OBSTACLE AVOIDANCE WITH 4WD RC ROBOT USING ULTRASONIC AND INFRARED SENSOR

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This report is submitted in partial fulfillment of the requirements for the award of Bachelor of Electronic Engineering (Industrial Electronics) With Honours

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Sesi Pengajian : 2004 / 2008

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Date	:.....8/05/08..

I dedicate this to both of my beloved parents, friends and electronic engineering education

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ABSTRACT

This project describes an obstacle avoidance method designed specifically for small sized mobile robot with differential driver motion capabilities. Although the project may sound an off-shelf product, in this project the mobile robot is expected to return to its original straight path after avoiding any obstacle in its path and continue moving. This mobile robot system is equipped with ultrasonic and infrared sensor to sense the obstacle in front of it. The information fetched from the sensor will be analyzed by a microcontroller (PIC16F877A) in order to deduce a logical operation on it. Unlike other commercial obstacle avoidance, this mobile robot was driven by four unit dc gear motor where each of it is controlling single wheel at every edge of the platform. Plus, with its gigantic and rough wheel, the robot can operate under various types of terrain and environment. Such ability makes it special compared to other commercial obstacle avoidance in the market.

ABSTRAK

Projek ini lebih berkisarkan tentang kaedah mengelak halangan yang direka pada sebuah robot beroda bersaiz kecil yang menggunakan kaedah pacuan berbeza (diffrential driver) untuk bergerak. Walaupun rekaan robot beroda yang melibatkan keupayaan untuk mengelak halangan adalah sesuatu yang sudah lapuk, tetapi dalam projek kali ini, robot beroda tersebut dijangka akan dapat kembali semula ke laluan asalnya selepas mengelak halangan dan seterusnya meneruskan perjalananya. Sistem robot beroda ini dilengkapi dengan pengesan ultra bunyi (ultrasonic) dan pengesan inframerah sebagai deria pengesan untuk mengesan halangan yang terdapat dihadapannya. Maklumat yang diperolahi daripada sensor akan dianalisa oleh sebuah cip mikropemproses (PIC16F877A) untuk dijalankan operasi logik keatasnya. Tidak seperti pengelak halangan yang lain, robot beroda ini dipacu menggunakan empat unit motor dc bergear yang mana , setiap satu mengawal sebuah roda di setiap penjuru robot tersebut. Tambahan lagi, dengan dilengkapi roda yang bersaiz besar dan lasak, robot ini mampu beroperasi pada pelbagai bentuk permukaan dan persekitaran. Keupayaan ini telah menjadikannya istimewa berbanding dengan rekaan-rekaan seumpanya di pasaran.

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CHAPTER 1

INTRODUCTION

1.1 Project Synopsis

The project aims is to design and program a standard 4WD RC robot as to make it possible to move on a straight path, and able to avoid the blockage in front of the robot by steer it around the obstacle in its path. The robot is equipped with ultrasonic and infrared sensor as the method to sense those obstacles. However, even though a straight driving avoiding the obstacle in the path may sound an off-the-shelf product, in this project the mobile robot is expected to return to its original straight path after avoiding any obstacle in its path and continue moving.

1.2 Problem Statement

In completing the project successfully, several problem statement and fact must be cleared. The problem statement in this project is to move a 4WD mobile robot in a straight path while able to avoid the obstacle in front of it and be able to return back to its original track. The robot will only using the Ultrasonic and Infrared sensor as the sensing media before giving response to a microcontroller (PIC) in order to control the robot movement.

1.3 Project Objectives

Due to the problem statement stated above, it's cleared that the objectives of the project is:

- To make sure that the robot can move in a straight path.
- To make the robot able to sense the obstacle in front of it and be able to avoid it.
- To ensure that the robot must be able to return to its original path after avoid the obstacle.

1.4 Work Scope

As to make the work easier, the work scope was set up as to control the project scope from become too large and unreachable. Thus, several parts in this project had been fixed to certain limit.

1. For the obstacle, we will only use a solid block with its dimension 480mm length, 35mm width and 190mm height. The block must firm and able to reflect the echo and light.
2. The designed robot will be move on by using four tires which is two tires for each side. Each tire supposes made from rubber and has the medium level of grip ness which is allow it to move in a flat path.
3. For the testing purpose, all simulation and testing will be conducted in flat and smooth terrain. In this case, we choose the simulation environment will be conducted inside the laboratory itself.
4. A microcontroller type PIC16F877A was used as the controller instead of using a Programmable Logic Control (PLC)

CHAPTER 2

LITERATURE REVIEW

Obstacle avoidance refers to the methodologies of shaping the robot's path to overcome unexpected obstacles. The resulting motion depends on the robot actual location and on the sensor readings. There are many type of algorithms for obstacle avoidance from basic re-planning to reactive changes in the control strategy. The proposed techniques differ on the use of sensorial data and on the motion control strategies to overcome obstacles.

Focusing on obstacle avoidance algorithm technique, many inventors have introduced various methods in order to detect and avoid the obstacle. Carmel for example, has applied 2 type of detection by using the ultrasonic sensor [1]. Carmel is the first mobile robot ever invented in the Michigan University. It was equipped with 24 ultrasonic sensors as shown in Figure 2.1 in order to trace all obstacles around it.

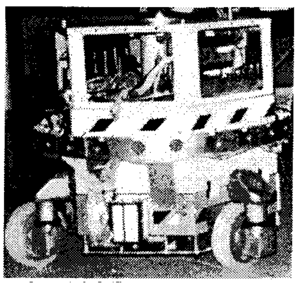

Figure 2.1: Carmel robot

Carmell sensing method actually doesn't sensing obstacle in front of it. It sensing operation is more likely to mapping the space around it. This robot was introduced with method for probabilistic representation of obstacle in the grid-type world model [1]. This grid type world model was divided with two types.

2.1 Certainty Grid

The first type were called *certainty grid.* This grid type world model had make the robot's work area is represented by a two dimensional array of square elements denoted as cells. Each cell contains a *certainty value* (CV) which use to indicate the measure of confidence that an obstacle exists within the cell area [2]. Using this method, the robot will remain stationary when taking the panoramic scan with its sensor. Then the CV will make measurement, depend on signal response to each cell. The higher the numbers of cell for the object, the greater the CV will respond which mean the higher probability of the area with obstacle exist. Figure 2.2 show how the occurrence possibilities of object in the space are related with the number of cell on the grid. The robot then will move to the new location, stop, and repeat the procedure scanning the space.

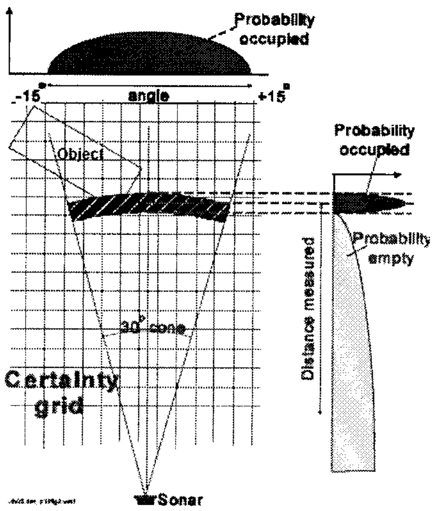

Figure 2.2: Probability scanning by Certainty Grid Method

2.2 Histogram Grid

The second type of the grid world model is called the *histogram grid.* This technique was applied to the Vector Field Histogram (VFH) method as for its obstacle representation.

Same like the *certainty grid*, the *histogram grid* also depends on value of CV which is representing the confidence of the algorithm in the existence of an obstacle at the location. It differs than the *certainty grid* in the way it is build and update. The first method, it generates a probability onto all those cells affected by a range reading. However, for this second method, increments are only for one cell in the *histogram grid* for each range reading.

The probability distribution is actually obtained by *continuously* and *rapidly* sampling each sensor while the vehicle is moving [2]. Thus, the same cell and its neighboring cells are repeatedly incremented. Figure 2.3 shows that on how each cell reading is incremented as soon as the sensor moves along side of the object.

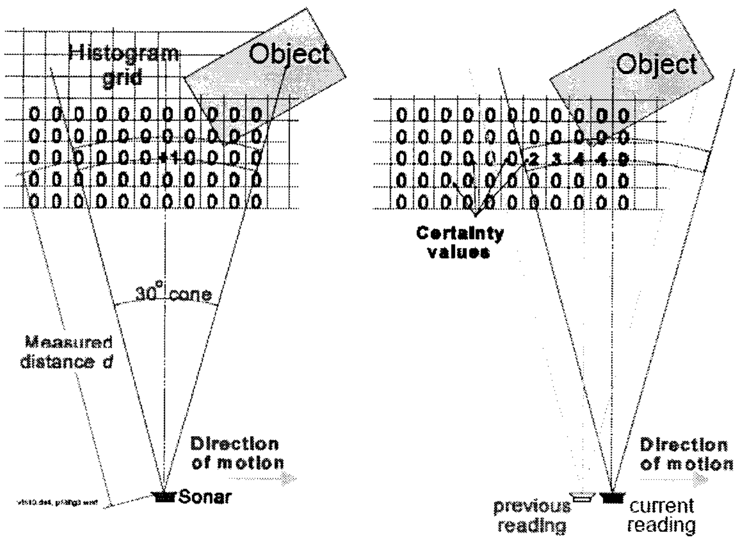

Figure 2.3: Probability scanning through Histogram Grid Method

Since it operates based on change of incremented cell reading, thus, it was not efficient to remain stationary while the reading was taken. Because of that, the measurement was taken during the robot was in motion and the action was taken at the same time. This feature gives the vehicle fast response to obstacles that appear suddenly, resulting in fast reflexive behavior imperative at high speeds.

2.3 Edge Detection Method

Other than two method stated above, there are one popular obstacle avoidance method which is based on *edge-detection*. In this method, the system will determine the position of the vertical edges of the obstacle and then steer the robot around either one side of the edges. In another *edge-detection* approach by using ultrasonic sensors, the robot remains stationary while taking a panoramic scan of its environment. After the application of certain line-fitting algorithms, an edge-based *global path planner* will be generated to plan the robot's path [11]. For early researchers, this method becomes the basic before come up with the better method. With the disadvantage of the system, the new method such as the *grid-type world model* method was born as to fix the flaw of this edge-detection method.

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2.4 Bug Algorithm

Other than that, there also an algorithm called *bug algorithm* that is widely used as the obstacle avoidance method. Similar method like *edge-detection*, the difference is that, as soon the obstacle is detected, the robot will do a full control around it, starting at the hit point H1. It purpose is to evaluating the minimum distance to the target L1. The robot then will continue contouring motion until reaching that point again. And the process will repeated if there another obstacle until it reaches the target point.

This *bug algorithm* method has the second version where here, it will start at the hit point H1 but ends at L1 where L1 is the point whenever the robot crosses the line to the target. Same thing like the first version, the robot then will repeat the operation until it reach to the target. Figure 2.4 and Figure 2.5 represent the bug algorithm for first and second version respectively.

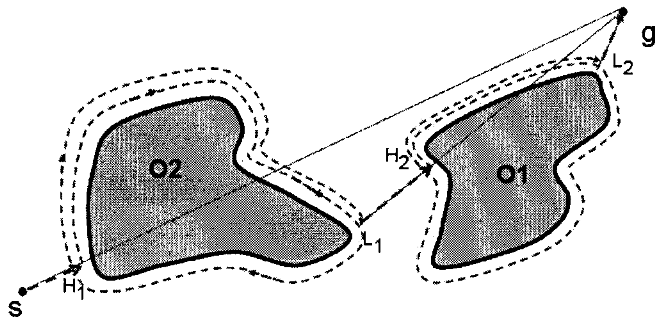

Figure 2.4: Bug Algorithm for first version

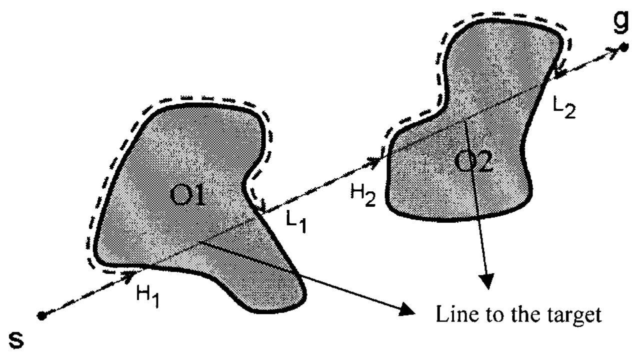

Figure 2.5: Bug Algorithm for second version