Homework 2

Roberto Ghedin 2015135
Miroljub Mihailovic 2021445
Luigi Sarrocco 2020634

January 2022

1 Introduction

In this task, we tried to implement a Pick & Place routine for Tiago. The robot has to pick up a target object from the table and place it on the corresponding cylinder, according to their colours.

1.1 Human node

In the room there are three possible objects that can be chosen to accomplish our task: a green triangle, a red cube and a blue hexagon identified by an ID which is 1, 2 and 3 respectively. The decision of which objects to collect and place is made by a human node, it selects one at random; in case of extra points mode, we take all items.

1.2 Navigation

For the navigation task we used the code developed for the first tasks, and we found six fixed positions (three positions for the table where we have to do the picking task and three positions for the cylinders where we have to place the selected objects) and two positions intermediate, one before Tiago has reached the table and one after Tiago has picked up the object (this only for the green triangle to prevent Tiago from going to the other side of the cylinder). This intermediate position was added to fix some bugs we found during the navigation part.

1.3 Moving the head and detection

To detect the objects on the table, the first thing to do is to move the head of Tiago, since in the default position it is looking a bit too high. It was really helpful to the rviz tool camera to understand better the head orientation of Tiago during the simulation and to find the best pose. After that, we have used the Apriltag ROS package to detect the objects and obtain their proper

IDs using the proper topic. Therefore, we transform the coordinates found previously from camera reference frame to base link reference frame.

2 Pick & Place

2.1 Collision objects

The first consist of creating a list of positions of the collision objects (plus the table) which contains their dimensions and positions along the x, y and z axes. A good choice is to set all dimensions a little bigger than the real ones, in order to avoid any possible contact with the environment. The target object must be included at the beginning and will later be declared as an object that Tiago's end effector can touch and pick. After the object is collected, it is necessary to remove everything from the interface of the design scene, to avoid conflicts during placement, where the position and size of the cylinder will be added (and again, after the activity, the cylinder will be REMOVED).

2.2 Pick task and safe position

The same pick procedure is made for all the three possible objects: a pre-approach position of the end-effector is fixed above and aligned with the target and finally the grasp is brought down and the left and right gripper are closed as much as we need to attach it. To ensure that the routine works fine, it is better to set the closure of the gripper a bit more tight than the real dimensions of the object. A post-approach operation is executed to move away the arm from table and the other collision object and finally a safe position is called to be sure that during the navigation Tiago does not collide with walls. After some tries, we have found that the best position is to set the grippers parallel to the ground in order to counter the gravity, avoiding that the object falls down.

2.3 Place task

As for the pick part, we have selected a pre-approach position that is fixed above a certain distance of the surface of the cylinder, where our target has to be placed. This decision was made as we have seen that, due to the finger gazebo problem, the object can fall off. After that the arm goes down, Tiago opens the grippers and lays down the object on the surface. In addition to this place routine, we first execute a motion of the arm in order to help the place task to try to control the velocity of the motion of the arm. Then, we move the arm in a safe pose like in the pick part.

2.4 Extra Point

The extra point is just the generalization of the pick & place routine of a single target in order to make it work correctly for all the three object. The human node select randomly the sequence of the 3 objects and save it in its relative srv

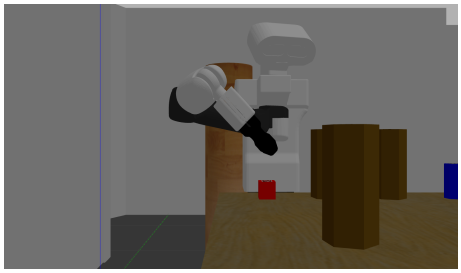

Figure 1: Pre-approach pick phase

Figure 2: Pick phase

Figure 3: Post-approach pick phase

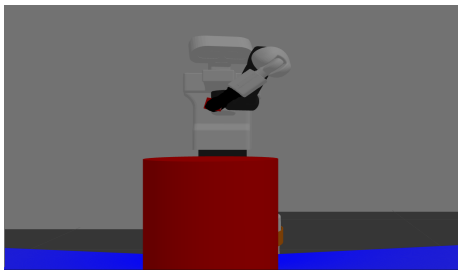

Figure 4: Pre-approach place phase

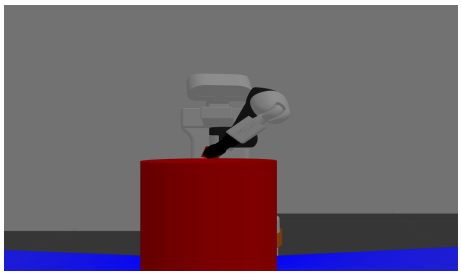

Figure 5: Place phase

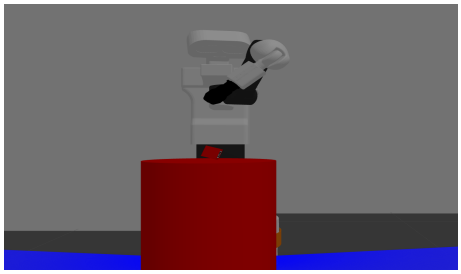

Figure 6: Post-approach place phase

file. The manipulation node has only to grab this list and execute for 3 times (with the specific grasps, positions and collision objects) the same procedure. At the end, all the three objects should be placed in the correct cylinder. Since sometimes an object can fall down during the routine (see chapter 3.3), if it remains in a position where Tiago has to pass, they collide and the navigation fails. In this case, the only way to fix the problem is to restart the simulation.

3 Insights and issues

During the development of our code, we had many troubles to implement correctly the pick & place routine. In this chapter, we will analyze all the various issues that we encountered during our work.

3.1 Weights of the objects

The first problem is about the high weights of the objects. This initially does not give the possibility to Tiago to perform correctly its task. This has been fixed, reducing the weights of the target objects and their tags, respectively, to 20 grams and 10 grams.

3.2 Plan

Another issue is about the planning of the movement of the arm. Our routine works pretty well with all the possible objects, but in very rare cases an error of "no motion plan found" is given. We have discovered that this could be related to the performance of our laptop (maybe the computations costs are too high, and it is not able to do the calculation). Another possible reason could be related to the tolerance that we have set for the goal trajectory. In our final version, all these problems should have been fixed, adjusting tolerance values. Another possible problem is that the object was not detached in the place pipeline, even if the place task result is "succeeded" and the controller finished successfully, and so the planner find collision when we want to pick another object.

3.3 Grippers closure

The last problem is about the instability of the grippers after the pick task, especially on the green triangle. During the simulations it is possible to see that, while Tiago is navigating from the table to the cylinder, the object slightly slide along the gripper, and sometimes it falls down before the placing, due probably to an insufficient force generated by the grippers and also for the low dimensions of the object. This problem has been fixed, partially reducing to low values all the possible velocity factor of each movement of the arm.

4 Conclusions

The code works pretty good, and the robot is able to execute a pick & place routine. There are still some small problems, but in part they are related to the environment and cannot be entirely solved, but only compensated.

5 Final considerations

We have moved all the header files inside the include folder, since for the first homework we forgot to do that. We have also created a hw2.launch file to speed up the execution of the code and avoid to open individually every node. A video is provided to see the execution of our code.