

Second problem is the use of human body (hand) to operate the conventional remote controller is an old navigation method that needs a lot of hand activities. Furthermore, each human has their own capabilities and limitation that makes them difference with each other's. This dissimilarity produces difference efficiency between human in operating the conventional remote control. When operating conventional remote control, a human need a lot of hand activities to control the mobile robot efficiently. Thus, it is believed that the mobile robot can be controlled without any assistance of hand activities when using the wireless voice activated controller system.

1.4 Project Objectives

- To develop a wireless voice activated controller system for a mobile robot.
- To analyse the performance of the wireless voice activated controller system.

1.5 Project Scopes

- The basic functions of the wireless voice activated controller system for mobile robot includes, Forward and Reverse Movements, left and right turns, as well as STOP function.
- The mobile robot will be controlled wirelessly through a microphone.
- The voice recognition system is designed for speaker dependent (one user) applications. This means the mobile robot can be controlled by one user only. If the users change, the system need to be reprogramming based on the new users voice.
- The connectivity range between transmitter and receiver of the wireless voice activated controller system will not be covered in this project.
- The ability of the wireless voice activated controller system to recognize the command word even in the presence of the background noise will not be discussed in this project.

1.6 Report Structure

This report consists of five chapters.

Chapter 1 shows the introduction of mobile robot and its vehicle guidance technology, background and brief history, the problem statement of the project, project objectives and scopes.

Chapter 2 explain the literature review of this project, includes the current and previous research that related to this project.

Chapter 3 propose some ideas on how the project will be implemented. The chapter will lists out the steps and methods involved in each process of the project. This methodology includes the software and hardware design and explanation on overall system theory of operation for the development of the wireless voice activated controller system for the mobile robot.

Chapter 4 provides the result and analysis of data based on system evaluation. It discusses on how the data are taken in order to analyse the performance of the wireless voice activated controller system.

Chapter 5 expresses the conclusion of the whole project and gives suggestions for future work improvements.

CHAPTER 2
LITERATURE REVIEW

This project is focusing on the development of wireless voice activated controller system for mobile robot. Section 2.1 of this report will explain the introduction of vehicle guidance technology of mobile robot, section 2.2 will explain about traditional navigation method and problem in navigation of mobile robot; section 2.3 will explain about the current navigation method of mobile robot, section 2.4 will explain about the propose project of wireless voice recognition based remote control for mobile robot, and lastly, section 2.5 summary of this chapter.

2.1 Vehicle Guidance Technology of Mobile Robot

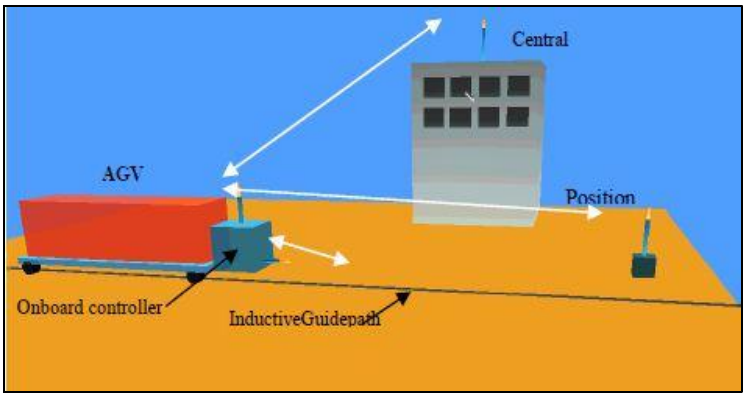

Figure 2.1: Sketch of a basic mobile robot system using fixed path guidance technology (Kelly *et al*., 2011).

K. Anitha *et al*. (2013) states that Vehicle Guidance Technology (VGT) shows the path ways and guide vehicles to follow the pathway.

AGV guidance systems have been growing for about 50 years. Kelly *et al*. (2011) defined that there are three guidance methods that have been popular over the time. Wire guidance is one of the guidance technologies which use wires embedded in the floor that are sensed inductively to determine vehicle position with the help of the wire. This in an oldest technology that is not used much today. Other guidance technology is inertial guidance that uses gyroscope and wheel odometer (measurement of distance travelled). This navigation technique is used to implement very accurate dead reckoning. Magnets are placed in the floor at regular intervals to be used to reset the unavoidable drift of the dead reckoning system. Laser guidance is the latest guidance technology that uses a spinning laser emitter- receiver that is mounted on the vehicle. It sense the bearings to retro reflective landmarks placed accurately in the facility and then it triangulates an accurate solution. Examples of fixed path guidance technology include rail tracks, embedded wires or other type of guide-ways (see Figure 2.1).

Today modern AGV systems do not use fixed guide-paths. The guide-paths may be computer-programmed and transferred to the vehicle's controllers. These vehicles are free-ranging and can find their path using optical (laser), magnetic, odometer, gyroscope, vision, or radio- frequency techniques (Tompskins *et al*., 2003).

An issue problem in the guide-path design is selecting a suitable type of guide-path system, but a guideline to select an appropriate guide-path system is not available yet. The conventional guide-path system can be seen regularly in warehouses and distribution centres (Koster *et al*., 2004).

AGV navigation methods include tape guide path, wire guide path, optical guide path, and off-wire guidance. In the wire navigation technique, wires with varying frequencies are buried in the floor. AGV choosing a path at a control point by referring to the assigned frequency. In the optical navigation technique, an AGV focuses a beam of light on a reflective tape or a painted strip and follows the path by calculating the amplitude of the reflected light (Yew *et al*., 2001).

2.2 Traditional Navigation of Mobile Robot

The guidance technique can be selected based on the type of mobile robot selected, its application, requirement and environmental limitation. Some of the significant guidance techniques include:

2.2.1 Wire Guidance

In wire navigation, a wired sensor is placed on the bottom of the AGV by facing to the ground. Then, a slot is cut in the ground approximately about 1 inch below the ground to place an energized wire. A radio frequency will be transmitted from the rooted wire and allows the sensor to detect the wire and then follows the path. This guidance technique is an earlier technology which is not used much today (Kelly *et al*., 2011).

Davich T. (2010), states that the key to an AGV lies within the guidance system. Methods in tracks or floor markings, such as painted lines or glued on reflective tape, can be used as a guidance system for AGV. The method that cause permanent track is not desirable and continuous wear on markings can cause system reliability issues.

Clayton (1983) explained in detail the methods of wire guidance. Firstly, the suitable route for the automated guided vehicles is selected and a groove approximately 2mm/3mm wide and 15 to 20mm deep is cut by using a circular disc cutter. Then, a plastic coated copper wire is place inside the groove and grouted in. A high frequency transmitter will feed the wire with a 10 KHz alternating current which produces a magnetic field that measured by the AGVs controller and then defined its route instructions. The control system for an AGV based on wire guidance can be seen in Figure 2.2.