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. **code** folder is holding the code files, “index.py” is the entry, “rrt.py” is the sampling module
2. **results** folder has input and output files, which is necessary to run the VREP simulation:

obstacle.csv: input file, including the central position and diameter of each circle obstacles

nodes.csv: output file, including the index , the position (x, y) and estimate optimistic cost to the goal

edges.csv: output file, with rows including two connected node id and the cost between them

path.csv: output file, the list of node id from start node to the goal node.

3. **graph/tree:** the screen shoot from V-Rep simulation, in the scene5 case with the **results** fold as input

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**
  $x_{\text{samp}} \leftarrow$ sample from $\mathcal{X}$
  $x_{\text{nearest}} \leftarrow$ 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 $\mathcal{X}_{\text{goal}}$ **then**
      return SUCCESS and the motion to x_{new}
    end if
  end if
end while
return FAILURE

More Details:

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

2. 4th step, searching 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)