Motion Planning under Sensing Uncertainty

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Why do we need Motion Planning?

In our labs, trajectories were generated by:

- Straight line interpolation
- IK for every waypoint

What is the problem with that?

- Automatic generation
- IK may be expensive
- Does not handle self-collisions
- What about other obstacles?

The problem of Motion/Path Planning

Given:

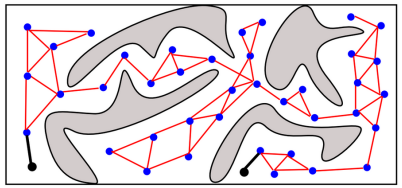
- Initial and goal robot configuration

Compute

- Path in joint space
- Connect initial and goal
- Avoid obstacles

Sampling-based Planners

- Randomly sample joint space and capture connectivity



Motion planning + MECH 498 together

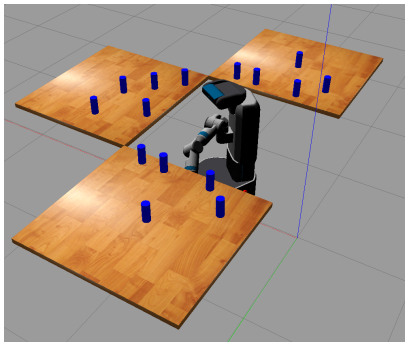
Scenes and robot

- Phisics simulator (**Gazebo**)
- Frame transformations **(ROS)**
- Controller **(MoveIt)**
- Octomap

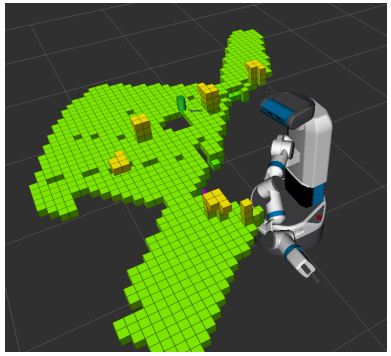
Planner

- Fetch: 7dof arm + torso
- RRT-Connect algorithm (**MoveIt-OMPL**)
- Collision checking (**FCL**)

Simulation of a Fetch robot using Octomaps



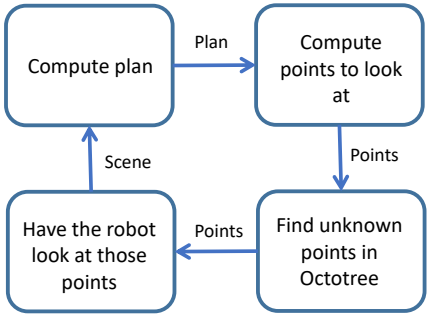
Complete scene

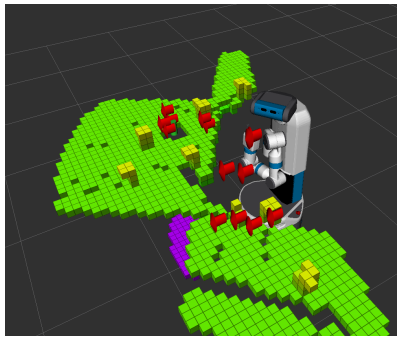


Octomap scene

Planning under incomplete scenes: look at the right spot

Idea: Use the planned trajectory for completing the scene before execution





$$\bigcup_{t \in [0,1]} \mathcal{A}(t) = ch\left(\mathcal{A}(t), \mathcal{A}(t+1)\right)$$

Scene competion strategies

- Look at object (**baseline**)
- Look fixed points around the object **(points)**
- Look all unknown frame origins throughout the trajectory (**origins**)
- Look all unknown points of the swept-out volume (**convex**)

Results

- Each strategy was run with **50** different scenes randomly generated
- Count how many succeded, failed or no path found
- Measured the time taken to look around before executing a path

	Baseline	Points	Origins	Convex
Time (mean, stdev)	26 (10.9)	23.6 (10.44)	71.9 (44)	62.8 (39.2)
Succeded	22	25	42	41
No path	0	0	3	7

Conclusions

- Motion Planning is a key step towards achieving fully autonomous robots
- We have implemented a full simulation of a fetch robot that successfully solves motion planning queries under incomplete scene information
- For this purpose we have used the swept-out volume of the robot´s arm to choose interesting points to efficiently complete the scene