Assignment 3

Advanced Graphics, Augmented Reality, and Virtual Reality

September 2020

1 Problem Statement

In this assignment, we will work with point clouds, and implement different flavors of the iterative closest point algorithm. We will do so first on some pre-existing data, and then on our own data. Making your code modular will help as a lot of tasks require the same backbone, and having interchangeable blocks will make doing them easy.

Generate random 3D point clouds of 100 points, 10,000 points and 1,000,000 points. Perform some random rotation and translation transforms on one of them, which we will call the source, and use them as inputs for the following.

1. Write a standard ICP implementation based on SVD.
2. Write a standard ICP implementation with with non-linear least squares optimization. Do for both point-to-point, and point-to-plane.
3. Use a KD-tree data structure for speeding up the ICP procedure. This is the industry standard algorithm for faster convergence. Report change in timings.
4. Apply a scaling transformation to the source point cloud. Code the Umeyama ICP method, or any other such methods which deals with scale transformations as well.

2 On A Standard Dataset

Find either

1. The MATLAB LivingRoom dataset (pre built into Matlab). This is a collection of RGBD images captured using a Microsoft Kinect. Pick image 1 and 3 from this, and run all 4 of your ICP algorithms on the two point clouds. Report the time taken and mean square error for each.
2. Find the Redwood RGB dataset here. This is a subset of 2 images from the Redwood dataset. Import them using the instructions here, and run all 4 of your ICP algorithms on the two point clouds. Report the time taken and mean square error for each.

Run your ICP algorithms on the data as is - then incorporate some method of outlier detection/clipping, and run the ICP algorithms again. Compare the errors.

3 On Your Own Dataset

Capture two separate point clouds of your room. You can use the *Point Cloud AR* app for iOS. For Android phones, look up specific ways to capture point clouds for your device / request it from someone having an iOS device. Run all 4 of your ICP algorithms on the two point clouds. Report the time taken and mean square error for each. Try your outlier detection/clipping methods.

4 Marking Scheme

Kindly make a clean, well-made report detailing your outputs. Your report should be verbose and complete, outlining all your algorithms and results. This will directly influence your overall grading as well. The 4 implementations listed above will roughly get you 20-20-30-30 marks each.

5 Submission Guidelines

The assignment can be written in MATLAB or Python. You are not allowed to use any pre implemented functions. You may use Open3D in Python to import the RGBD images. Submit four code files, your .ply / .pcd point clouds, and a complete report with your plots, errors and other findings. Please submit all your files in a roll numbered zip on Moodle on or before 11.55 PM September 29, 2020. Keep in mind the late day policy, and use them wisely.

Find a MATLAB activation/installation guide (included with your College ID) here.

Best of luck!