CS4610/CS5335: Homework 4

Out: 3/29/19, Due: 4/5/19

Please turn in this homework to the TAs via email on the due date. HW PA Q1 and Q2 should be submitted in the form of a set of two files named Q1.m and Q2.m. All this should be zipped up into a single file and emailed.

Have a look at the accompanying zip file. Stub files for Q1.m and Q2.m are provided to you. You should implement each of these. Once implemented, you should be able to run "hw4(X)" in order to run code for question "X". hw4.m is given to you and should not need to be modified. The only thing you need to do is to insert code into the stub functions in Q1.m and Q2.m.
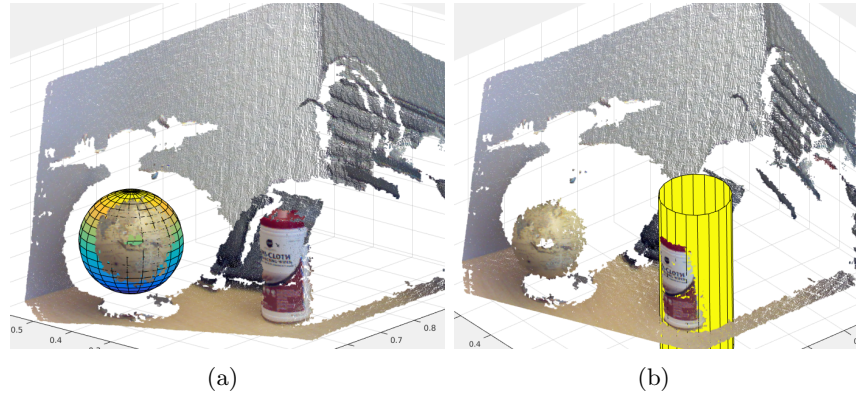
Figure 1: (a) the sphere localized in Q1. (b) the cylinder localized in Q2.

PA Q1: In this question, you must use RANSAC to localize a sphere given point cloud data. The point cloud contains a ball that is only partially visible to the sensor. The position of the center of the ball is unknown. The radius is unknown, but between 5cm (0.05m) and 11cm (0.11m). Write a function in Q1.m that calculates these two quantities. You can test your code using the cropped point cloud (see commented hw3.m). But, you should submit code that works on the entire point cloud without cropping. Important: please do NOT use the built-in Matlab function for sphere fitting. However, you MAY use the built-in function for computing surface normals, PCNORMALS.

Hint: one way to generate sphere hypotheses is as follows:

1. sample a point from the cloud;

2. sample a radius of the candidate sphere between 5 and 11cm;

3. project a vector from the sampled point in the direction of the associated surface normal for a distance equal to the sampled radius. This point would be at the center of the candidate sphere.

PA Q2: Same as Q1 except for a cylinder. This question is harder because you need to calculate the center, the orientation, and the radius (between

0.05m and 0.1m). The orientation should be returned in the form of a unit vector pointing along the axis of the cylinder (either direction is fine). You only need to solve this problem for the segmented cloud, as implemented in the code.

Hint: one way to generate cylinder hypotheses is as follows:

1. Sample a radius for the candidate cylinder between 5 and 10 cm.

2. Sample two points from the cloud

3. Set the cylinder axis direction equal to the direction of the cross product between the surface normals associated with the two sampled points.

4. Pick one of the sampled points from the cloud and use it to estimate a candidate center, just as you did in Q1.

5. Project the points in the cloud onto the plane orthogonal to the axis you just calculated. You can do this projection by multiplying the points in the cloud by this matrix: $I - \hat{a}\hat{a}^T$, where $\hat{a}$ is equal to the axis of the cylinder. Also project the candidate center into this plane in the same way.

6. Evaluate number of inliers in the plane for a circle with the given projected center and the sampled radius.