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FUZZY LOGIC BASED OBSTACLE AVOIDANCE STRATEGY FOR MOBILE ROBOT

LEE JENG YE

Report submitted in partial fulfilment of the requirements for the award of the degree of Bachelor of Engineering (Hons.) in Mechatronic Engineering

Faculty of Manufacturing Engineering

UNIVERSITI MALAYSIA PAHANG

June 2016

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ABSTRACT

The application of mobile robot often used in an inappropriate place for human. Sometime, it would involve in unknown environment. Obstacle avoidance are the key feature to control the mobile robot in order to avoid collision which provide safety to the mobile robot and the environment object. Obstacle avoidance is basically a strategy to define an obstacle by processing the distance between it, decision making in controller and giving output which control the movement or motion of the mobile robot. In this research, an obstacle avoidance strategy is using fuzzy logic approach to control the action of mobile robot was designed. The simulation design and algorithms of the obstacle avoidance with fuzzy inference system is described. The consideration of obstacle are depend on the data calculated throughout the design. The result shown are included on three model which is the target driven model, obstacle avoidance target driven model and multiple obstacle avoidance target driven model. The mobile robot are able to avoid all obstacle that set on the simulation environment.

ABSTRAK

Penggunaan robot mudah alih sering digunakan di tempat yang tidak sesuai untuk manusia. Kadang-kadang, tempat tersebut akan melibatkan dalam persekitaran yang tidak diketahui. Mengelakkan halangan adalah ciri utama untuk mengawal robot mudah alih untuk mengelakkan perlanggaran. Ini bagi memberikan keselamatan kepada robot mudah alih dan objek di alam persekitaran. Mengelakkan halangan pada dasarnya ialah strategi untuk menentukan halangan dengan memproses jarak antara objek dengan robot mudah alih, membuat keputusan dalam pengawalan dan memberikan output yang mengawal pergerakan robot mudah alih. Di dalam kajian ini, strategi mengelakkan halangan menggunakan 'Pendekatan Logik Kabur' untuk mengawal tindakan reka bentuk robot mudah alih. Reka bentuk simulasi dan algoritma mengelakkan halangan dengan sistem inferens 'Pendekatan Logik Kabur' dihuraikan and dijelaskan. Objek-objek dalam tempat tersebut akan dianggap sebagai halangan atau objek biasa melalui pengiraan dalam reka bentuk simulasi. Keadaan dipaparkan termasuk tiga model iaitu sasaran model, pengelakkan halangan dengan satu halangan dan sasaran model dan pengelakkan halangan dengan pelbagai halangan dan sasaran model. Pada akhirnya, robot mudah alih dapat menggelakkan semua halangan yang ditetapkan dalam alam simulasi ini.

CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

Mobile robot are often employed to deal with activities that are dangerous and activities that involve in an uncomfortable environment. Mobile robot are applicable in various industries such as aerospace, chemical, construction, manufacturing and others. High temperature environment in manufacturing processes are one of the example that require mobile robot. Obstacle avoidance strategy is an algorithm of the mobile robot's action when detecting an obstacle. The purpose of the obstacle avoidance strategy is to prevent the robot from any collision with any object or obstacle which may cause damage to the obstacles and the mobile robot itself. In aerospace industry, numerous mobile robot are used in an unknown place which does not have information of the obstacle around the place while in manufacturing or chemical industries, raw materials, machines, parts and products are the examples of the obstacles for mobile robot. Thus, it is also important to prevent any damage on the component.

In obstacle avoidance, obstacle detection are important element to decide the motion and direction of the mobile robot. For example, a mobile robot will accelerating until optimum speed if obstacle are far from the mobile robot while mobile robot will decelerate if obstacle are close to it and make a turn. There was difference of sensor or process that used for obstacle detection such as sonar sensor, image processing and others.

Sonar sensor is one of the common sensor that is used to detect the obstacle. The sensor detects the range between the sensor and obstacle by transmitting ultrasound wave with constant wavelength which will be reflected by the obstacle. The transmitter are used to send the transmitted wave and the receiver are used to receive the reflected wave. Sonar sensor does not depend on the colour of the object. There are a few disadvantages of sonar sensor. Sonar sensor have a range of sensing range. Other than that, the change of environment will affect the accuracy of the sonar sensor such as humidity and temperature.

1.2 PROBLEM STATEMENT

Numerous field of industry have use mobile robot or each application and other industries are start to consider mobile robot in their applications since the improvement of technology lately. Obstacle avoidance system provides safety for both mobile robot and obstacles around. This would prevent any costing for repair and without increase the cost of maintenance or repair of the mobile robot. Mobile robot without obstacle avoidance will be unsafe for both obstacles and mobile robot. In critical situation, it may cause accident that causes major losses.

Development of obstacle avoidance system have a number of complication with difficulties in algorithm design. The difficulties included unseen environment and to avoid contact or collide with objects within a field. The algorithm are developed that can evade more than one obstacle and which will decide the direction of mobile robot to heading. Simulation of an obstacle avoidance mobile robot to avoid collision are depend on the direction of x-axis and y-axis heading and position in time domain and the detection of the obstacle around of x-axis and y-axis. Angle of heading are needed also to determine in time domain so it is applicable for obstacle avoidance. A series of equation or relation needed to develop for the obstacle avoidance simulation to be used as obstacle avoidance system. Fuzzy logic control system will be used for simulation of the obstacle avoidance system. The advantage of fuzzy logic is that it does not need an exact or precise input or information to proceed the system. In other hand, it is challenging to keep the accuracy, reliability, and extensiveness for the built the fuzzy logic rule base.

1.3 OBJECTIVE

The objectives of this research:

- 1. To develop an algorithm for obstacle avoidance mobile robot using fuzzy logic rules.
- 2. To verify the algorithm by using simulation.

1.4 PROJECT SCOPE

Obstacle avoidance mobile robot itself is a broad field of study. In order to bind this research to be in manageable scale, the scope of this project is limited to:

- The axis of the mobile robot travel area is only covered in two dimensional analysis only, which is on X and Y axis. Z axis is assumed constant to ease and simplify the algorithm development.
- 2. The surface of the mobile robot travel is assumed to be operated in flat and smooth surface (normal friction coefficient, in dry surface). Different friction coefficient will affect the calculation of the mobile robot travel distance due to the wheel slip and will affect the decision making of the mobile robot controllers.
- The characteristic for the obstacle is assumed to be in perfect polygon shape such as triangle, square, and circle. Complex or nonlinear shape will introduce sensor reading error to the mobile robot.
- 4. Only static obstacle will be taken into consideration. The moving obstacle will involve more parameters into consideration and add extra modelling process to the moving obstacle detection.

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