MOBILE ROBOT FOLLOWING OBSTACLE AVOIDANCE AND COLLISION

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DEDICATION

Dedicated to my parents, Pathil Bin Hj Abdul Rahman and Lijah Binti Yusoff, my sister Nur Arafah Binti Pathil, my wife Lina Mastura Binti Jasmawi, my sons Muhammad Aliff Nasyraff, Muhammad Amirr Nasymarr and Muhammad Aniqq Nasyhaqq, my supervisor Engr. Khairuddin Bin Osman, and not forgotten to all my friends.

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ABSTRACT

Nowadays, various robots are built to perform multiple tasks. Multiple robots working together to perform a single task becomes important. One of the key elements for multiple robots to work together is the robot need to able to follow another robot. This project is mainly concerned on the design and construction of the robot that can follow another robot. In this project, the follower robot is the robot that follows the robot and the leader robot is the robot being followed. The follower robot can follow leader robot using analog distance sensors. Analog distance sensors are installed in the follower robot to obtain the relative position of the leader robot. Besides, the follower robot also can avoid the collision with the leader robot when perform the task following. Follower robot always maintains a safety distance from the leader robot to avoid the collision with leader robot. Furthermore, the follower robot is also equipped with infrared sensors to detect and avoid obstacles around the environment when perform the task following. The follower robot can perform the following task better with the obstacle avoidance feature.

ABSTRAK

Pada masa kini, pelbagai robot dibuat untuk melakukan pelbagai tugas. Keperluan untuk pelbagai robot bekerjasama untuk melakukan satu tugas menjadi penting. Salah satu elemen yang penting bagi robot-robot untuk bekerja bersama adalah kemampuan untuk mengikut robot lain. Projek ini fokus kepada reka bentuk dan pembinaan sebuah robot yang boleh mengikut robot yang lain. Dalam projek ini, robot pengikut adalah robot yang mengikut robot lain dan robot pemimpin adalah robot yang diikuti. Robot pengikut dapat mengikuti robot pemimpin dengan menggunakan sensor jarak analog. Sensor jarak analog dipasang pada robot pengikut untuk mendapatkan kedudukan relatif robot pemimpin dari robot pengikut. Selain itu, robot pengikut juga boleh mengelakkan pelanggaran dengan robot pemimpin ketika mengikuti robot pemimpin. Robot pengikut selalu akan berada pada jarak selamat daripada robot pemimpin untuk mengelakkan pelanggaran dengan robot pemimpin. Selain itu, robot pengikut juga dilengkapi dengan sensor infra-merah untuk mengesan dan mengelak pelanggaran dengan halangan di sekitar laluan ketika mengikuti robot pemimpin.

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CHAPTER I

INTRODUCTION

1.1 Background

Nowadays, robots are built to perform multiple tasks with different level of complexity. There are some situations that require multiple robots to perform a single task. When these situations are required, the robots are required to cooperate with each other. One of the key elements for the multiple robots to work together is that the robot need to able to follow other robot or human. This element leads to the study of the leader and follower behavior.

Basically, the leader in leader/follower behavior is the target that is followed by the other robot (follower). The leader (target) can be either human or robot. The follower, which is a robot, need to follow the leader autonomously. The task of this behavior is called task following.

When a robot (follower) performs a task following, the most important thing for the follower is to be able to obtain the position of the target (Leader). The follower must be able to obtain its current position relative to the target before it makes decision on how to follow the target. “Localization” or knowledge of its current location is calculated by one or more means, using sensors such as motor encoder, vision, laser or sonar sensors. There are many vision systems being built to track and follow the target effectively. The method can be seen in [1], [2], and [3].

The visual tracking system installed on the follower enables the follower to follow the leader robustly in a variety of environment. Despite this advantage, there are quite a number of disadvantages for using vision system. One of the main disadvantages of the vision system is that it is costly to build. This is due to the high computational power required to process the raw data obtained from vision sensor. This reason makes the vision tracking system less preferable to be used.

1.2 Robot

A robot [6] is a mechanical or virtual artificial agent. In practice, it is usually an electro-mechanical system which, by its appearance or movements, conveys a sense that it has intent or agency of its own. The word robot can refer to both physical robots and virtual software agents, but the latter are usually referred to as bots. There is no consensus on which machines qualify as robots, but there is general agreement among experts and the public that robots tend to do some or all of the following: move around, operate a mechanical arm, sense and manipulate their environment, and exhibit intelligent behavior, especially behavior which mimics humans or animals.

1.3 Project Objective

The main objective of this study is to design and construct an autonomous robot. It is two identical mobile robots. It means that the robots are communicating to each other and will collaborate to accomplish specific task given. Each robot is equipped with infrared sensors to detect and avoid obstacles around the environment when perform the task following.

The second objective is to integrate the concept of collision avoidance into the leader/follower behavior. The follower can follow the leader effectively. Besides, the follower can follow the leader when the distance between them is too close.

The last objective of this project is to improve the capability of the robot in performing the following task smoothly by using different approaches compare to the previous projects.

1.4 Problem Statement

It is an increased in research interest in systems composed of multiple autonomous mobile robots exhibiting cooperative behaviour. Groups of mobile robots are constructed, with the aim to studying such issues as group architecture, resource conflict, origin of cooperation, learning, and geometric problems.

As yet, few applications of cooperative robotics have been reported, and supporting theory is still in its formative stages. One of the main tasks for cooperative wheeled mobile robots is the object (target) following task, which usually represents to follow another robot. Also, the following task is important for the wheeled mobile robots in and the target can be static or a dynamic object.

There are many problems arise when designing a robot to perform a following task. These problems include robot may looses or hits the target being followed. Besides, the robot may also choose not to follow the desired object and goes after another detected object from the environment in a dynamic environment.

1.5 Project Scope

The scopes of this project are:

i. The design and construct an autonomous robot.
ii. Study the concept of collision avoidance into the leader/follower behavior.
iii. Study the capability of the robot in performing the following task smoothly.
iv. Learn about Basic Compiler Programming for interaction between the Leader Robot and the Follower Robot using PIC.
v. Learn more about MPLAB IDE, Proteus 7 Professional and OrCAD.
vi. Simulate and investigate the circuit for the leader robot and the follower robot.

1.6 Outline of Thesis

This thesis consists Five chapters. In chapter 1, it discuss about the objective and scope of this project. While Chapter 2 will discuss literature reviews that have been done. It well discuss about various type of robot, advantages and limitation for each of the robots.

In Chapter 3, the discussion will be on the methodology hardware and software implementation of this project. The result and discussion will be presented in Chapter 4. Last but not least, Chapter 5 discusses the conclusion of this project and future work that can be done.

CHAPTER II

LITERATURE REVIEW

2.0 Introduction

This chapter review some of the robots that were built to perform the task following. The advantages and disadvantages for each of the robot are also included in the review.

2.1 Low Cost Sensing for Autonomous Car Driving on Road

According to [1], a car-like robot equipped with a system called HANS shown in figure 2.1, is able to navigate in an autonomous and safe manner, performing trajectories similar to the ones carried out by human drivers. The system was successfully tested in both simulations and in a laboratory environment using a mobile robot to emulate the car like vehicle. As a result, this autonomous car can follow the front vehicle in curve road. Besides, this mobile robot also can follow the road, keeping the car in the right lane, maintaining safe distances between vehicles, and avoiding collision. For this mobile robot, it is assumed that there are no cars driving faster than the HANS vehicle which means that no cars will appear from behind.

Figure 2.1 HANS Vehicle [1]

HANS in [1] uses a low resolution web camera located in the centre of the vehicle behind the rear-view mirror and a set of sixteen sonar sensor. The key role of the camera is to act as a vision system. It is used to detect the side lines that bound 7 the traffic lanes, the position and orientation of the robot relative to these lines, and the vehicles driving ahead and determining their lane and distance to the robot.

The sixteen sonar sensor was arranged to build up a occupancy grid as shown in figure 2.2. This strategy is to reduce the influence of sonar reflections. Each sonar sensor will form up one cone and each cone is divided into zones. The distance of each zone is defined from the robot. Obstacles lying over a region of the occupancy grid contribute to the voting of the cells. The zone with the highest number of measurements (votes in a sense) is considered as being occupied by obstacle. Sonar sensors are also used to detect emergency stopping conditions. With combinational of camera and sonar sensor, the perception of environment also can be mapped for the robot making autonomous decision.

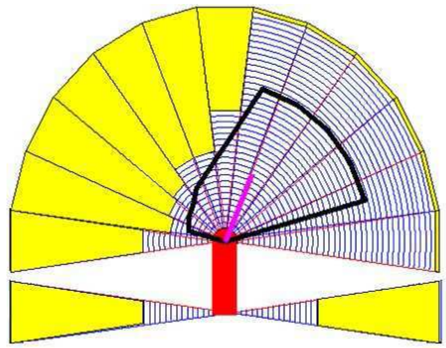

Figure 2.2 Occupancy Grid [2]

2.2 Raccoon

RACCOON is a vision-based system that tracks car taillights at night as described in [2]. The RACCOON system was developed at Carnegie Mellon University. The prototype was built and integrated with RACCOON system. This system enables the autonomous vehicle to chase the leading car effectively under low light condition. According to [2], this project was inspired by following reason:

a) The road cannot be seen clearly at night.

b) Unlit landmarks cannot be detected so corners and intersections have to be negotiated based solely on the observed actions of the lead vehicle at night.

Problems above make the following vehicle cannot detect the leading vehicle clearly at night using normal vision system and algorithm. In normal algorithm, the taillights can be easily extracted from a dark background. After the extraction, the autonomous car steers toward the taillight of lead vehicle. According to [1], the autonomous vehicle may follow the lead vehicle successfully with this algorithm.

However, this algorithm fails when lead vehicles turns to follow winding road. When this scenario occurs, the computer controlled may steer towards taillights of lead vehicle and then results in corner cutting. These problems can be solved by using RACCOON system.

Under RACCOON system autonomous car, the image sensor can build a global map in real time that contains the position of lead vehicle based on the location and separation of the taillights (taillights of car) in a sequence of video images. Only one color camera was used as sensor. According to [1], RACCOON is creating an intermediate map structure which records the lead vehicle's trajectory.

The path is represented by points in a global reference frame. After that, the computer controlled vehicle is steered from point to point to follow lead vehicle's trajectory. The autonomous vehicles can follow the lead vehicle at any desired speed to keep the lead vehicle's taillights in sight. Using this approach, the autonomous vehicle steers around corners and obstacles rather than through them.

2.3 Scale Invariant Feature Transform (SIFT) algorithm

In [3], a robot was constructed to follow human or another robot using the vision system. The vision system in this project utilized the SIFT algorithm as shown in figure 2.3. In this algorithm, the robot uses the feature extracted from the training image of target to track the target. Firstly, it uses the SIFT algorithm to recognize the target. After the target is recognized, it estimates the position of the target. Then it uses the PID controller to control the motor to maintain the minimum distance between the follower and the target.