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Team E: PLAID
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1. Individual progress

Since perception now has become critical path for our project, the first priority after winter break is to design and create prototype for perception sub-system. I am in charge of the software part, and the software is developed based on the hardware design. For hardware, the architecture is shown in Figure 1. Basically, every bin has a corresponding RGB-D camera for getting top-down view, and every camera will be connected to one computer. Computers communicate and exchange data with each other via local network. The computer number is still under evaluation, and the decision will be based on how many CPU usages will be consumed by one camera. For bin, two strips of Apriltag will be attached on it for localization.

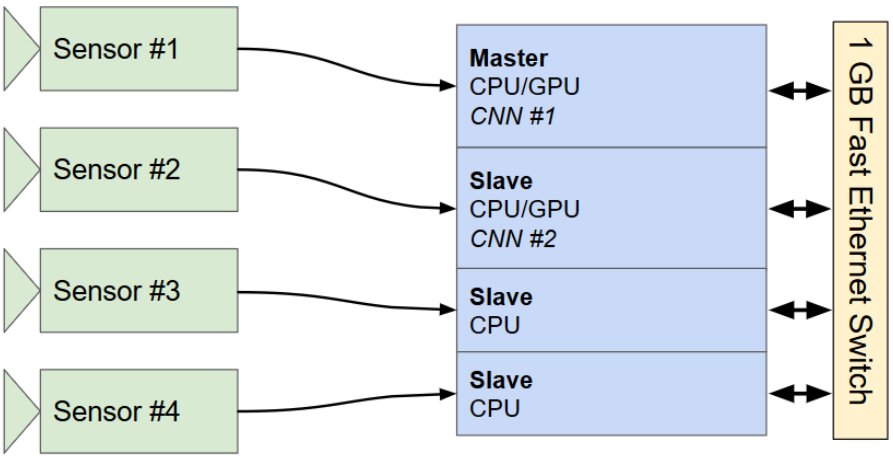

Figure 1. Perception Sub-System Hardware Diagram

As for Software, the architecture is shown in Figure 2. Four bin perception ROSNodes will be deployed for each camera. There is only one copy of source code, but multiple instances will be launched. Each ROSNode is distinguished by using different parameters and setting in launch file. Those ROSNode will act like proxies of camera, providing RGB image and segmented point cloud for other ROSNodes. RGB image is the top-down view of bin, and segmented point cloud is objects' point cloud. Also, transform between bin and camera will be broadcasted after Apriltags are localized.

For CNN ROSNode, it requests RGB image from bin perception ROSNode and item list from JSON file, and it will publish the identification result and bounding box after running through CNN.

Perch will use all information we have to estimate items' poses for grasping sub-system. It asks segmented point cloud, item candidate list and transform between camera and bin to search possible poses for each item by enumerating all items pose in three-dimensional space. Once it finds most possible pose, it will return such pose to user for further use.

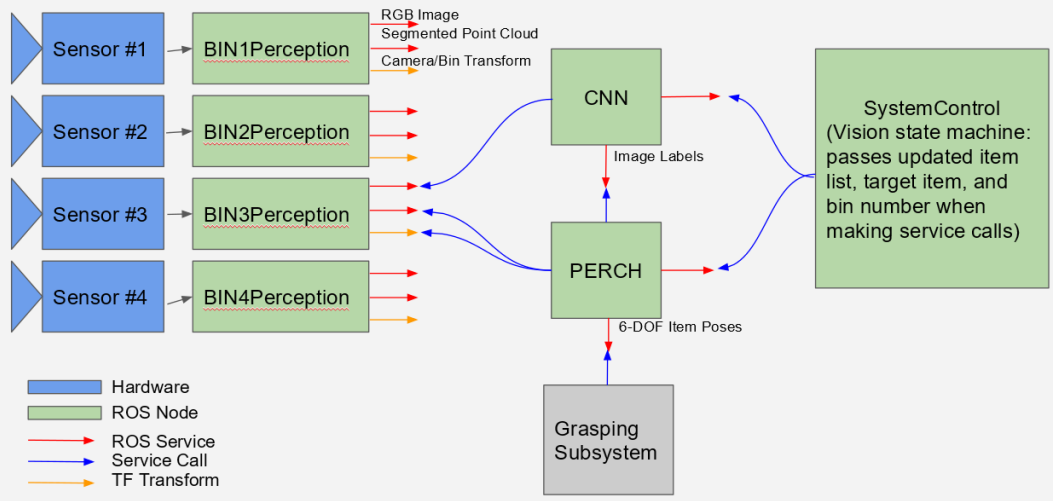

Figure 2. Perception Sub-System Software Diagram

2. Challenges

One of the biggest challenge so far is to get accurate transform between camera and camera depth sensor origin. For camera mounted on the arm, we could get the transform by looking at the base of robot, which is used by last year's team. However, same strategy can't be applied on cameras mounted on the frame. In those cameras' view, there is no ground truth position could be used as reference. One possible solution is to attach Apriltag on robot arm and stick arm into the bin. We are still seeking other elegant solutions to solve this difficulty.

Another obvious challenge is to identify unknown items by merely using CAD models which are released forty-five minutes before competition. We don't have consensus on solution so far, but training CNN with depth-RGB images seems like a reasonable solution.

3. Teamwork

For progress review six, we focus on different domains and break down the tasks as follows:

- Michael Beck – Project manager. Michael handles project schedule and goal. Michael keeps helping team to break tasks down and monitor progress of sub-tasks. He also helped to create design documents for reference.
- Akshay Bhagat – Akshay helped team to fabricate mount for linear slider, bin mockups, and shelf frame. He also contributed a lot to perception sub-system. Fast-RCNN is up and running and able to train on several 2016 APC items.
- Matt Lauer – Matt assembled server rack and create new planning scene for our new shelf and robot arm. Because we have already procured UR10, he also migrated planning packages from UR5 to UR10.

- Che-Yen Lu – I create a perception code template after discussing with all teammates and project PHD advisor, Venkat. With Venkat's help, I also got PERCH (Perception via Search) working on 2016 APC items now.
- Jin Zu – Jin do a lot of experiments and measure error to decide what size of Apriltag should be used in project.

4. Future plans

Since everything depends on shelf frame, we will create wood frame and bin prototype first for other sub-systems development. We target at finishing fully functional frame before the middle of April. As for perception, several CNN methods will be evaluated under different environments and scenarios. Mechanism for camera calibration will also be designed and implemented before PERCH comes into play. Schedule of unknown objects' identification will be pushed off till we are confident with the result of known items.