LAB 6

Extra Credit Assignment

6.1 Objectives

This is the extra credit lab of the semester and will integrate your work done in previous labs with python, ROS, OpenCV and forward/inverse kinematics. This lab will allow you to further explore the OpenCV library and implement more complex pick and place tasks.

- Use OpenCV functions to find and mark the centroids of multiple colored blocks that make up a larger object.
- Use centroids of multiple blocks to determine the orientation of the object.
- Report the world frame coordinates \((x_w, y_w, \theta_w)\) of the centroid of object in the camera’s view.
- Move each object to the designated location.

6.1.1 References

- Appendix B which explains how to derive the intrinsic and extrinsic equations for the camera.
- HSV Color Space:
  - https://stackoverflow.com/questions/10948589/
  - Converting RGB to HSV
- Simple Blob detector:
  - www.learnopencv.com/blob-detection-using-opencv-python-c/
  - https://stackoverflow.com/questions/8076889/
6.2 Task

In this lab, we will continue using built-in functions in the OpenCV library to locate blocks based on their color and find their centroids. They will allow us to efficiently complete tasks without having to develop algorithms ourselves. Similar to Lab 5, the task for this assignment is to pick and place blocks within the robot’s task space. The TA will place the blocks at a random location within the camera’s field of view. The goal is to line up each block next to one another, such that the orientations are parallel world frame’s x-axis. In order to accomplish this, we will need to extract the object’s pose information using the centroids from multiple blocks in the form \((x_{\text{start}}, y_{\text{start}}, \theta_{\text{start}})\). Using the inverse kinematics subroutine implemented in the previous lab, we can obtain the goal joint states. Once we have obtained the start and goal joint states, we can use the move block subroutine to move the blocks. The intent for this assignment is to be open-ended so students can be creative with their solutions.

6.2.1 Block Construction

In this lab, we will use larger blocks comprised of 3 normal blocks in order to have a meaningful orientation. The steps to construct a larger block for use in your lab are simple.

1. Select three different colored blocks.

2. Place them adjacent to each other in a line.

3. Use tape around the outside edges to fasten all the blocks together to create the larger block.

This will leave you with a large block with both a meaningful orientation and three different colors visible to the camera. Finding the centroids of each colored block can aid you in determining its position and orientation in the work area. **NOTE:** Please do not deconstruct any larger blocks you find already made by previous groups. Feel free to use any pre-made blocks you find if you do not wish to make your own.

6.3 Report

None required.
6.4 Demo

Show your TA the program you created. Your program should successfully pick the blocks and place them neatly **aligned with the world x-axis on the left side of the work area**. You will need at least 2 blocks with the same color-scheme, and should place them oriented the same way (i.e. not flipped color-wise).

6.5 Grading

This lab will count for up to 50 extra credit points towards your overall lab score. Your final lab score is not capped at 500, so theoretically a student can finish the semester with a score of 550/500 in the labs.

Each demo attempt will deduct 10 points from your score on this lab. If you take more than 5 attempts to successfully demo, you will earn no extra credit.

A *demo attempt is defined as showing a TA your solution when the TA places the blocks in the workspace*. If the student places the blocks, it does not count as a demo attempt. For clarity, the grading scheme is listed below.

- Successful demo on first attempt: 50 extra credit points earned
- Second attempt: 40 points
- Third attempt: 30 points
- Fourth attempt: 20 points
- Fifth attempt: 10 points