Validation of A Real-Time 3D Path Planning Algorithm With A Robotic Test-Bed

A. M. Hamid, Jordan Boehm, Alex Johnson, Chris Kennedy and Dr. Mumu Xu

INSTITUTE FOR SYSTEMS RESEARCH
A. JAMES CLARK SCHOOL OF ENGINEERING

Introduction

A novel algorithm , Hierarchical D* Lite (HD*), combines the incremental D* Lite with a hierarchical path planning approach to re-plan paths sufficiently fast for real-time operation. HD* does not need to update the map representation before planning a new path. To ensure feasibility, path smoothing and Catmull-Rom splines are used. Computation time and path quality are dependent on parameters such as map size, environment complexity, sensors range, and any restriction on planning time. Monte Carlo simulations were used to asses the performance and it was found that HD* finds paths within 10% of optimal in under 35 ms for the most complex environments tested.

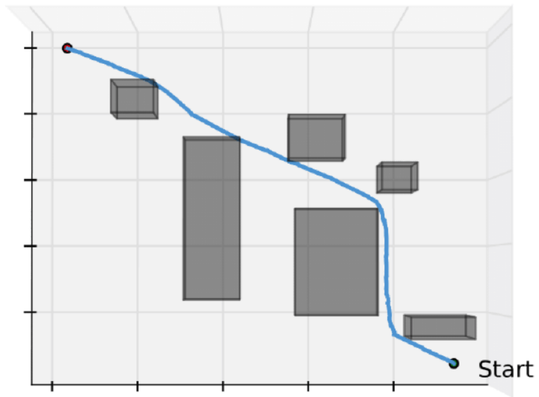

Fig.1 Path finding process

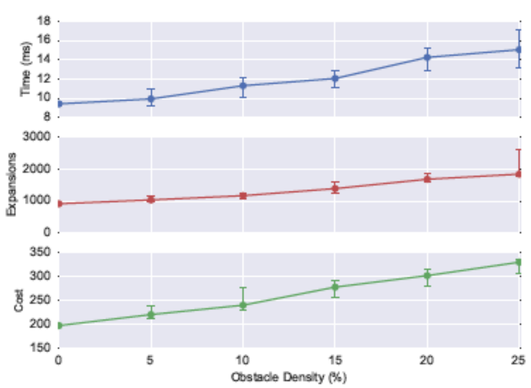

Fig.2 Effect of obstacle density on performance

Objectives

The objective is to verify the capability of a 3D hierarchical path planning algorithm HD*, to produce cost efficient paths in a timely manner in realistic scenarios for unmanned vehicles by demonstrating path planning capabilities for unmanned rovers and extending to UAVs.

References

[1]Solomon, M. D., "Development of a Real-Time Hierarchical 3D Path Planning Algorithm for Unmanned Aerial Vehicles," Masters Thesis, Department of Aerospace Engineering, University of Maryland, College Park, MD, 2016.

[2]Koenig, S., and Likhachev, M., "Fast Replanning for Navigation in Unknown Terrain," IEEE Transactions on Robotics and Automation, Vol. 21, No. 3, 2005, pp. 354-363.

HD* Configuration

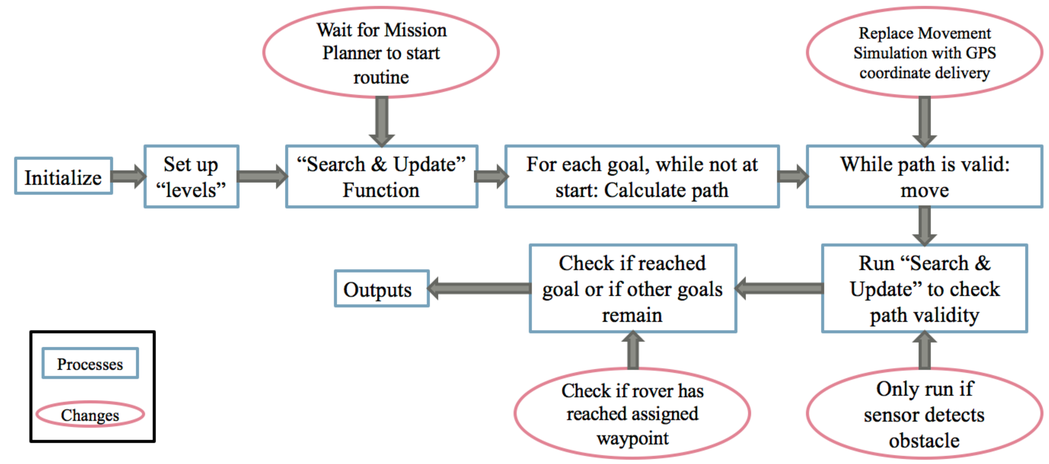

Fig.3 HD* configuration and modifications

Interfacing with HD*

Mission Planner software used to handle navigation and control of the rover. Raspberry Pi-3 and NAVIO-2 autopilot used to coordinate the rover movements and handle telemetry.

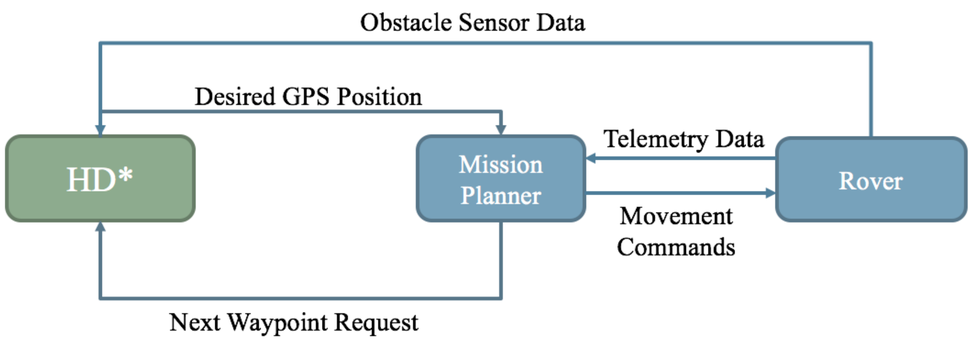

Fig.4 Interfacing with HD*

Fig.5 Mission Planner software interface

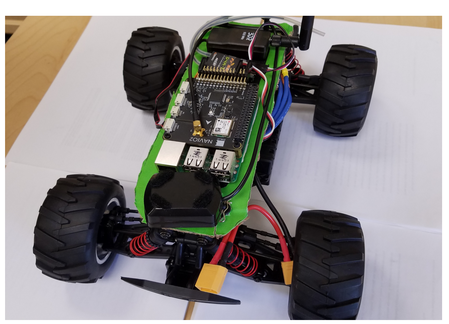

Fig.6 Rover's hardware test-bed

This project is funded by NAVAIR

Special thanks to Matthew Solomon for giving first-hand experience with the development of the algorithm