Universität Stuttgart
Institut für Flugmechanik und Flugregelung

Augmented maps for informative path generation

Master Thesis

Background:

A robot navigating an environment usually needs a map representation of it that divides the known space into free, unknown, and obstacle areas. Path planning is then applied over the map to generate feasible paths toward goals. Based on the application, the planning can be enhanced to include additional pieces of information. Those applications include, but are not limited to, active SLAM, target tracking, and feature tracking. To do so, sampling-based methods or enhanced control algorithms need to be employed.

Problem definition:

Our Active SLAM solution [1,2] consists of a three-layer framework that tries to optimize and influence every step of the exploration. The main source of information in our algorithm is the amount of entropy observable from a given point of view. Still, the path planning is done in classic 2D occupancy grids. Usually, to enhance navigation, informative path planning [3], sampling-based methods [3], force fields, and other methods [4,5] are being used. All of those use additional information to refine either the global or the local planning. Nonetheless, we believe that a smarter representation of the map can be used directly. With an „augmented“ occupancy grid/costmap the planning itself will be influenced by the desired metric. This will lead to sub-optimal paths in terms of length but to a more informed and enhanced exploration.

Task:

- Research „augmented“ maps and informed path planning both in 2D and 3D.
- Develop a method to incorporate other sources of information in the map.
- Apply classical exploration algorithms (A*, Dijisktra, OMPL) for checking collision avoidance.
- Test the approach and results both in simulation and real hardware.

Requirements:

- Interest in SLAM, control, navigation
- Experience with ROS / Gazebo required
- Experience in OpenCV preferred
- Good problem-solving capabilities
- Experience with C++ / Python desired
- Good academic performance

If interested, please contact:

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[1] iRotate: Active Visual SLAM for Omnidirectional Robots https://arxiv.org/abs/2103.11641
[2] Active Visual SLAM with independently rotating camera https://arxiv.org/abs/2105.08958
[3] An Efficient Sampling-Based Method for Online Informative Path Planning in Unknown Environments https://arxiv.org/abs/1909.09548
[4] https://www.cmu-exploration.com/a-tare-planner
[5] Perception-aware Path Planning for UAVs using Semantic Segmentation http://ras.papercept.net/images/temp/IROS/files/0496.pdf