Motion-Planning Lab 3

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Introduction

This project aimed to show the advanced manipulation capabilities of a robotic system in a structured environment. Utilizing a UR5e robotic arm, the experiment was designed to arrange six cubes within a simulated environment to form the initials "N" and "O", representing the first letters of our names. This task not only demonstrated precise robotic manipulation but also the robot's ability to navigate and plan in a space filled with obstacles.

Methodology

Environment Setup

The experimental setup included a UR5 robotic arm and a predefined workspace where six cubes were randomly distributed. The task was to rearrange these cubes to form the shape of the specified letters. For the letter "N," it was assumed that an additional cube was already placed in the environment to complete the structure, given the limited number of available cubes.

Trajectory Planning with RRT*

For trajectory planning, we utilized a modified version of the RRT* algorithm, with several enhancements:

- **Adaptive Pathfinding:** We introduced a mechanism within the RRT* algorithm to reset the search if a path was not identified within a certain number of iterations. This significantly improved the algorithm's efficiency by avoiding prolonged computations on infeasible paths and ensured that the system could efficiently navigate through the workspace, even in scenarios where initial pathfinding attempts were unsuccessful.

- **Dynamic Environment Handling:** The algorithm was adapted to dynamically account for changes within the environment, such as the new displacements of the cubes, ensuring continuous validity of the planned paths.

Results and Conclusions

The implementation successfully demonstrated the robotic arm's ability to rearrange the cubes according to the desired destinations to form the letters.

The project showcased the practical use of advanced trajectory planning techniques in robotic manipulation tasks. However, we noticed that the UR5 robotic arm was about to to collide along some of its planned paths due to the positioning of the cube after it was catched by the end-effector, leading to potential collisions with surrounding obstacles. To enhance the current algorithm, a solution can involves representing the cubes being placed within the workspace as slightly larger to mitigate collision risks. Similarly, enlarging the representation of the cube being grasped can further reduce the likelihood of collisions during manipulation tasks.

Furthermore, it's worth noting that we dropped the cubes from a height of 10 cm and we did not take in consideration the effect of this drop on their final placement, resulting in them not landing precisely at the intended destination.