Hybrid Path Planning Incorporating Global and Local Search for Mobile Robot

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Abstract. This paper proposes a hybrid path planning algorithm incorporating a global and local search mechanism for mobile robot. The global path planning is based on Voronoi graph to establish a backbone path for the map with significantly reduced nodes for the original grid map. With the use of the backbone path, the D* algorithm is adopted to determine a shortest path between the starting and end points. Taking advantages of the D* algorithm and Voronoi graph, the proposed hybrid path planning algorithm is capable of obtaining a desired path for the mobile robot, overcoming the efficiency problem while maintaining maximum safety distance from the obstacles when the mobile robot navigates in the environment.

Keywords: path planning, mobile robot, Voronoi Graph, D* algorithm, A* algorithm.

1 Introduction

This paper proposes a hybrid path planning algorithm incorporating global and local path planning schemes for mobile robots. The global path planning is based on Voronoi graph [1] to establish a backbone path for the map with significantly reduced nodes for the original grid map. With the use of the backbone path, the D* algorithm [2] is adopted to determine a shortest path between the starting and end points. With the use of the D* algorithm and Voronoi graph, the proposed hybrid path planning algorithm is capable of obtaining a desired path for mobile robots, overcoming the efficiency problem while maintaining maximum safety distance from the obstacles when the mobile robot navigates in the environment.

2 Hybrid Path Planning

The mechanism of the proposed hybrid path planning algorithm can be divided into global and local search mechanism. A backbone Voronoi path is first established for a given grid map. A starting point (P_{Start}) and end point (P_{Goal}) are given to select n

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G. Herrmann et al. (Eds.): FIRA-TAROS 2012, LNAI 7429, pp. 441–443, 2012.

adjacent nodes as SG_α and SS_β on the backbone Voronoi path. Assume SG_α is a set of adjacent nodes on the backbone Voronoi path to the starting point, where $\alpha = 1, 2, ..., n$, and SS_β is a set of adjacent nodes to the end point, where $\beta = 1, 2, ..., n$. According to formula (1) and (2), optimal nodes SG_O and SS_O on the backbone Voronoi path can be respectively obtained.

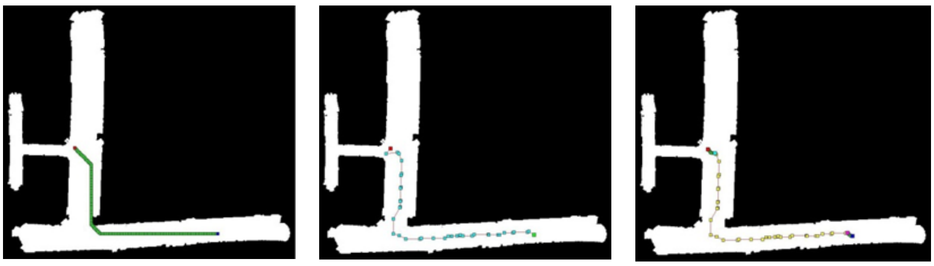
$$SG_O = \min_{0<\alpha\leq n}\left(\overline{P_{SG_\alpha}P_{Goal}} + \overline{P_{SG_\alpha}P_{Start}}\right) \tag{1}$$

$$SS_O = \min_{0<\beta\leq n}\left(\overline{P_{SS_\beta}P_{Goal}} + \overline{P_{SS_\beta}P_{Start}}\right) \tag{2}$$

Finally, we use SG_O and SS_O as the starting and end points, and then use the D* algorithm to obtain a path P_G on the backbone Voronoi path. Subsequently, we use the A* algorithm to obtain a path P_{LS} between the starting point and SG_O, and a path P_{LG} between SG_O and the end point. Therefore, combining the paths of P_{LS}, P_G and P_{LG}, we have obtained a complete path between the starting and end points.

3 Experimental Results

In this paper, a parameter n = 3 is used to choose the adjacent nodes. Fig. 1 shows the path planning results by using the D* algorithm, the GVG algorithm, and the proposed hybrid algorithm, respectively. The proposed hybrid algorithm is more time efficient than the D* algorithm without worrying possible collisions with the obstacles. There is a detoured path by using the GVG algorithm, which has been avoided by using proposed hybrid algorithm.



(a) D*algorithm (b) GVG algorithm (c) Hybrid algorithm

Fig. 1. Path planning results by (a) D* algorithm, (b) GVG algorithm, (c) proposed hybrid algorithm

4 Conclusions

It is observed that the D* algorithm is time-consuming with a derived path too close to obstacles. The GVG algorithm may derive a detoured path, which is unnecessary and not convenient for moving the robot. As an attempt to solve these problems, this paper has presented a hybrid path planning algorithm for mobile robot, incorporating a global and local search mechanism, not only improving the performance of the D* algorithm but also keeping a safe distance from the obstacles. Simulation results have confirmed the feasibility of the proposed algorithm for practical use in the real-world environment.

Acknowledgments. This work was supported by the National Science Council, Taiwan, under Grants NSC 100-2622-E-032 -004-CC3 and NSC 99-2221-E-003-025-MY2.

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