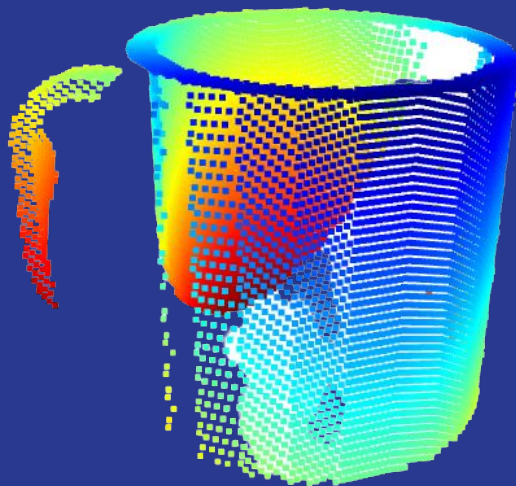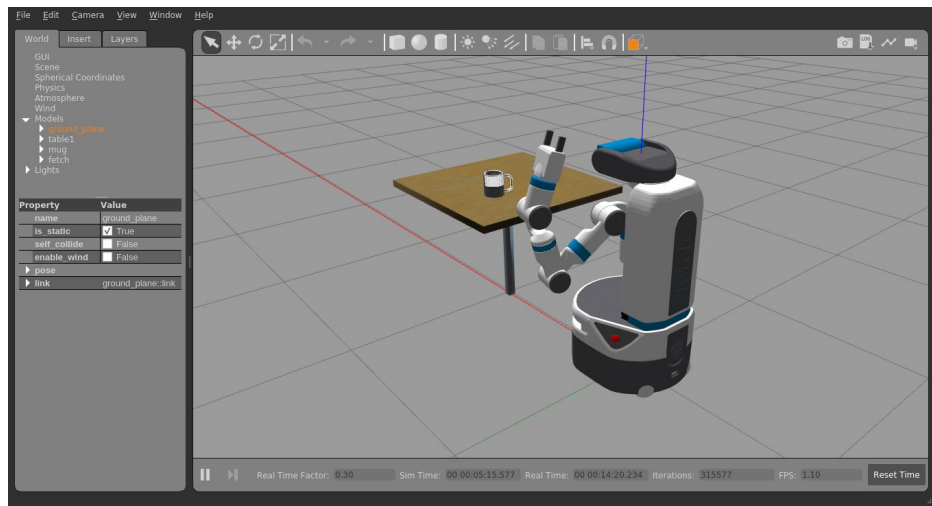# 6D Model-Free Mug Grasp Planning
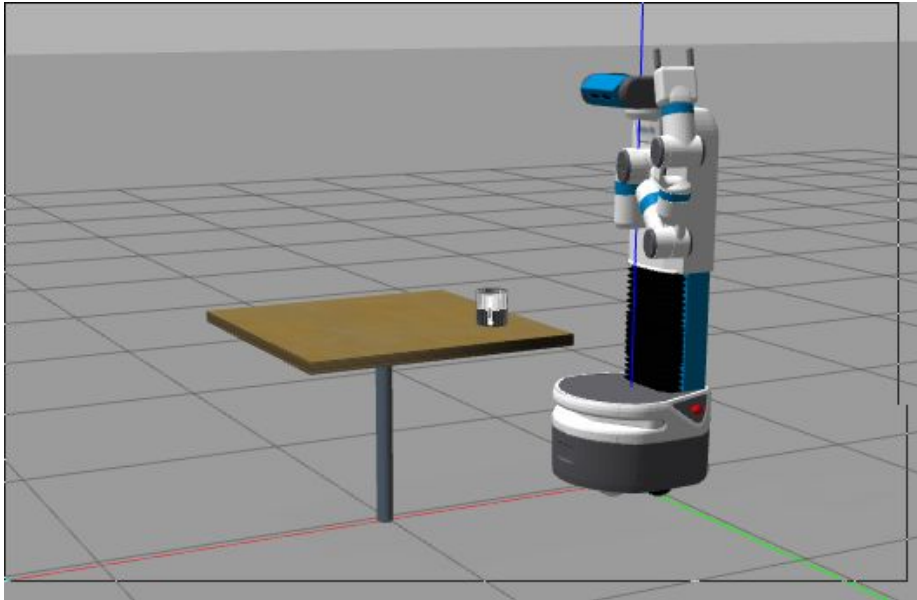
Ayush Agarwal, Rishi Chandna, Ty Ponzo

Introduction

The goal of our project is to pick up a mug using a model free approach, utilizing the Fetch Mobile Manipulator's stereoscopic camera to obtain object point clouds, which will be used for grasp planning and object manipulation.

Environments/Models

- Ros
- Gazebo
- SketchUp 3d Warehouse (Mug Model)

Approach Overview

Take in environment input
1
Use stereoscopic camera data to generate ROS point cloud

Data transformation
2
Use Open3D API to process and manipulate the ROS data

Understand environment
3
Perform plane segmentation and isolate Mug shape

Find key points
4
Use Intrinsic Shape Signatures to extract key points from 3D Mug point cloud

Find mug handle location
5
Using key points, find mug handle location

Find Grasp Point
6
Take average of mug handle key points to find a possible grasp point

Taking in Environment and Generating Point Cloud

- Using stereoscopic camera data, subscribe to PointCloud2 messages
- Take in ROS data, convert to a 3D point cloud using Open3D
- "Missing" data leaves holes in point cloud
- Colors correspond to Z-axis
- Point cloud contains all data in environment - table, mug, etc.
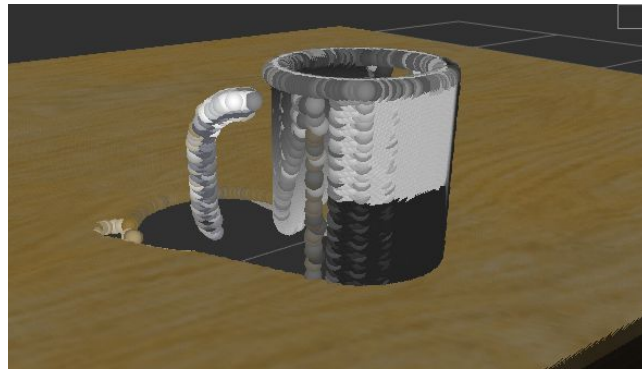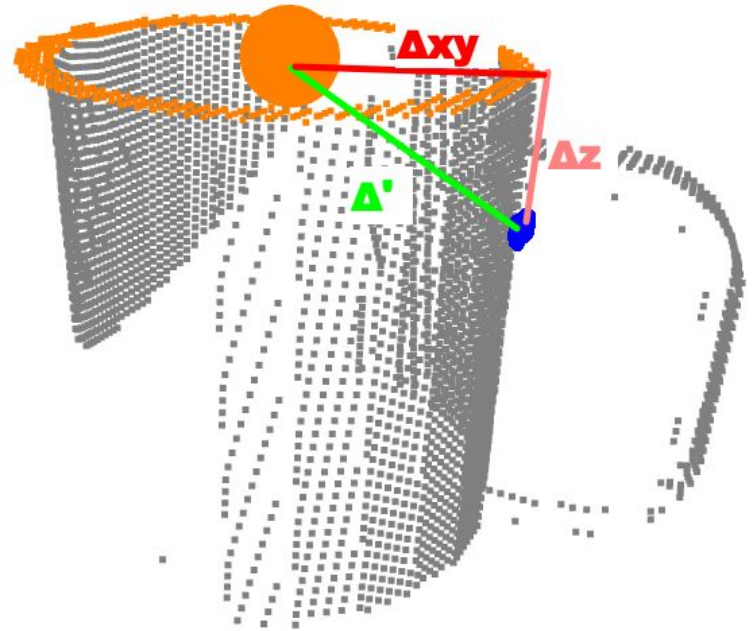
Isolating the mug

- Need to filter out environment to get object of interest
- Attempted to use Open3D's clustering algorithm - couldn't differentiate mug from table
- Used plane segmentation - find floor and table planes
- Selecting points on upper side of table plane will isolate mug
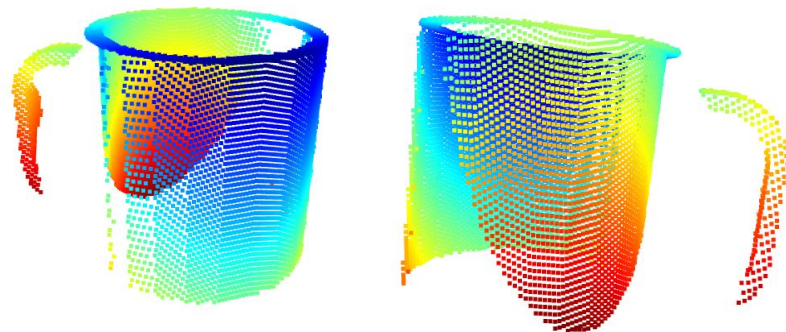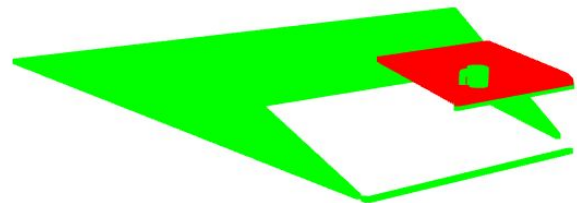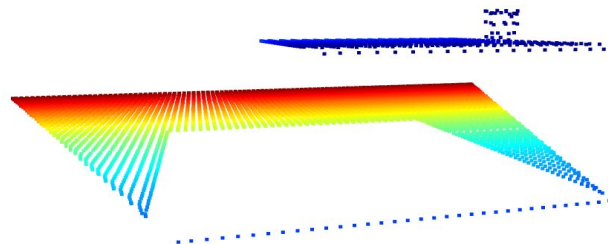
How to find the handle?

- Assumptions:
- Most points on the surface of the mug will be the same distance from the center of the mug - radius of mug
- The points on the handle will be farther away

Finding the handle?

- Using just the average of the mug cloud as the center leads to issues
  - sight lines, mass distribution
- Coordinate system shifted, have to isolate x-y in the mug frame
- Use the center of the rim!
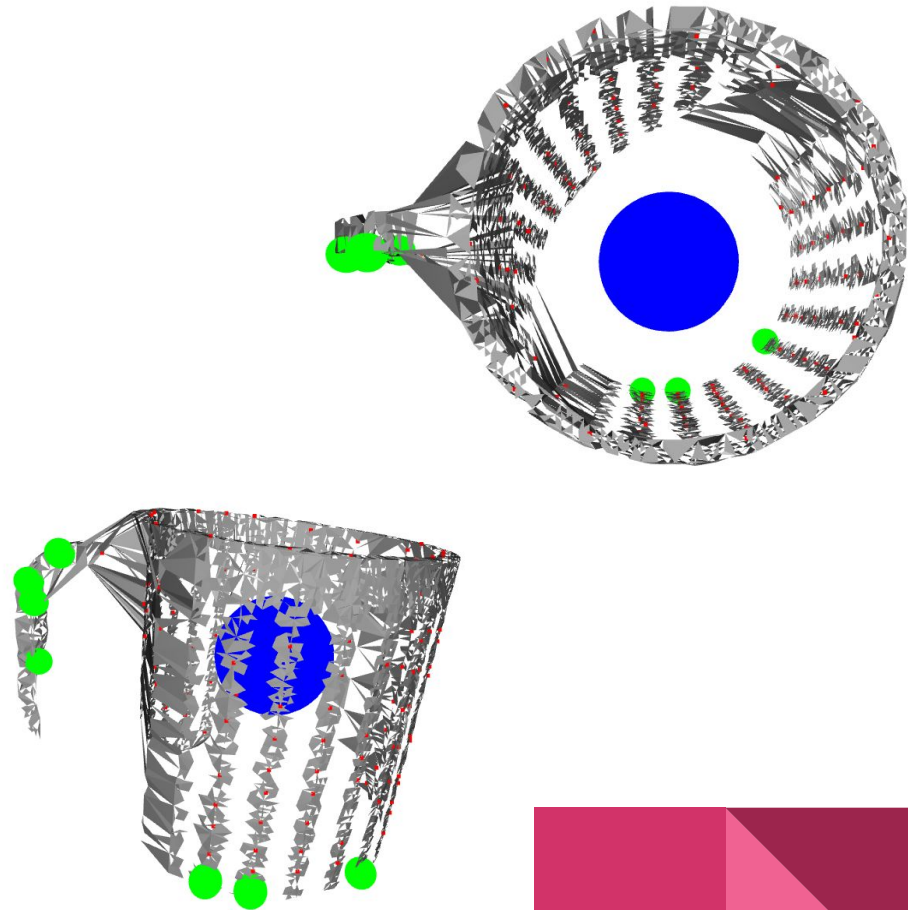
Finding Rim Center

- Compute proximity from table-plane for all points in the mug cloud
- Take the top 10th percentile as the rim
- Use the average of these points as the rim center
- Attempted triangle mesh from point cloud
- Compute intrinsic shape signature (2009) - red points
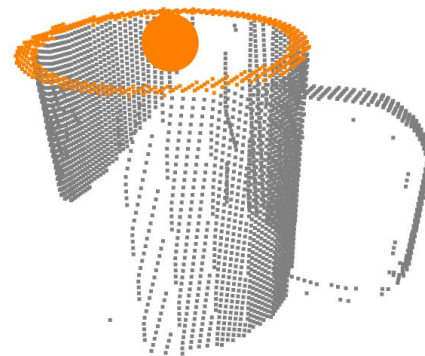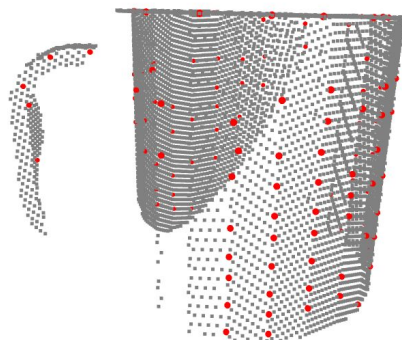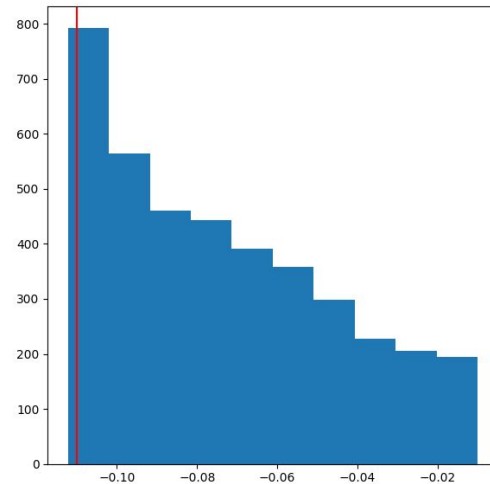
Grasp planning for handle

- Found handle by calculating center of mug, and then selecting points furthest from it
- Select ISS points using above parameter and average to find a possible mug handle
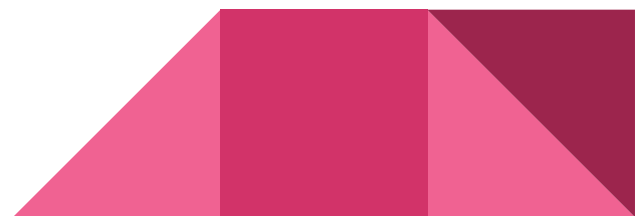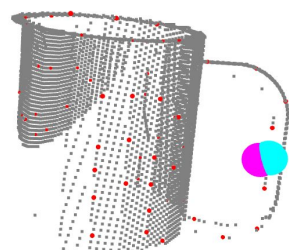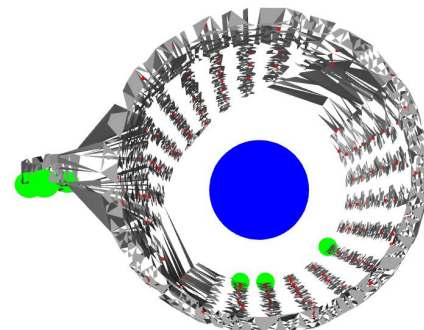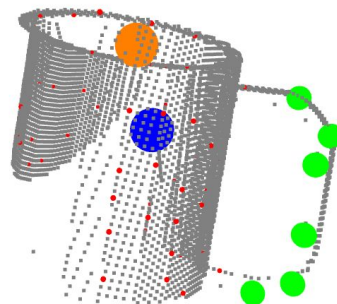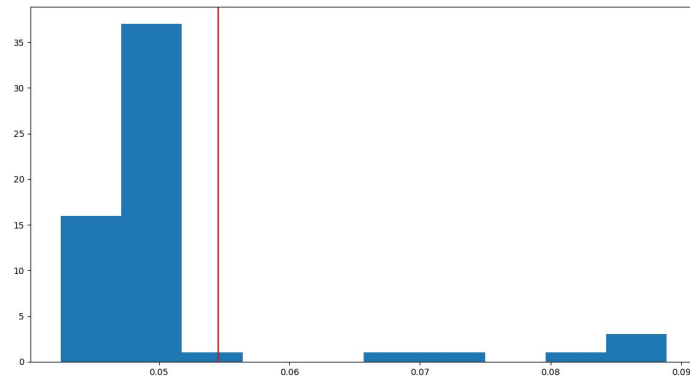
Future Considerations

- Consider unique handles, shapes, and orientations
- If there are multiple items on table, which one is the mug?
- Mug placement and movement
  - Pick up and put down
  - Pouring liquid
- Grasping different whole mug vs handle

Demo

Citations

[1]https://docs.ros.org/en/lunar/api/sensor_msgs/html/msg/PointCloud2.html

[2]http://www.open3d.org/docs/release/tutorial/geometry/pointcloud.html

[3]http://www.open3d.org/docs/release/tutorial/geometry/pointcloud.html#Plane-segmentation

[4]http://www.open3d.org/docs/release/tutorial/geometry/iss_keypoint_detector.html