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CSCI 547 : Sensing and Planning in Robotics
Project Final Updates : Extracting Identical colored Duplos from a given point cloud.

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Model Fitting IA-SAC

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Clustered cloud from Euclidean clustering process

Sample Consensus Initial Alignment Registration Algorithm:

Model Fitting algorithm based on relationships between the geometrical properties of the points in the k-neighborhood and their estimated surface normals.

- Normal Estimation
- FPFHEstimation using FPFHSignature33

They use radius search for feature and normal radius of 1 mm

Model Alignment:

This tries to find the maximum correspondence between the points in the various models provided as input and target cloud iteratively till it finds the best match.

If the fitness score is considerable or it crosses # of specified iterations, it terminates. It then calculates the final transformation for the best alignment. This transformation is applied to model to fit the target cloud.

Better than iterative closest point which works only if one cloud is a rigid transformation of another. Also icp doesn't use feature correspondence to find the best fitness

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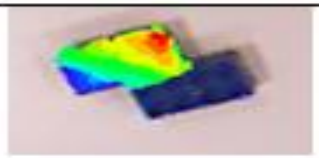
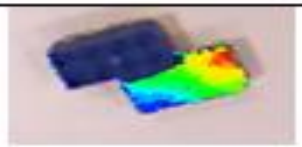
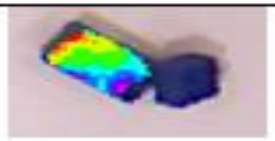
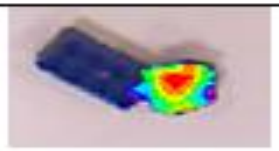
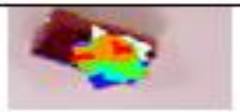
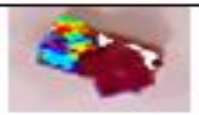
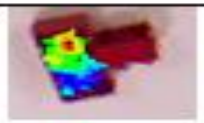
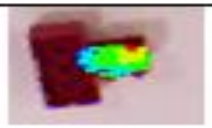
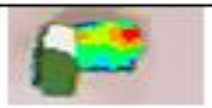
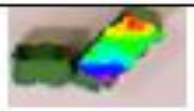
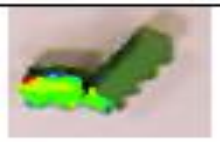
Results for the original problem statement

Input File	First Matched Duplo	Second Matched Duplo
 Group12_1.pcd		
 Group12_2.pcd		
 Group12_3.pcd		
 Group12_4.pcd		
 Group12_5.pcd		
 Group12_6.pcd		

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Results from the extended cluttered environment

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Tuning Parameters

Minimum Sample Distance: This parameter is tuned to 1 mm which specified the samples to pick within this distance

Maximum Correspondence Distance: The maximum distance threshold between a point and its nearest neighbor correspondent in order to be considered for the alignment process. This parameter has been tuned to “0.01*0.01” in terms of squared distance.

Maximum Iterations: The number of iteration carried by the algorithm for fitting a model to the data. It’s actually the maximum number of iterations the internal optimization should run for. We have used the 1000 iterations which give a pretty stable result.

Normal Radius: Specifies the size of local neighborhood to use when computing the normals.

Feature Radius: The radius to use when performing the correspondence search

KdNeighbors Search Radius: We have tuned it to 0.009 for the kdtree radiusSearch.

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Algorithm Design Issue

- Matching is normalized on number of elements matched, leads to local minima for fitness score
- Performance is slow after using 5 templates, better matching can be achieved using more templates but performance drops heavily
- Model Matching doesn't work well with duplos with upside down, non-planar surfaces
- Reflection and color clustering issues.

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Duplo Cloud Extraction Demo

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