RoboND Perception Project Report

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I. Point Cloud Filtering Pipeline

The intermediate results of the point cloud filtering are shown in Fig. 1. The point cloud (1) is first passed through an outlier filter (2, `project_template.py:134`). It is then downsampled (`project_template.py:118`) and filtered by a pass-through filter that clips the cloud in the y- and z-directions (3, `project_template.py:151`). Next, the points belonging to the table are determined by applying RANSAC (4, `project_template.py:169`). The complementing points then belong to the objects (5). Finally, the objects are segmented by applying Euclidean clustering (6, `project_template.py:189`).

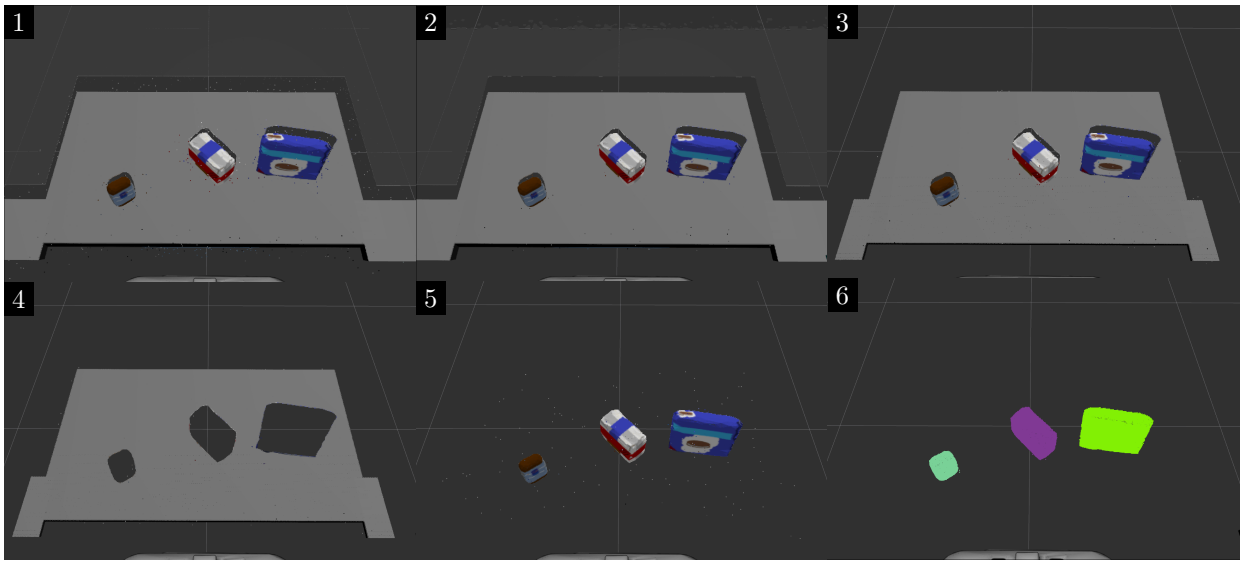

Figure 1: Stages of the filtering pipeline. (1) Unfiltered point cloud. (2) Outlier filtering. (3) Pass-through filtering in y- and z-directions. (4) RANSAC filtering: table. (5) RANSAC filtering: objects. (6) Euclidean clustering of objects.

II. Feature Extraction and SVM Training

In order to extract features for the SVM classifier, the object point clouds are first converted from the RGB to the HSV color space (`features.py:21`). Then, color histograms are computed for the three color channels with 32 bins and 256 value steps (`features.py:33-35`). Additionally, a histogram of the normal vectors is computed (`features.py:47-59`). Here, only the x- and y-components of the normal vectors are considered because in a normalized vector the third component is linearly dependent on the other two components. The normal vector histograms are computed with 22 bins and a value range of $[-1.0, 1.0]$. Both color and normal histograms are concatenated from their components and then normalized to one. Finally, the normalized color and normal histogram vectors are concatenated into one feature vector.

The SVM was trained by sampling 50 randomly generated poses for each object type. The confusion matrix of the trained classifier is show in Fig. 2. As can be inferred from this matrix, the classification accuracy lies between 90% ("book") and 100% ("eraser") for all objects in the training set.

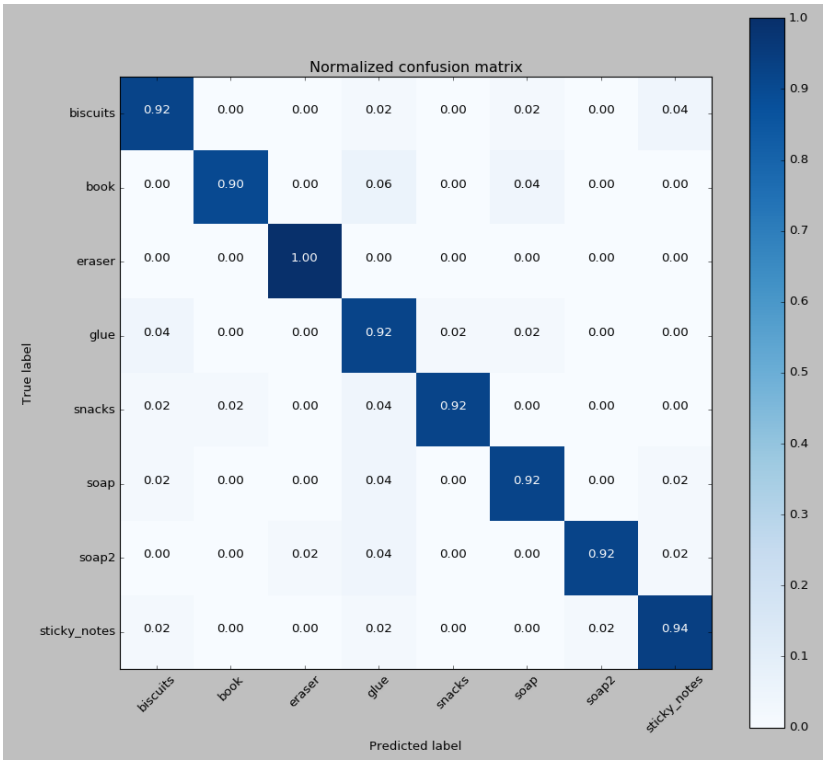

Figure 2: Confusion matrix of the trained SVM classifier.

III. Results

Results of the filtering pipeline with SVM classifier for the three different problem sets are shown in figure Fig. 3. As can be seen in these screen shots, the SVM is able to reliably classify all of the objects, even in cluttered scenes.

Figure 3: Object classification results for the three problem sets.