Aalto University
School of Electrical
Engineering

ELEC-E8126

ROBOTIC MANIPULATION

Report: Exercise -5

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1 The approach chosen for planning the grasp:

With the given data of friction coefficient to be 1, which makes that $tan^{-1}(1) = 45^{\circ}$ will be the angle required to compute the friction cones.

I used friction cones to compute the stable grasps first. To do this,
1. Read the vertices from the given file

2. Generate pairs of points from the polygon : From the list of points, create set of paired points next to one another. That is, I pair up two two points

3. Generate Initial Grasp Positions: Generate possible grasp positions by calculating the midpoint of those pairs of points found in step 2

4. Calculate the approach angles of robots at each point.

5. Compute the friction cones of each grasp point: To do this, we will get the slope of each pair calculated in step 2, then calculate the perpendicular slope(-1/m). Then take the angle from slope at which we need to generate the cone, followed by which I added +45°and -45°to the calculated theta, to generate the vertices of the cone(in 2D). Then I store this cones for each grasping point, i.e. I link every grasping point with their friction cones.

6. Compute the grasp pairs from this friction cones: I will check which other points are present inside the each grasping cones. To do this, I use a bounding box algorithm which tries to check which points are present inside a polygon. And then I link the grasping points with their possible grasping pair(the points which are present in their corresponding friction cones)

7. Find the stable grasps: Then I will check all the stable grasps by checking mutual presence of points inside the friction cones. i.e. if point 1 has a possible grasp of point 5 , then i check the same if point 5 has a possible grasp of point 1 though point 5's friction cone. If they have mutual occurrence in their friction cones, then I will assume it as a stable grasps. Since the given object is symmetric, there can be multiple stable grasps.

8. Finally I compute the distance of each grasping points pairs to the origin(i.e. center of the object) to get one final stable pair. The pair with smallest distance will be my final chosen grasping point.

9. Finally I write the data to the grasp data file.

2 How to run your grasp planning code:

To run the planning code please follow the steps below:

cd exercise5 (please log into exercise5 folder in work space)
cd data/
sh generate_grasp_points.sh

The data will be generated in the designated file.

3 Visualization of the grasping points, approach direction, and friction cones on the object polygon:

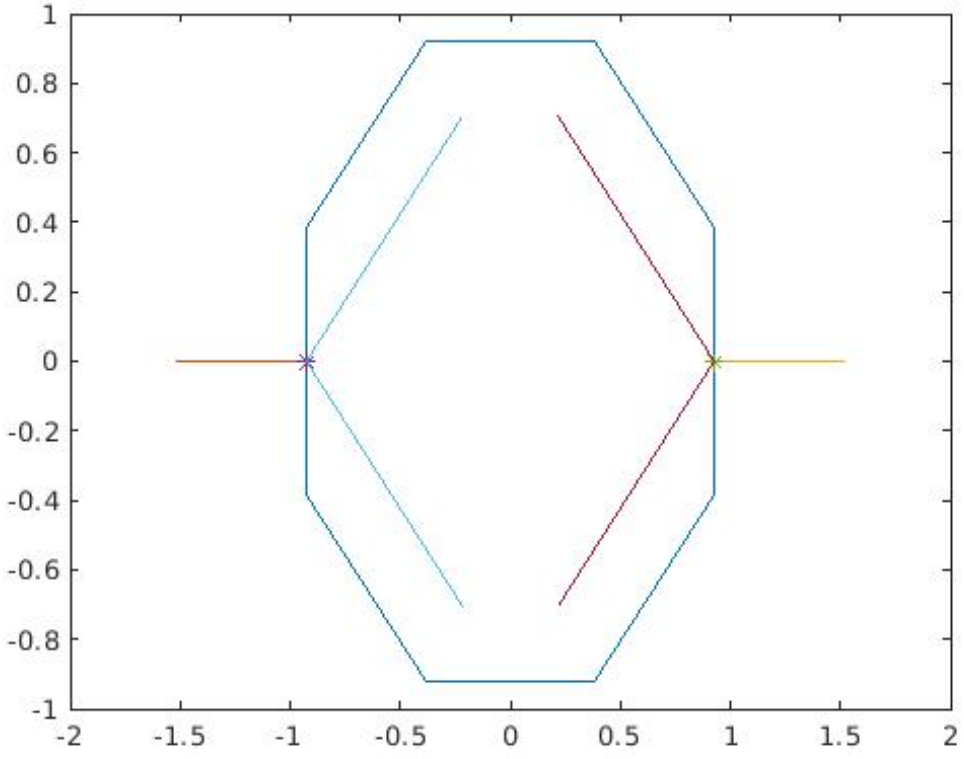

Figure 1: Plot of grasping points

4 Discussion of the results and answers to the following questions:

4.1 Is the grasp both force-closure and form-closure, either of, or neither? Explain why.

I feel like the grasp is Force-Closure. As the there exist for every friction cone, there exist another contact which cancels the force. So the final external wrench is compensated.

4.2 If the object was not force-closure, where would we need to place additional contacts to achieve it?

Sorry, I'm not sure about this question. But If the Object is not force closure, we need to have contacts at convex hull of friction cones. Also the contacts should be in such a way that they are placed by maximising the grasp quality metrics.

5 Estimate of time spent on this exercise:

This was really challenging exercise. I had to spend more time. Spent approximately 20 hrs to solve this problem.