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Team D: CuBi

Teammates:
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ILR04

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Individual Progress

The main focus for this review was to estimate the size and orientation of the detected objects and have a real-time visualization of how our robot looks at the world. I worked mainly on the following:

- Wrote program to fit a tight OBB (Oriented bounding box) around the individual clustered out object point clouds and visualize it with cubic markers on Rviz. Results are shown in **Fig 1.**
- Developed modular URDF of the robot with launch and RViz files. It currently has the turtle-bot base and the camera mount with proper frame links and joints which can be helpful for visualization. Results are shown in **Fig 2.**
- Mounted the camera and validated its position along with Paulo.
- Transformed point clouds from camera frame to the front base link of the robot for better visualization and calculations.
- Improved the 3D detection pipeline a bit by further tuning the hyper-parameters. E.g. min size for clustering, down-sampling leaf size. This needs further improvement.

Results:

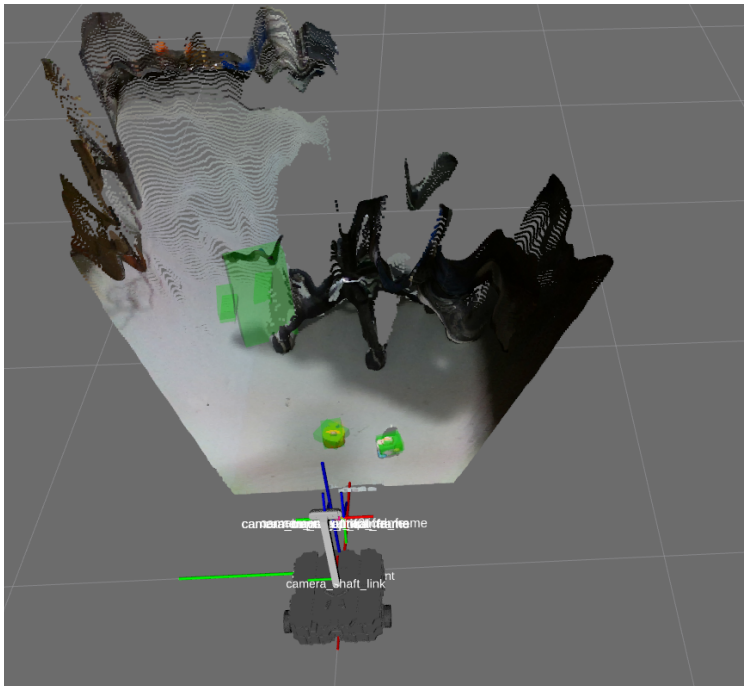

Fig. 1 Results of 3D object detection and plotting oriented bounding boxes

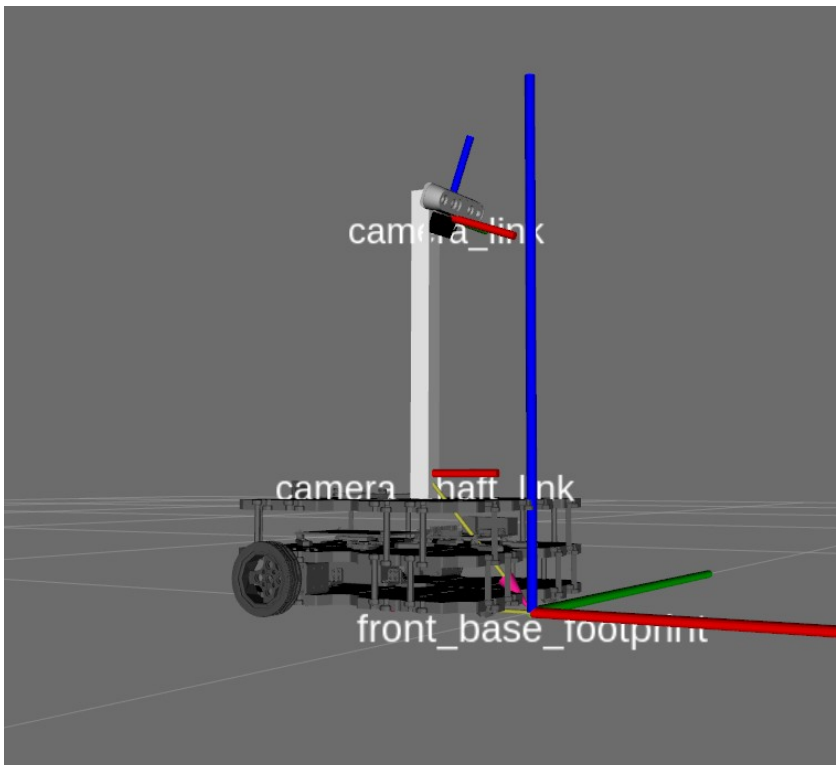

Fig. 2 Initial URDF for robot

Challenges

Individual challenges:

The major challenges were/ are with their proposed solutions:

- **Noisy detections (False positives)**
  Improve the hyper parameters of the 3D detection pipeline. Use learning based methods to complement the 3D detection pipeline. E.g. Initial 2D object detection for bounding boxes and segmenting these 2d bounding boxes with 3D point clouds to estimate size and pose. Consider objects attached just to the ground.

- **Objects detected that do not fit the FOV of camera**
  Find a way to see objects that touch the maximum FOV and remove them. Can identify them later when they can be seen completely.

- **Keeping track of and assigning id to individual clustered objects**
  Implement SORT algorithm

- **Decreasing accuracy with increasing distance (Harder for segmentation)**
  Overcame this currently by restricting the FOV (cropping the point cloud).
  Use learning based method to complement the 3D detection pipeline. E.g. 2D object detection and segmentation.

Team challenges:
The major challenge for the team this time was making the dynamixel motors work. We finally solved it by ordering a new motor for the middle joint, assigned correct IDs and baud rates individually to each motor and controlling them in a chained manner with ROS and joystick.

Next challenge is to work together and communicate more to integrate subsystems in order to be successful in SVD.

Teamwork

Important work I did for teamwork this time was to develop the URDF file which can be used by everyone to get the transforms, visualize things in real time, attach more sensors and experiment different things. It can be seen in **Fig 2.**
Following describes the work done by the team members and how I interacted with them:

Paulo:
Assembled the manipulator and its assembly as shown in **Fig. 3a. and 3b**. He modified the arm lengths and changed bracket designs to allow more movement and keep the arm as close to the base. I worked with him for the camera mount and its positioning and height. We mounted the camera on the base.

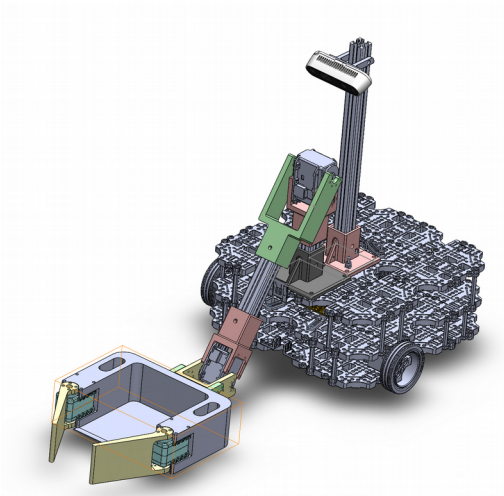

Fig. 3a. Final robot assembly in SolidWorks (Credits: Paulo)

Fig. 3b. Final robot assembly in real

Bobby:
Optimized the wiring for robot. Worked on resolving motor issues and ordered a new motor. Worked on resolving TX2 issues. Calibrated 0 positions for motors and added joystick code for motor control. I discussed with him about the integration of vision and SLAM and made an initial work-flow.

Jorge and Nithin:
Worked together on the motors. They changed the connectors for power and communication. Each motor was configured individually. They connected motors in series and made publisher and subscriber nodes to send commands to the motors.

Future Work

Individual plans:

- Finalize the hyper-parameters for 3D object detection pipeline according to the camera placement.
- Maintain a list of current objects and try to assign same color to clusters rather than random colors at every frame.
- Make 3D pipeline more robust and attempt to remove false positives.
- R&D for learning based techniques to improve detection pipeline.
- Work with Paulo to complete URDF.
- Work with Jorge and Nithin on 2d object detection.

If time permits:

- Research on optimizing and further improving the pipeline like using temporal information. E.g. average over n previous frames to make the 3D reconstruction more robust.

Team plans:

- Complete URDF
- Feedback-based trajectory follower for CuBi to execute pre-defined paths
- Implement and test the lidar SLAM algorithm using our robot
- Mounting of LiDAR
- Validation of payload