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Fuzzy Control Interface and Semi-Grid D* Algorithm for Robot Navigation System

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Abstract

Navigation in unknown and dynamic environments has been considered as a complex task. We designed a new hierarchy system that contains two levels. Planning algorithm runs at first level. We used Semi-Grid D* as planning algorithm. Second level is fuzzy control interface. Fuzzy control interface generates smoother paths for passing wide, sharp edged and complex obstacles. Fuzzy control interface affects both angle and velocity of robot. Also we defined new linguistic variables for features of obstacles that are considered as effective in navigation problem like complexity and obstacle's width. The environments that considered here are unknown and dynamic. We evaluate our work in 3D modeling simulator. Results from implementations show accuracy and robustness of our work in various environments.

Key words: Semi-Grid D*, Fuzzy control interface, Fuzzy logic, Hierarchy system, Unknown environments, partially-known environments.

1. Introduction

Planning task has been considered as an important problem in last decades. Navigation of robot in obstacle free environments is straight forward problem but in environments with complex, non-smooth obstacles, it becomes a complex problem. Most research has assumed that the environment is properly known, terrain map is given or environment is not dynamic. Different approaches have been developed to solve planning problem [1] like cell decomposition, road map and potential field. Most of these approaches have problem of configuration space dependency. A* algorithm [2] is well known solution for path finding in static and known environments. A* is a heuristic based search algorithm. A* finds the least cost path from initial state to goal state. There are other approaches of A* algorithm that have tended to modify algorithm to act in faster and in more accurate manner such as (I) AA*(ACCELERATED A*) [3]. Algorithm extends the original A* algorithm to be usable in large-scale environments without forgetting about the search precision, (II) Path Planning for Autonomous Vehicles in Unknown Semi-structured Environments [4] has got two phases, first part uses variant of A* search and second part is about improvement in the quality of the solution via numeric non-linear optimization, (III) Optimized Path Planning for Robots with Motion Uncertainty and Imperfect State Information(LQG-MP) presented a new approach for evaluation of paths in motion planning with dealing with motion and sensing uncertainty [5], (IV) Fusion of Probabilistic A* Algorithm and Fuzzy Inference System for Robotic Path Planning [6] used a combination of A* algorithm and fuzzy interface and other researches like[7];[8] .