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Path planning with obstacle avoidance based on visibility binary tree algorithm

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HIGHLIGHTS

- A new algorithm for robot navigation, referred to as visibility binary tree algorithm is introduced.
- The construction of this algorithm is based on the visible tangents between robot and obstacles.
- The shortest path is run on top of the visibility binary tree.
- The performance is compared with three different algorithms for path planning.

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ABSTRACT

In this paper, a novel method for robot navigation in dynamic environments, referred to as *visibility binary tree algorithm*, is introduced. To plan the path of the robot, the algorithm relies on the construction of the set of all complete paths between robot and target taking into account inner and outer visible tangents between robot and circular obstacles. The paths are then used to create a visibility binary tree on top of which an algorithm for shortest path is run. The proposed algorithm is implemented on two simulation scenarios, one of them involving global knowledge of the environment, and the other based on local knowledge of the environment. The performance are compared with three different algorithms for path planning.

1. Introduction

Path planning and obstacle avoidance are two important aspects of autonomous mobile robot navigation. Based on the sensor information available, the approaches to path planning can be classified into global and local methods [1,2]. In global methods, the robot plans its trajectory on the basis of a global information on the environment [3]. This approach guarantees the convergence of the robot path to the target, and also indicates if the goal is reachable or unreachable. On the other side, planning approaches based on sensors providing limited (local) information, although of simpler implementation, do not guarantee the global convergence to the target [4], since the robot uses its sensors to locate nearby obstacles at each control cycle and to plan the next action to be executed.

Many techniques for path planning in the presence of obstacles employ a Voronoi diagram under the hypothesis either of a global [5] or a local knowledge scenario [6]. In the global knowledge scenario the assumption is that each robot has complete information about all obstacles in the environment, while in the local knowledge scenario the information of each robot is limited to its sensing range. In approaches based on the Voronoi diagram, the planned trajectory is either a piecewise linear trajectory or a smooth path. In the first case, the robots have to stop at each of the trajectory segments end, change its orientation according to the next segment and then restart again. This kind of motion is disagreeable and leads to additional waste of power. In order to get a smooth path, the use of different curves instead of linear segments has been proposed. An example is the use of Voronoi diagram for smooth path planning and better obstacle avoidance by iterative enhancement proposed in [7]. Another example is the use of Bezier curves. Smooths paths that are reliable with robot dynamics are generated by using Bezier curves of degree three [8]. Time optimality [9], navigation in presence of corridor constraints [10] and

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