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Team D - HARP
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ILR03
Oct. 30, 2015

Individual Progress

This week, I worked on integrating Kinect sensor service into SMASH state controller and PR2 Gazebo simulation for moving its right arm from one pose to another.

The pointcloud from Kinect was published as a ROS topic using OpenNI libraries. A skeleton service node which subscribes to this ROS topic was created. This service node is a boilerplate for perception code. When this service is called, the perception algorithms will process the pointcloud along with RGB data and return the pose of the required item so that path planning of the suction gripper can be performed.

The PR2 arm was controlled using inverse kinematics action library. The Gazebo was used to simulate the PR2 robot. The PR2 arm controllers were launched. A ROS service was developed to call the inverse kinematics action library and compute the joint space trajectory from state space data (arm pose in XYZ and quaternions). A python script will call this service passing the required XYZ and quaternions as arguments. The figure below shows the initial and final pose of the right arm of the PR2 robot. The arm was moved from the default pose to position (-0.59, -0.36, -0.93) and quaternion orientation (0.65, -0.21, 0.38, 0.62). This motion of the arm was visualized in rviz.

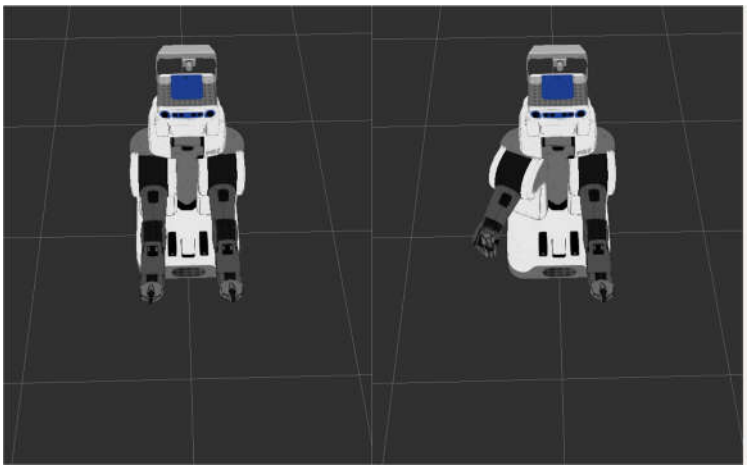

Figure 1: The right arm of PR2 robot is controlled and visualized in rviz

Challenges

An issue we had foreseen last week was incompatibility of Ubuntu versions. We were previously developing on Ubuntu 14.04 with ROS Indigo but the PR2 runs Ubuntu 12.04 with ROS Groovy. We could not upgrade the PR2 installation as other researchers using it required

Ubuntu 12.04. So a decision was made to switch to Ubuntu 12.04 and ROS Groovy. This created a few dependency issues.

The SMACH state controller from the Ubuntu 12.04 repository did not work and we had to compile it from source. The Kinect OpenNI library also did not work out of the box and a few settings had to be tweaked.

The major challenge was getting a ROS node to publish the Kinect2 pointcloud in Ubuntu 12.04. Kinect2 requires a Linux kernel of version 3.16 or newer but Ubuntu 12.04 has only Linux kernel version 3.13. Alex and Bhatia worked together to overcome this by running ROS Indigo on a separate laptop with Ubuntu 14.04 and connecting it over Wi-Fi to the ROS master running Ubuntu 12.04 and ROS Indigo. We were able to receive the Kinect2 pointcloud as a ROS topic but we could not visualize it in rviz as the required '/base_link' transform of the Kinect2 was not being published.

Team Work

Rick worked on designing the suction gripper mount for the PR2 arm and it was fabricated by Alex. Rick used the shop-vac to test this suction gripper on 12 of the 27 objects from last year's Amazon Picking Challenge. We found that 9 of the objects could be gripped correctly. We faced difficulty gripping an item with three squeaky toy balls packed in wire mesh. We also had an issue with a small toy which got sucked into the suction gripper and we plan to build a mechanism to prevent this. We had expected difficulty in successfully gripping a small box containing a spark plug but it worked out well – the bellows of the suction gripper wrapped around the box and it could be gripped easily.

Abhishek Bhatia worked on tele-operating the PR2 base, torso, head and arms using a wireless PlayStation 3 controller and also worked on turtlesim. Alex continued worked on understanding SMASH state controller library and got the SMACH viewer working, allowing us to visualize the state flows enabling easier testing and debugging.

Rick also worked on color based segmentation and clustering of the objects inside the shelf bin and matching it with the pointcloud. Lekha worked on 3D cloud pose estimation and object recognition using correspondence matching features using a generic data set.

Plans

For this week, I will be testing the arm controller on the actual PR2 robot. I will also be switching to the MoveIt controller which uses the Open Motion Planning Library (OMPL) plugin. This is done to enable us to swap out the path planner later for the Search Based path planner

being developed at the SBPL by Prof. Maxim's students. I will fully integrate this arm controller into the SMACH state controller. I will be working closely with Abhishek Bhatia to design the electronic circuits for the suction gripper system – relay control for the vacuum motors and pressure sensor circuitry.

On the perception front, Rick will improve the color based clustering using shelf content data. Lekha will be developing an algorithm to recognize and accurately segment out the shelf from the pointcloud data.

Alex and Rick will be working together to finalize the mechanical design of the suction gripper. Alex will also understand how transform trees work in the ROS environment and implement the 'base_link' transform we need in order to visualize Kinect2 pointcloud data.