UNIVERSITI TEKNIKAL MALAYSIA MELAKA

VISION-BASED LINE FOLLOWING ROBOT

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

by

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTEM as a partial fulfillment of the requirements of the degree of Bachelor Of Manufacturing Engineering (Robotic and Automation) with Honors'. The member of the supervisory committee is as follow:

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ABSTRACT

Nowadays, technology grows rapidly including the development of the robot. This project will explore the technology behind vision-based application to control the movement of the robot. The aim of this project is to develop the vision-based line following robot. The robot will detect and follow the line image that will be captured by a camera attached to the robot. Camera that used to capture line image is mounted on the top of the robot. Moreover, combination of hardware and software plays an important role along this project. Therefore, one of the objective of this project is to use the C++ platform and Visual Basic to process the line image. The line image had to be process through a series of functions to convert into a binary form. Meanwhile, Micro C is used to process the output from Visual Basic so that Microcontroller (PIC) can read the instruction. Once the microcontroller received signal from the PC, it will actuate respective motor in order to make the robot move along the line.

ABSTRAK

Saat ini, teknologi berkembang pesat termasuk pembangunan robot. Projek ini akan menjelajah teknologi aplikasi berasaskan visi untuk mengendalikan gerakan robot. Tujuan dari projek ini adalah untuk membangunkan garis visi yang berpusat robot berikut. Robot ini akan mengesan dan mengikuti garis gambar yang akan ditangkap oleh kamera yang melekat pada robot. Kamera yang digunakan untuk menangkap gambar garisan yang telah dipasang di bahagian atas robot. Selain itu, gabungan dari peranti keras (hardware) dan peranti lembut (software) memainkan peranan penting di sepanjang projek ini. Oleh kerana itu, salah satu tujuan daripada projek ini adalah menggunakan landasan C + + dan Visual Basic untuk memproses gambar garisan yg telah ditangkap.

Gambar garis harus melalui proses siri fungsi-fungsi untuk menukarkan ke dalam bentuk binari. Sementara itu, Micro C digunakan untuk memproses keluaran (output) dari Visual Basic sehingga Microcontroller (PIC) dapat membaca arahan yang ada. Setelah microcontroller menerima isyarat dari PC, maka akan mendorong motor masing-masing dalam rangka untuk membuat robot bergerak sepanjang garis.

DEDICATION

This thesis is gratefully dedicated to my family and all my friends.

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Assalamualaikum and I am grateful to God that finally I complete the PSM 1 and PSM 2 on building and designing a vision-based line following robot. First and foremost, I would like to express my appreciation and deep respect to my supervisor, Mr. Mohd Nazrin bin Muhammad for the guidance and encouragement through out the progress in completing this project.

Secondly, I want to thank my lovely mother and my late father because supporting me to continue this study. With prayers and moral support from both of them, I have gained strength to endure in this study. I also want to thank UTeM management especially from the Faculty of Manufacturing because they give me the opportunity to get more experiences and knowledge during the period of the research. Special thanks to my friends that share their idea and advice in completing my project. Their support and encouragement in my project have helped me in various aspects. Without their help, this project would very difficult to complete and it will take a long time to finish.

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Thank you.

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CHAPTER 1

INTRODUCTION

Nowadays robot has been widely used in various fields like industries, academic, research and development, militaries and others. This chapter defines the robot, the project on vision based line following robot. There are objective and scope of project those give the direction to successfully this project. The project is to build a line following line robot that has capability to following the line. Others the robot will attach visual system that human able to monitor the robot vision using computer.

1.1 Background

Nowadays, we have many advance technology in the world. One of the advance technologies is a robotic. The field of robotics is growing rapidly. It has been estimated that during the years 2006–2009 about 5.6 million units of service robots for personal use will be introduced. The number of professional service robots has also been estimated to increase. To perform effectively in real-world settings, robots must be able to plan and execute tasks in the presence of uncertainty. Typical sources of uncertainty in a robotic work cell include limited sensing accuracy, errors in dynamic models, and discrepancies between geometric object models and physical objects (including the parts to be manipulated and the robot itself).

Because of this, the application of robotic technology to manufacturing problems has typically been restricted to situations in which uncertainty can be tightly controlled (for example, by using specialized featuring devices). In order for mobile robots to walk around in a dynamic environment, the robots must detect the changes of the environment in real time. Visual information is the most significant information to detect the changes. Especially when the mobile robots must react with a rapidly changing environment, a fast image processing system like a human brain is indispensable. To increase the performance of this vision, the performance analysis should be doing.

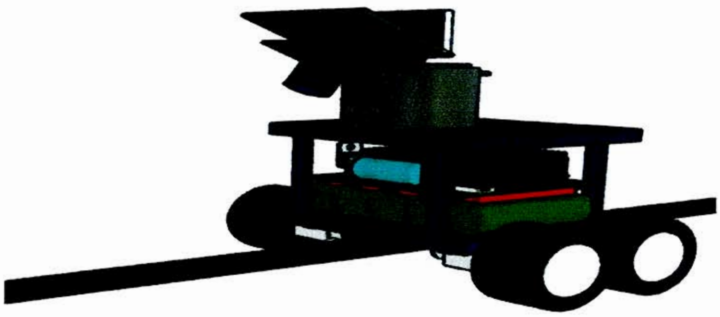

Figure 1.1: Line following robot

Line-following robots are popular among robotics hobbyists because these types of robots can be relatively simple to build, and yet is very entertaining as they follow whatever size path you lay out for them. Unlike room-exploration robots that often get stuck against chairs and carpet edges, you don't have to chase after a well-designed line-following robot.

1.2 Robots

Robots have increasingly being used in industries, especially in manufacturing and assembling in major industrialized countries. There are some advantages of using robot, they are:

(a) Reduce labour cost.

(b) Improved the work quality.

(c) Elimination of dangerous or undesirable jobs.

(d) Controlled and faster inventory.

(e) Increase precision.

Robot that are capable to perform complicated motion and have external sensor such as vision, tactile or force sensing are required for a more complicated applications such as welding, painting, grinding and assembly. This is because these operations resulted in the increase of interaction between the robot and its surrounding.

A robot by definition is a machine that looks like a human being and performs various complex acts, walking and talking of a human being. It is also defined as fictional machine whose lack of capacity for human emotions is often emphasized. By general convention a robot is a programmable machine that imitates the actions or appearance of an intelligent creature such as human.

From the Robot Institute of America, robot is defined:
"A robot is a programmable multifunctional manipulator designed to move material, part, tools or specialized device through variable programmed motion for the performance of a variety of tasks."

British Robot Association (BRA) defines robot as:
"A programmable device with a minimum of four degrees of freedom designed to both manipulate and transport parts, tools or specialized manufacturing implements through variable programmed motion for the performance of the specific manufacturing task" (Al Salameh, 2000)

1.3 Problem statement

The current design of robot following line will be replaced with the robot that uses vision system to follow lines. Line following robot are actually able to execute tasks using specific landmarks or other systems which give global localization. However, without these systems, powerful perception systems are required to allow them to navigate. Vision is a type of sensor that is nowadays broadly used. Literally, a webcam will take an image of the line and the system will process the image with a special algorithm. Then, it will transmit a signal to a microcontroller through the serial cable. Based on the signal, the microcontroller will actuate the motors to so that the robot will move either in forward, left or right direction.

1.4 Objective

There are three main objectives in this project.

(a) The first objective of this project is to study the feasibility to develop a vision-based line following robot.

(b) Secondly is to develop the line following robot based on the vision system.

(c) The third objective is to assess the performance of vision-based compared to sensor-based line following robot.

1.5 Scope

The following are the guidelines that listed to ensure the project is conducted within its boundary of mechanical hardware modification, electronics including sensors and programming. This is to ensure the project is heading in the right direction to achieve its intended objectives.

The scope is to build a line following robot with following the line. The line is black and white. To build a robot with ability to following line, a webcam is needed.

There are many type of webcams. But, for this project, the laptop webcam has been chosen as the vision sensor.

To build vision algorithm in order to detect line, to interface and do handshaking task between program and robot, to develop simple mobile robot that can manoeuvre forward, left and right, to set up the suitable track consists of lines where the robot can operate on. The other scope is the line following robot is only can detected only one line in one time. The line of the robot movement has no specific length.

CHAPTER 2

LITERATURE REVIEW

Conducting the literature review is done prior to undertaking the project. This will critically provide as much information as needed on the technology available and methodologies used by other research counterparts around the world on the topic. This chapter provides the summary of literature reviews on topics related to line following robot or robot that has capability to survey the environment via wireless vision system including autonomous robot.

2.1 Autonomous Robot

Autonomous robots are robots which can perform desired tasks in unstructured environments without human guidance needed. Many kinds of robots have some degree of autonomy. Different robots can be autonomous in different ways. A high degree of autonomy is particularly desirable in fields such as space exploration, where communication delays and interruptions are unavoidable. Other more mundane uses benefit from having some level of autonomy, like cleaning floors, mowing lawns, and waste water treatment. Some modern factory robots are "autonomous" within the strict confines of their direct environment.

Maybe not every degree of freedom exists in their surrounding environment but the work place of the factory robot is challenging and can often be unpredictable or even chaotic. The exact orientation and position of the next object of work and (in the more advanced factories) even the type of object and the required task must be determined. This can vary unpredictably (at least from the robot's point of view) [5].

One important area of robotics research is to enable the robot to cope with its environment whether this it is on land, underwater, in the air, underground, or in space. A fully autonomous robot has the ability as follow:

(a). Gain information about the environment.

(b). Work for an extended period without human intervention.

(c). Move either all or part of itself throughout its operating environment without human assistance.

An autonomous robot may also learn or gain new capabilities like adjusting strategies for accomplishing its tasks or adapting to changing surroundings [5].

2.1.1 Manual Remote or Tele-op

A manually tele-op robot is totally under control of a driver with a joystick or other control device. The device may be plugged directly into the robot, may be a wireless joystick, or may be an accessory to a wireless computer or other controller. A tele-op robot is typically used to keep the operator out of harm's way. Examples of manual remote robots include Foster-Miller's Talon and iRobot's PackBot.

2.1.2 Guarded Tele-op

A guarded tele-op robot has the ability to sense and avoid obstacles but will otherwise navigate as driven, like a robot under manual tele-op. few if any mobile robots offer only guarded tele-op.

2.1.3 Line-following Robot

Some of the earliest Automated Guided Vehicles (AGVs) were line following mobile robots. They might follow a visual line painted or embedded in the floor or ceiling or an electrical wire in the floor. Most of these robots operated a simple "keep the line in the center sensor" algorithm. They could not circumnavigate obstacles; they just stopped and waited when something blocked their path. Many examples of such vehicles are still sold, by FMC, Egemin, HK Systems and many other companies.

2.1.4 Autonomously Randomized Robot

Autonomous robots with random motion basically bounce off walls, whether those walls are sensed with physical bumpers like the Roomba cleaners or with electronic sensors like the Friendly Robotics lawn mower. The simple algorithm of bump and turn 30 degrees leads eventually to coverage of most or all of a floor or yard surface.

2.1.5 Autonomously Guided Robot

An autonomously guided robot knows at least some information about where it is and plans its path to various goals and or waypoints along the way. It can gather sensor readings that are time- and location-stamped, so that a hospital, for instance, can know exactly when and where radiation levels exceeded permissible levels. Such robots are often part of the wireless enterprise network, interfaced with other sensing and control systems in the building. For instance, the PatrolBot security robot responds to alarms, operates elevators and notifies the command center an incident arises. Other autonomously guided robots include the SpeciMinder and the Tug delivery robots for hospital labs.

2.1.6 Sliding Autonomy

More capable robots combine multiple levels of navigation under a system called sliding autonomy. Most autonomously guided robots, such as the HelpMate hospital robot, also offer a manual mode. The ARCSinside control system, which is used in the ADAM, PatrolBot, Speci-Minder, MapperBot and a number of other robots, offers full sliding autonomy, from manual to guard to autonomous modes.

2.2 Line Following Robot

Line following is one of the autonomous robot type. This type of robot is the most basic function for autonomous robot. This robot consist IR sensor that use as the indicator for the robot to follow the line at the given colour and if the robot out the line colour, the robot will researching the line.

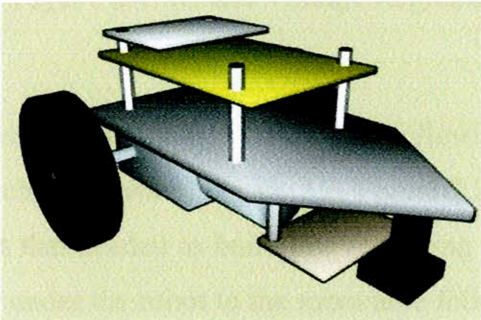

Figure 2.1: Line Following Robot

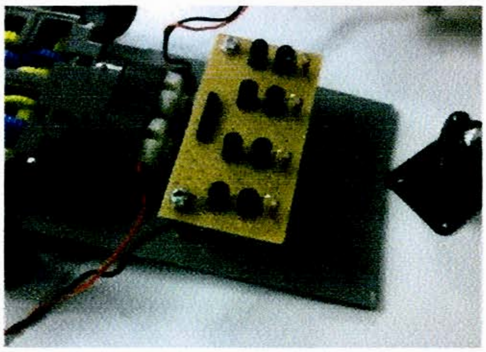

Figure 2.2: IR sensor Placement

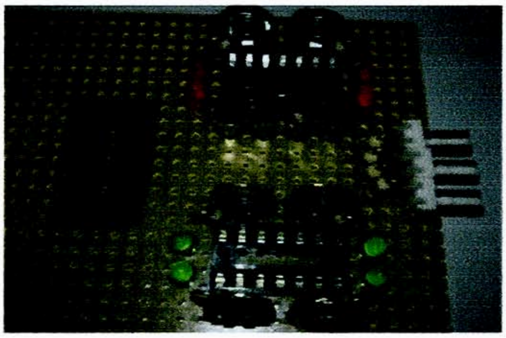

Figure 2.3: Comparator Board