Individual lab report #8

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Team E

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1. Individual Progress

My major task was to collect new training data for the 2017 new item set, so that we can compare the two new neural networks and select one.

1.1 Lighting condition

Even the bin bottom covered by paper looks very reflective (Figure 1). The strong reflection might affect the item identification accuracy. Thus, I looked for alternative lighting conditions.

The lighting condition was improved by using the diffusive LED light borrowed from SoyBot group (Figure 2). The reflection was much weaker, but there was still obvious reflections still present near the center of the bin.

Figure 1. Reflective condition

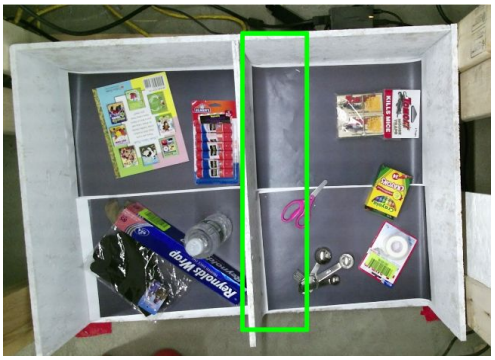

Figure 2. LED strip lighting condition

The LED strip was mounted at the center of the bin and used the dimmer to lower the intensity (Figure 3). The LED strip has a diffusive cover, which decreased the reflective light intensity.

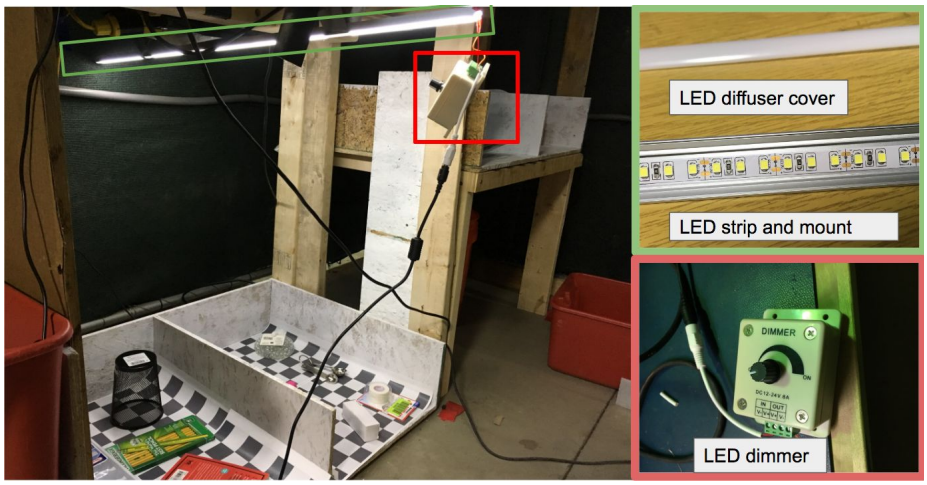

Figure 3. Lighting setup

2. new dataset
The computer vision system would need to identify items in the bin for picking and also items from the tote for stowage. Comparison between FCN and Faster R-CNN deep-learning networks need to be made on the new itemset.

Since the bins are still prototype, but the tote would be the ones from Amazon, we decide to train RGB data using the tote first to compare the two networks (Figure 4).

Data were collected for 1 to all the 38 items in the bin. The frequency that each item appeared in the training set was controlled to be uniform. Each item appeared for at least 8 times.

Figure 4. Crowded bin with ground truth labeling

To check how well the training result from the red tote could work on the customized bin, and to test suitable background color, data were also collected using different background(Figure 5). There were a lot of white items, so the original white background might not be a good choice.

Figure 5. Data collected using different background

2. Challenges and problems

It was difficult to find a good lighting condition for our use. To decrease the impact of ambient light at competition time, we might need to cover part of the shelf to shield ambient light, so the lighting condition can be controlled by light mounted on tote.

Given the space and budget constraint on the shelf, the current solution I could think of is try to find a more diffusive LED light strip than what we borrowed from SpyBots team. The lighting inside bin need to be strong enough to counter the possible shadow caused by lighting from outside but not causing reflections.

There were a lot of items have reflective surface or packaging in this year's item list (Figure 6). I will train the neural network on the small set of images for new items first to see if the current lighting is good enough.

Figure 6. Examples of reflective items in 2017 item set

3. Teamwork

This week, Michael worked on the new 1-DOF gripper. Matt worked on making the PCB for the slider. Leo worked on integrating Asus with our current system, locating bins using AprilTags and generate bounding box result from Faster R-CNN, segment point cloud and project the segmented point cloud into bin. Akshay worked on pose estimation for segmented point cloud.

I received a lot of help both from within the team and outside the team. When the items had issues with reflection, Akshay brought up the idea of borrowing LED strip from SoyBot. SoyBot team also told us how they setup the dimmable LED lighting. Matt and Michael helped me with assembling the LED light. Our MSCV group mate Sharon helped me with collecting and labeling data. I also worked with Sharon to compare FCN and Faster R-CNN using the old itemset. The result showed that FCN has a higher overall accuracy and performs better on occluded items (Figure 7).

Algorithm	Faster RCNN	FCN*
Average IoU	0.7839	0.8309
Centroid drift	5.9602	5.4044

* FCN output bounding boxes are filtered. Assume that size>20*20

Figure 7. Comparison of two algorithms for object identification (Sharon)

4. Plan

The next step would be getting the MVP running and train the new dataset.

Currently the neural network we are using is Faster R-CNN. FCN will give a pixel wise labeling, which makes it easier to segment the point cloud. My next step would be train Faster R-CNN using the new items. If the FCN outperforms Faster R-CNN in accuracy for the new itemset, we will integrate RCN to ROS. Leo will teach me how to integrate FCN with ROS, and I would received help from Sharon for learning how to use FCN.

Appendix: 2017 Item List