Assignment 10, EECS 397/600: DARPA Robotics Challenge
System Integration: Wall Cutting
due Tuesday, November 18

For the following, you will be organized into 4-person teams. The objective is to integrate multiple capabilities to create a system for wall cutting. Your tasks are:

Operator interface design:

The operator interface should have the following functionality:

Wall identification: From Rviz, the operator should see LIDAR-based point-cloud points on a wall. The operator selects three patches (using point-cloud selection), and from this, a corresponding wall distance and wall angle (relative to pelvis orientation) are returned.

Cuttability computation: using the wall distance and wall angle, the cuttable regions of the wall should be computed (see package: cuttability_ik and example_wall_cutting, and their README files).

Cuttability template overlay: A graphical overlay (markers) of the cuttability regions should be displayed on the wall in Rviz.

Contour specification interface: the operator should be able to select "patches" of point-cloud points from the Rviz display (restricted to the cuttable regions). These patches will define a sequence of vertices of a polyline, implying the desired contour to cut. The resulting vertices should be communicated to the system for cutting execution.

Joint-space Path Plan Generation:

Given the polyline vertices, a corresponding path plan should be generated, consisting of 8-DOF solutions that include: 6 right-arm joints, 1 torso joint, and pelvis height. (see the packages example_joint_space_planner and example_wall_cutting).

This solution should be design as an "action server". It should accept the polyline vertices, and it should return a result consisting of a vector of 8-dof poses.

The package "eigen_to_msg" defines some useful message types for transmitting a path. The example code shows usage.

The motion corresponding to the cutting contour should be pre-pended with an approach and appended with a depart move. These moves should approach and depart the wall safely. (see, e.g., atlas_hand_kinematics package).

Pelvis Position Action Server:

The height of the pelvis is controllable using coordinated motion of the legs. (See example_whole_body). This server should accept requests corresponding to pelvis height and move the leg joints accordingly to achieve this height. Ideally, pelvis sagittal (front/back) pelvis motion would be automatically adjusted as well to keep the whole-body COM centered within the support polygon (based on feedback from the ankle torques).

Coordinated Motion Execution:

Given a path, defined as a sequence of 8-DOF poses to reach, the path should be executed, coordinating pelvis motions with arm and torso motions. This motion program should communicate with the pelvis

position action server as well as with the joint_traj_behavior action server. (See example_traj_client).

The entire system should be integrated to work together in drcsim. Be prepared to demonstrate your team's solution in class.

The resulting solution should involve:

*preposition the robot in front of a wall (approximately 0.6m from pelvis origin to wall)

*display LIDAR points in rviz

*enable the operator to define the wall by selection of 3 patches

*provide a cuttability overlay on the wall for the operator

*enable the operator to define cutting-contour vertices

*invoke execution of the cutting trajectory, with approach, cutting in 8DOF, and depart

Submit a (brief) document describing your approach, your interfaces, and any useful observations. Identify your packages and how to run them. Zip up your packages and submit them with your report.