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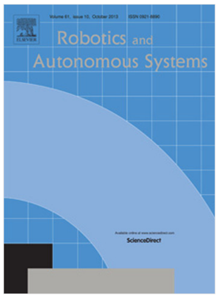

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Bi-objective Path Planning using Deterministic Algorithms

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Abstract

Path planning has become a central problem in motion planning. The classic version of the problem aims to find an obstacle-free path with the minimum length for a given workspace containing a set of obstacles and two sources and destination points. However, some real world applications consider maximizing the path clearance (i.e., the distance between the robot and obstacles) as the secondary objective. This bi-objective path planning problem has been studied using evolutionary and other heuristic algorithms which do not guarantee achieving Pareto optimal paths. In this paper, we first study this problem using deterministic algorithms. Next, we propose an efficient algorithm for the problem in the grid workspace. We then propose an $O(n^3)$ time algorithm for the problem under the Manhattan distance in a continuous workspace containing n vertical segments as obstacles. Finally, we show the obtained solutions are proper approximation for the problem under the Euclidean distance.

Keywords: Bi-objective optimization, Path planning, Clearance, Pareto optimal, Approximation.

1 Introduction

Robot Path Planning (PP) problem as a practical problem in industrial and daily routine work is an interesting and challenging problem in computer science and robotics. In the classic PP problem, a workspace containing obstacles and two *source* and *destination* points, denoted by *s* and *d,* are given and the goal is to find an obstacle-free path for a robot starting from *s* and ending at *d*, denoted by *s-d-path.* Most of studies in this literature have focused on finding the shortest *s*-*d*-path [1, 2]. There are numerous parameters like shape, dynamic, abilities and constraints of robot, dimension and characteristic of workspace that are important in the exact definition of PP problem and its complexity. Consequently, various versions of the problem like static\dynamic, holonomic\non-holonomic, continuous\discrete, known\unknown or smart workspace [3] have been studied. With regard to these varieties and the complexity of PP problem which is NP-hard in general, several types of approaches have been proposed for solving it. *Cell decomposition* [4], *sampling roadmaps*, *potential fields* [1, 2, 5] and heuristic