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Pre-Lab 3

1) Will you plan in the workspace or configuration space?

Will plan in the configuration space using the origin and final position. The result of the planning will be a function of time q(t) such that q(0) = q_0 and q(t_f) = q_f where q is the general form of a configuration.

2) How will you represent the space that you are planning in?

We will represent the configuration space as a 6-length vector of joint angles and dimensions of end-effector opening.

From the textbook:

> *A complete specification of the location of every point of the robot is referred to as a configuration, and the set of all possible configurations is referred to as the configuration space.*
>
> *For manipulator arms, the vector of joint variables often provides a convenient representation of a configuration.*

3) How will you check for collisions?

We will check for collisions by first sampling the configuration space using uniform random sampling. We will develop and use a collision checking algorithm to detect when a sample configuration is not in free space.

Our collision checking algorithm will ensure that neither the end effector or the robot body lie in the occupied regions of the configuration space.

With the end effector?

Checking if the origin of the end effector coordinate frame is in the free configuration space. If yes, then check if points on the boundary of a sphere centered around that point with appropriate radius are in free collision space.

With the rest of the robot?

Repeat the same check as done for the end effector but at the origin of each joint in the robot with varying radii depending on link lengths.

A method for determining the radius of the spheres can be half the link length of the link connecting frame i to frame i+1.

4) How do you plan to account for the geometry (volume) of the robot?

By approximating the volume of the robot using the spheres centered around each joint, as described above.

5) How will you compute waypoints?

Using a sampling-based approach such as Rapidly Exploring Random Trees (RRT).

From the textbook:

The construction of an RRT is an iterative process in which a new vertex is added to an existing tree at each iteration. The process of adding a new vertex begins by generating a random sample from a uniform probability distribution on the configurations space.

The sample is used to determine how to grow the tree by choosing the vertex which is closest to the sample and adding an edge from the nearest neighbor in the tree to the new vertex.

A new node is connected to the tree by solving a local path planning problem of stepping along the straight-line path from the nearest tree neighbor to the new vertex.

The construction time of an RRT can be amortized across all the planning tasks the robot performs in the same bounded configuration space.

6) How will you interpolate between waypoints?

To interpolate between waypoints using path smoothing techniques. The simplest path smoothing algorithm is to select two random points on the path and try to connect them with the local planner.

Another approach we will try out is quintic polynomial trajectories. Using six constraints (one each for initial and final configurations, initial and final velocities, and initial and final accelerations), we can ensure that acceleration does not experience any discontinuities which cause impulsive jerks.