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Modern Robot Programming Problem Set #7

CODE LINK: https://github.com/art81/EECS373/tree/master/problem_set_7

Theory Of Operation:

Centroid Manipulation

Given the pixel coordinates (where 0,0 is top left) of the object's centroid, we must find where the object is located in meters in reference to the robot. First, I transformed the centroid so that 0,0 was the center of the image and that upper left was positive x and y (like a normal coord plane). Next, I needed to find a variable that represented meters per pixel on the image to convert the centroid to meters (in reference to where the camera is). I moved the object a known amount in meters, and then saw how many pixels it moved and divided those values to get the scale factor. Now I have object coordinates in reference to the camera's frame and must now transform this to robot coordinates. To do this I needed 3 more values, the x position of the camera, the y position, and also the yaw rotation of the camera. I moved the object until the centroid was 0,0 and that marked the x and y coords of the camera. To get the yaw rotation, I moved the object in the x-direction (robot frame) and then saw at what angle it moved in the camera's frame. I then said that the robot x and y were equal to the normalized camera centroid, times metersPerPixel and then times the camera transform (given by yaw angle and x/y position). I then published this x,y coordinate (meters in the robot frame) to be used by the example_object_grabber to pick up the object and move it to a known location. I also had to detect and manipulate orientation which I will discuss next.

Orientation Manipulation

Firstly, we need to figure out the orientation of the block in reference to the camera using image processing techniques. What I did was create vectors holding all of the x data and all of the y data. I then used the following equation to calculate the slope of the line that is fit to the data: slope = (EXY-(EX*EY)) / (EXX-(EX*EX)) which I learned in STAT 332: statistics for signal processing. This slope will represent the slope of the block in space, after that, I did the arctan of the slope to figure out the angle that the block is at and then used this to find a quaternion that represented the orientation of the block. Now that we have the orientation of the block, we must manipulate the block so that it is placed in a specific orientation. In order to do this, I created a transform for the block in reference to the gripper that described that the two should have aligned x axes, and opposite z-axes (and in turn opposite y-axes). This will make it so that the gripper picks up the block in a way where the gripper and the block have aligned "coordinate" frames. When I place the block, all I have to do is set the gripper to a certain orientation and the block will have that same orientation because their coordinate axes are aligned.

Observations of Behavior and Limits

One limit that I have noticed is in the variable that represents meters per pixel of the camera. I noticed that the robot was not finding the exact centroid of the block through the image processing and I think it is because this variable was not the exact correct value. This

makes it so that the centroid of the block will be slightly off which will even trickle down to there being error in the placement of the block in a specific spot. One thing that I observed during this assignment was that the vacuum gripper doesn't always pick up the block even if the two are in contact. I clicked to "view contacts" and they showed that the two were touching but the gripper still didn't pick it up about 50% of the time. Not sure why this was happening but I think it was an issue with the backend code to the gripper as Dr. Newman said that there was an error like this in the past where the fix may not have made it to the code that we were given.