3D Perception Project

April 20, 2018

EXCERCISES

EXERCISE 1

The preprocessing of the images start with the reduction of the noise acquired while obtaining them with the simulated *RGB-D* camera. For this, a *statistical_outlier_filter* is used. This process can be observed better in figures 1 and 2, where are presented a raw acquired image and its quality improvement after the statistical filter, respectively.

Once the quality of the raw image was improved, a *voxel_grid_filter* was used to reduce the information within the image, and then to increase its processing velocity. The effects of using this filter is presented in figure 3.

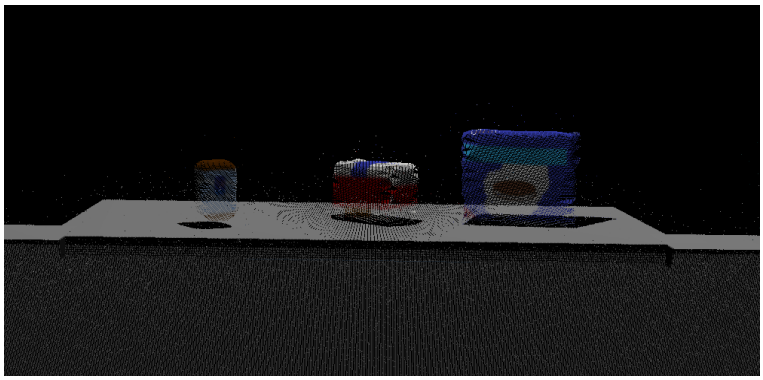

Figure 1: Raw acquired image

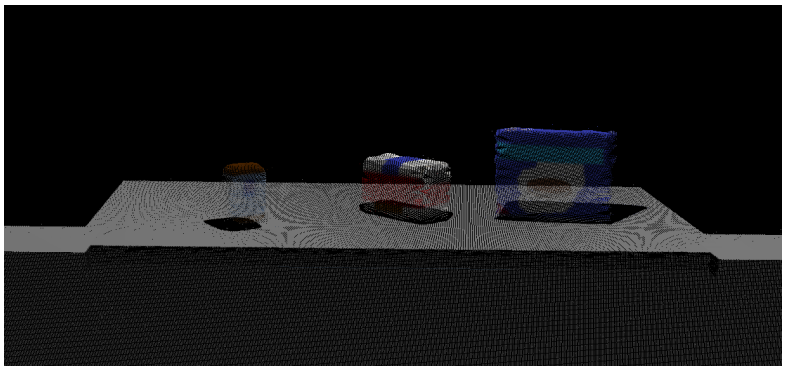

Figure 2: Image after a statistical outlier filter.

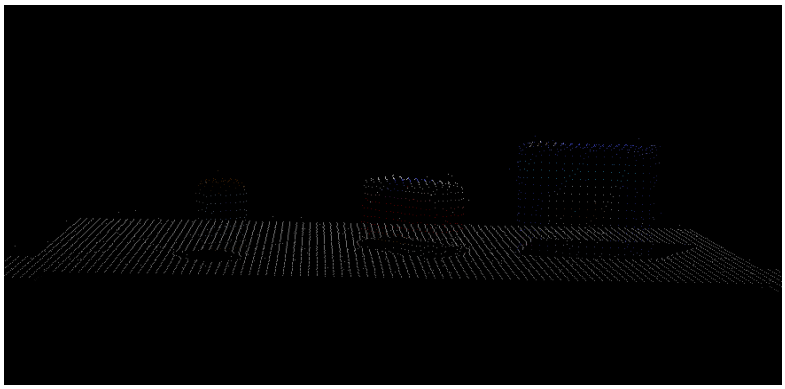

Figure 3: Image obtained after a voxel grid filter.

Then, a *make_passthrough_filter* was implemented to determine the objects inliners and outliers, as can be observed in the following images.

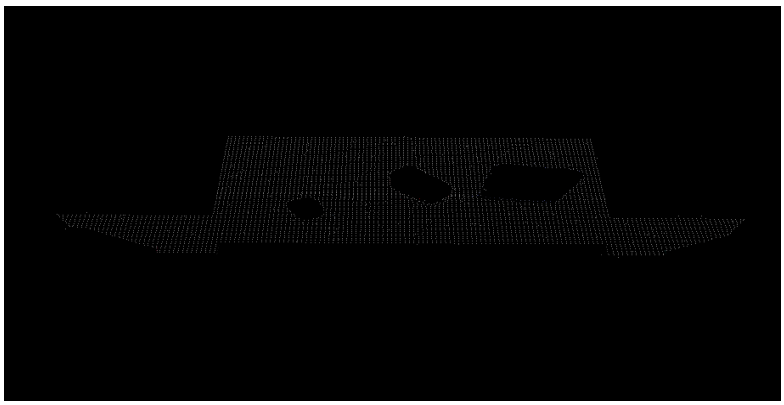

Figure 4: Outliers.

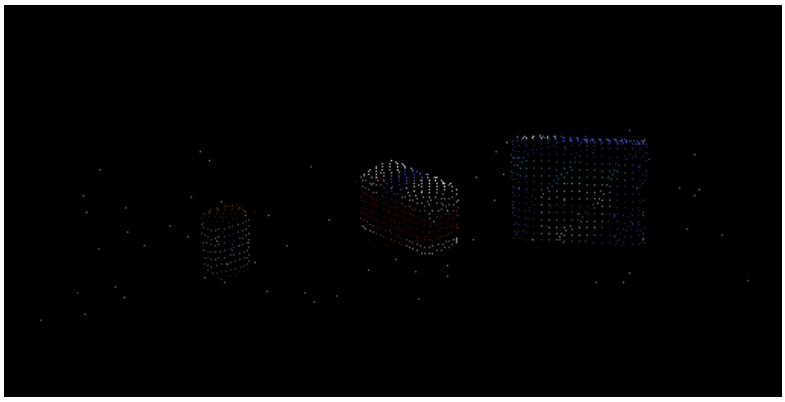

Figure 5: Inliers.

EXERCISE 2

The cluster segmentation was obtained implementing a *RANSAC Plane Segmentation*, using a *segmentation filter*. As result, the cluster was segmented in different objects, depending on the parameters used. An example of the results obtained is presented in the next figure, where each color represents a different object obtained by segmenting the cluster.

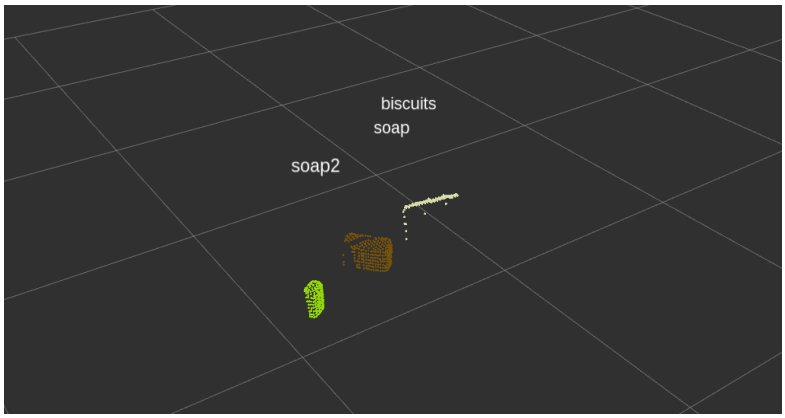

Figure 6: A boat.

EXERCISE 3

Additionally, in order for the robot to recognize each of the objects obtained by segmenting the clusters, a machine learning algorithm was implemented. For this case, a *Support Vector Machine* algorithm was used, which was trained by creating datasets generated by obtaining images from the targets objects to identify. Furthermore, the characteristics of the images were generated as their colors *histograms*, which were used as patterns to identify each object of interest. The performance of the trained SVM classifier is presented next.

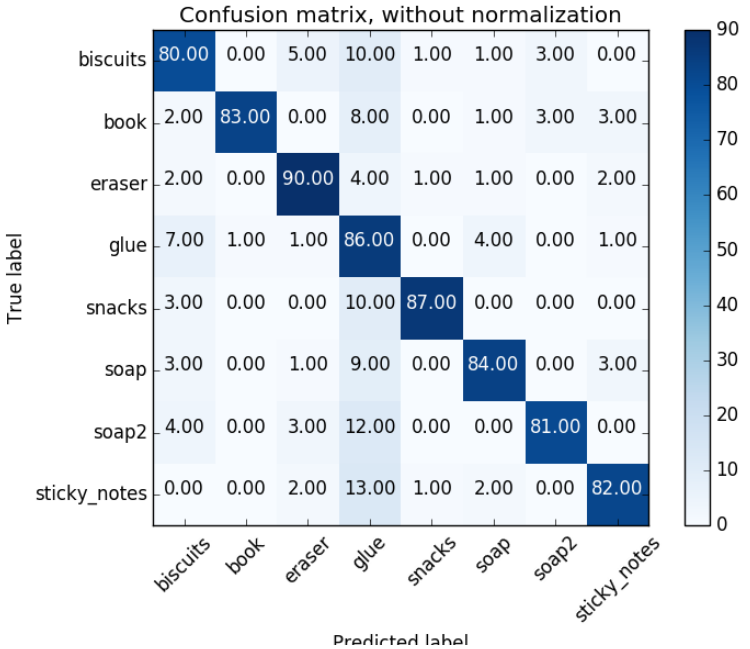

Figure 7: SVM confusion matrix.

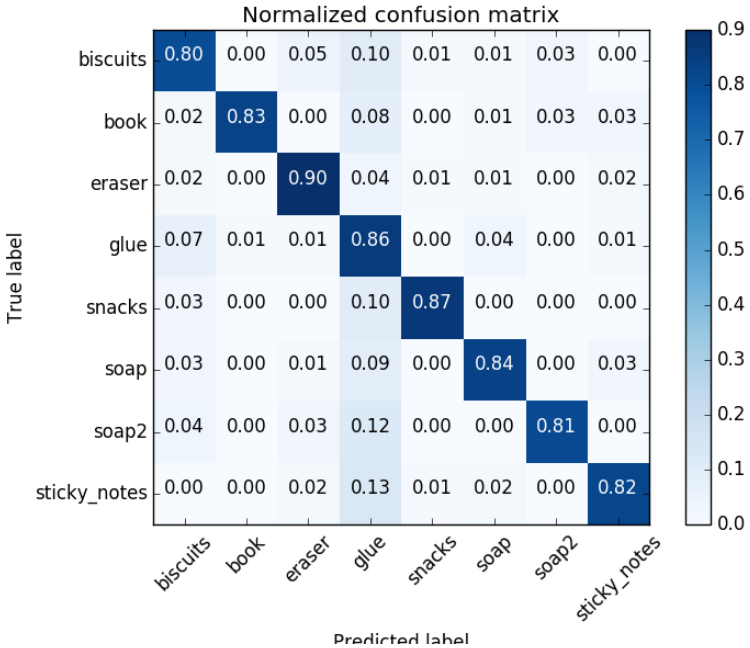

Figure 8: Normalized SVM confused matrix.

PICK AND PLACE SETUP

The pick and place process was implemented based on the methods presented in the previous section. However, even when all methods are important to achieve the pick and place procedure, the crucial part was the recognition of the objects. As result, the performance of the trained SVM for recognizing objects of interests is presented in figures 9, 10 and 13, for three different scenarios.

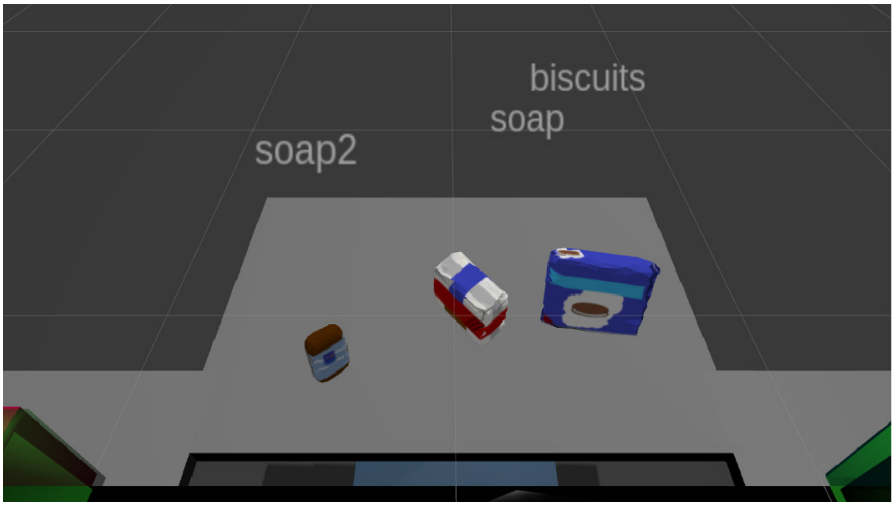

Figure 9: SVM classifier for the recognition of three objects of interest.

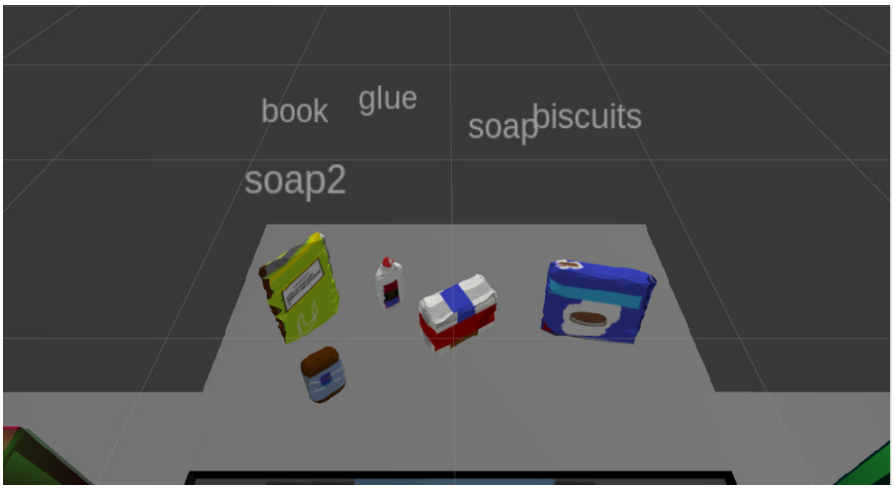

Figure 10: SVM classifier for the recognition of five objects of interest.

Figure 11: SVM classifier for the recognition of eight objects of interest.

Therefore, the pick and place process used the obtained targets as commands to a *PR2 robot*, to let the robot know where are located and to which group correspond each of them. Then, the robot can pick the target from the received location and store it to a specific group, as shown in the following images.

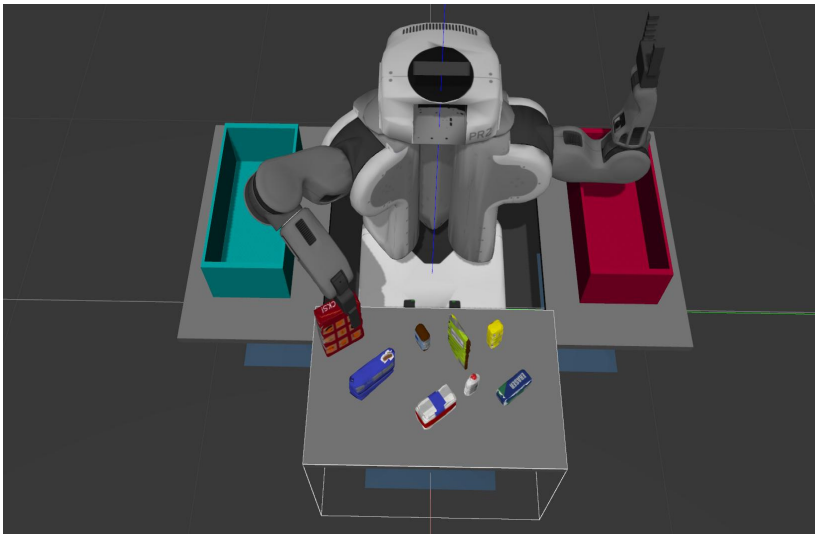

Figure 12: Picking process for the PR2 robot.

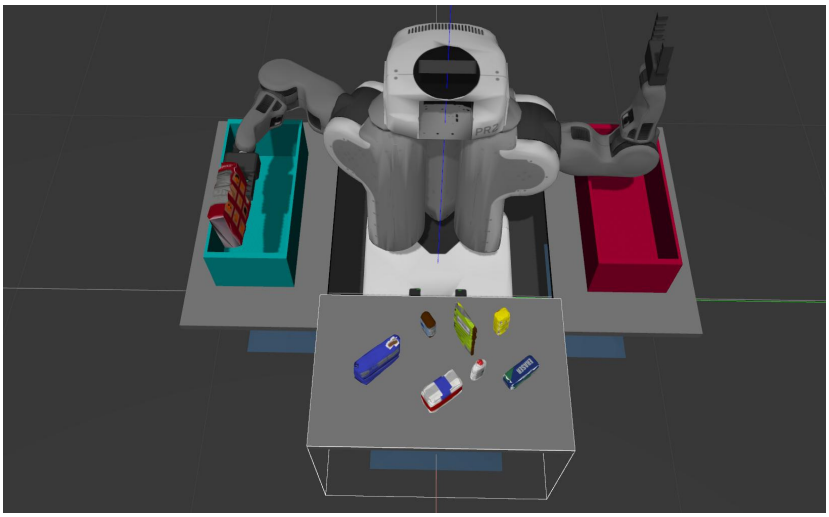

Figure 13: Placing process for the PR2 robot.