Modern Robotics, Course 4: Robot Motion Planning and Control

Project Name: Sampling-Based Planning

Description: This project is about the motion planning of a planar robot. Rapidly Exploring Random Tree (RRT) sampling method is implemented, it takes the “obstacle.csv” file as input and generate other three CSV file, “nodes.csv”, “edges.csv” and “path.csv”.

Environment: Python3, V-REP

Content List:
1. the code folder is holding the code files,“index.py” is the entry, “rrt.py” is the sampling module
2. the results folder including input and output files, which is necessary to run the VREP simulation: “obstacle.csv”,“nodes.csv”, “edges.csv” and “path.csv”

Running Steps is from the book
MODERN ROBOTICS: MECHANICS, PLANNING AND CONTROL

Algorithm 3 RRT algorithm.

```
initialize search tree T with x_start
while T is less than the maximum tree size do
    x_samp ← sample from X
    x_nearest ← nearest node in T to x_samp
    employ a local planner to find a motion from x_nearest to x_new in
        the direction of x_samp
    if the motion is collision-free then
        add x_new to T with an edge from x_nearest to x_new
        if x_new is in X_goal then
            return SUCCESS and the motion to x_new
        end if
    end if
end while
return FAILURE
```

More Details:

1. 3rd step, it just sampling from a uniform random distribution over the square [-0.5, -0.5] x [0.5, 0.5].

2. 4th step, to search the nearest node in T to the sample node, a search map is created for the Breadth-First Search (BFS). the map is filled by the node in search tree T.

3. 5th step, the local planner is utilized to find the new node by the sample node and the nearest node. A new node is one step from the nearest to the sample, in the 8-connected grid, unless the sample node is on the search tree T.

4. Collision check for segment AB and a circle with central O and radius r:
   If any endpoint, A or B is inside the circle: there is a collision
   Else:
   Then, check the angle between each endpoint to central and segment.
   The angle between vector AO and vector AB (angle1)
   The angle between vector BO and vector AB (angle2)
   Only if both of angle1 and angle are obtuse or acute, there is no collision.
   (Special Case: angle1 and angle2 both are 0 or pi, no also)