Robotic Manipulation Course

Exercise2

January 20, 2020

1 Assignment

The goal is to benchmark various planners available in MoveIt. To make planning task harder, you will add a collision box in front of the robot and the goal of the planning will be to reach behind the box. You need to modify URDF/XACRO model of robot for adding the collision box. The xacro file is located at *exercise2/model/robots/sim.urdf.xacro*. Add box with the following dimensions: $0.2 \times 0.5 \times 0.5$ at the pose defined w.r.t. *base_link* by transformation matrix:

$$T = \begin{bmatrix} 1 & 0 & 0 & 0.25 \\ 0 & 1 & 0 & 0.1 \\ 0 & 0 & 1 & 0.3 \\ 0 & 0 & 0 & 1 \end{bmatrix} \tag{1}$$

As an example of collision object look at the *floor* object in the xacro file. After you modify the model you need to compile it:

```
cd ~/ros/src/exercise2/model/robots && xacro sim.urdf.xacro --inorder > sim.urdf
```

Than you can launch the robot with command

```
roslaunch exercise2 sim_with_box.launch
```

and you should see the robot with a box in front of it. Modify the provided template code to compute 5 plans for each of the different planning algorithms. The goal position of robot in joint space is:

$$\begin{bmatrix} 1.15 & -1.55 & -1.68 & -2.43 & -0.14 & 2.03 & 0.68 \end{bmatrix}^\top. \tag{2}$$

To run the code use:

```
rosrun exercise2 plan
```

Compare following planners (run each planner 5 times) with planning time set to 5 s:

- PRM,
- RRT,
- RRT*,
- KPIECE (Kinematic Planning by Interior-Exterior Cell Exploration) (grid based search)

with respect to the following metrics

- planning time,
- plan length (define meaningful metric in joint space).

To test your code you need to launch the simulation by:

```
roslaunch exercise2 sim_with_box.launch
```

and than run your node with

```
rosrun exercise2 plan
```

Your node should run all planners several times and compute the metrics. The same commands will be used for testing by TAs. Therefore, do not change the package/node names.

2 Report

In addition to code, you are supposed to write a technical report (pdf) in which you will document the steps performed to fulfill the assignment. Your report should contains:

- your name, student number, date, exercise number and course name
- the mathematical equation of plan length computation
- all information necessary to replicate your results (number of plans computed per planner, starting and goal position, etc.)
- graphs visualising the computed metrics for planned paths
- discussion of the results (why plan X performed better than Y w.r.t. metric Z)
- answers to the following questions:
  - Assuming infinite planning time, will there be a difference in planned path length of RRT and RRT* in MoveIt?
  - In the evaluation you should compute 5 plans per planner. Why is it necessary to compute more plans with the same planner to get meaningful comparison?

3 Submission

To submit your code and report, fork a repository named *robotic_manipulation_2020/exercise2* to your gitlab group. Modify the code in the forked repository. Be sure to push your code before the assignment deadline. The commits pushed after the deadline will be ignored.

4 Deadline

Deadline for this assignment is 4th of February at 23:59.

5 Resources

- MoveIt `https://moveit.ros.org`
- OMPL planners `http://ompl.kavrakilab.org`
- URDF, XACRO tutorials `http://wiki.ros.org/urdf`