Navigation of Mobile Robot with Polygon Obstacles Avoidance Based on Quadratic Bezier Curves

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Abstract

Navigation and obstacle avoidance problems are introduced and solved in this paper. A new algorithm called quadratic Bezier curves is used to navigate a mobile robot in an unknown environment. The quadratic Bezier curve can be improved through a division and conquer technique whose basic operation is the generation of multiple midpoints on a specific curve. The platform of the mobile robot is constructed with three ultrasonic sensors placed around the front of the platform with 45° between them. These sensors are utilized to sense the locations of obstacles in any environment surrounding the mobile robot. Based on sensor(s) detection for obstacles in the environment of the mobile robot, five different scenarios are introduced and studied. To navigate the robot in the unknown environment, two main points are taken into consideration: Firstly, the smooth rotation of the mobile robot around the obstacles should be performed to avoid a collision; and secondly, the shortest path should be followed by the robot to reach a target with minimum time. Visual basic language is used to simulate the navigation of mobile robot in different environments. The quadratic Bezier curves algorithm is investigated real-time experiment, and the obtained results have proved the efficiency and evaluation of the proposed algorithm.

Keywords Navigation and obstacle avoidance problems · Path planning · Mobile robot · Quadratic Bezier curves · Visual basic language

1 Introduction

The obstacle avoidance and navigation of a mobile robot are an essential issue in the path planning field. The term "Obstacles Avoidance" has two parts: sensing obstacles by sensors and designing a collision avoidance system to obviate hindrances in unknown environments. Depending on the type of the environment surrounding the mobile robot, the navigation problem is classified into two types: local navigation and global navigation. In local navigation, the locations, shapes and numbers of obstacles are already known. Therefore, the shortest path from a starting point of the mobile robot to a target point can be selected without colliding with obstacles. If the surrounding environment of the mobile robot is unknown or partially known, the problem is called global navigation. In this case, the mobile robot should be designed with a collision avoidance system to avoid hindrances.

In the past decades, many researchers introduced numerous path planning algorithms to navigate a mobile robot. Some approaches such as cell decomposition and artificial potential field algorithms are used to govern the movement of the mobile robot in different environments. The aim of the cell decomposition algorithm is to decompose a C-space into a set of simple cells and then calculate the adjacency among cells (Montiel et al. 2015). In the artificial potential field algorithm, the speed and direction of the mobile robot are governed by two forces: a repulsive force that is generated from obstacles toward a robot and attractive force that compels the robot to move toward a target (Khatib 1986). The artificial potential field algorithm can be described using simple mathematical equations; therefore, it is simple to implement. On the other hand, this algorithm has serious drawbacks in some situations, especially when the obstacle is very close to the target. In this case, the repulsive force becomes bigger than the attractive

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