Home Service Robot
UDACITY robotics nanodegree project report

Description

The goal of this project is to build *ROS* packages to autonomously navigate a robot model to a virtual object, pick it up and deliver it to the drop-off location. The robot model used is *Turtlebot* simulated in *Gazebo* environment. The *Gazebo* world model used for the project is from *Build My World* Project. Also environment map used for this project was generated in *Map My World* Project.

In this project we use the *Turtlebot* model, *Gazebo* world and map and add *ROS* navigation stack for this simulation.

We also add 2 new packages and nodes: *pick_objects* to navigate to pickup and drop-off locations and *add_markers* to show and hide the virtual object.

Setup

The project was done in Udacity Workspace Environment. After creating catkin workspace the following official *ROS* packages were installed:

-*gmapping*: This package contains a ROS wrapper for OpenSlam's Gmapping. The gmapping package provides laser-based SLAM (Simultaneous Localization and Mapping), as a ROS node called slam_gmapping. Using slam_gmapping, we can create a 2-D occupancy grid map (like a building floorplan) from laser and pose data collected by a mobile robot.

-*turtlebot_teleop*: Provides teleoperation using joysticks or keyboard.

-*turtlebot_rviz_launchers*: Launchers for visualizing TurtleBot

-*turtlebot_gazebo*: Gazebo launchers and worlds for TurtleBot simulation

The map and world files were added to the project from previous projects and 2 new packages were created: *pick_objects* and *add_makers*. The overall workspace directory structure is like the following:

```
├──                              # Official ROS packages
|
├── slam_gmapping                # gmapping_demo.launch file
|   ├── gmapping
|   ├── ...
├── turtlebot                    # keyboard_teleop.launch file
|   ├── turtlebot_teleop
|   ├── ...
├── turtlebot_interactions       # view_navigation.launch file
|   ├── turtlebot_rviz_launchers
|   ├── ...
├── turtlebot_simulator          # turtlebot_world.launch file
|   ├── turtlebot_gazebo
|   ├── ...
├──                              # Your packages and direcotries
|
├── map                        # map files
|   ├── ...
├── scripts                  # shell scripts files
|   ├── ...
├──rvizConfig                    # rviz configuration files
|   ├── ...
├──pick_objects                  # pick_objects C++ node
|   ├── src/pick_objects.cpp
|   ├── ...
├──add_markers                   # add_marker C++ node
|   ├── src/add_markers.cpp
|   ├── ...
└──
```

To test SLAM, localization and navigation for the robot and environment the following existing launch files were used:

-*turtlebot_world.launch* to deploy *turtlebot* in environment created in previous project. The launch file was modified as following:
<arg name="world_file" default="/home/workspace/catkin_ws/src/worlds/kam.world" />

-*gmapping_demo.launch* to perform SLAM

-*view_navigation.launch* to observe map in rviz

-*keyboard_teleop.launch* to manually control the robot with keyboard commands.

-*amcl_demo.launch* to localize the robot

New packages and nodes

To simulate pickup and drop-off, 2 new packages each with one node were added:

-pick_objects: A node that communicates with the *ROS* navigation stack and autonomously sends successive goals for the robot to reach. The *ROS* navigation stack creates a path for the robot based on Dijkstra's algorithm, a variant of the Uniform Cost Search algorithm, while avoiding obstacles on its path.

The node sends 2 goals to navigation stack for pickup and drop-off. The robot has to travel to the desired pickup zone, display a message that it reached its destination, wait 5 seconds, travel to the desired drop off zone, and display a message that it reached the drop-off zone.

-add_markers: A node to model a virtual object with markers in rviz. The virtual object is the one being picked and delivered by the robot, thus it should first appear in its pickup zone, and then in its drop off zone once the robot reaches it.

To simulate pickup and drop-off, *pick_objects* publishes 3 topics. When the node starts, it publishes “poseobject” first to tell *add_marker* subscriber where to pose the marker initially. When it gets to pickup location it publishes the “pickup” topic to tell *add_marker* to hide the marker. When it gets to drop-off location it publishes “dropff” topic to tell *add_marker* to show the marker at drop-off location.

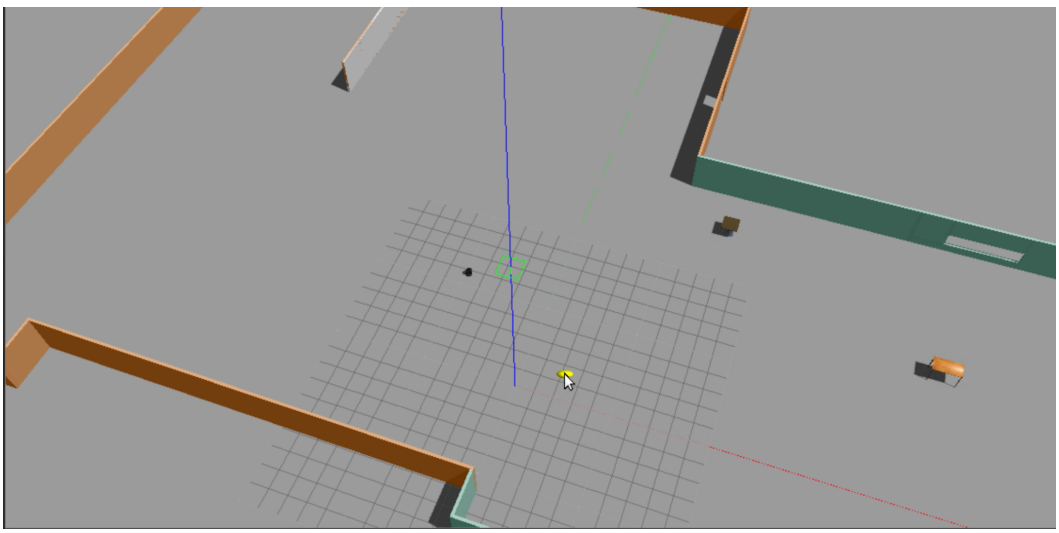
The *add_markers* node subscribers to the 3 topics and calls callbacks to show the marker at pickup or drop-off or hide it.

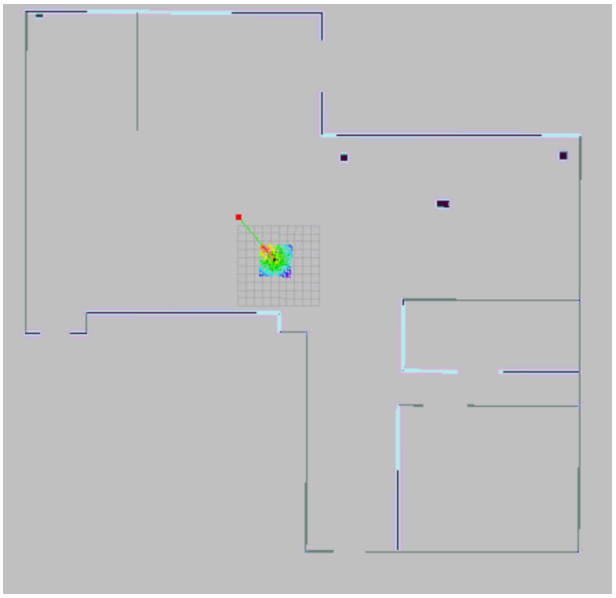
shell scripts

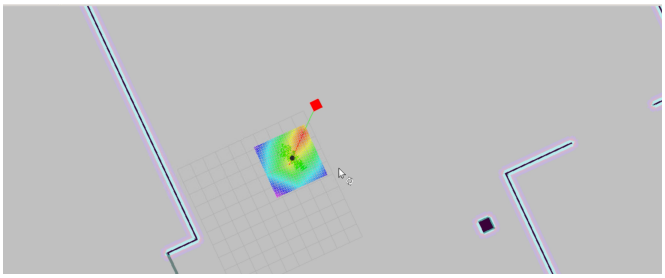
To make it easier to run nodes and launch files, shell scripts were created to run multiple launch files and nodes with a single command. To perform pickup/drop-off we need to run *home_service.sh* which runs all the nodes needed to perform the simulation.

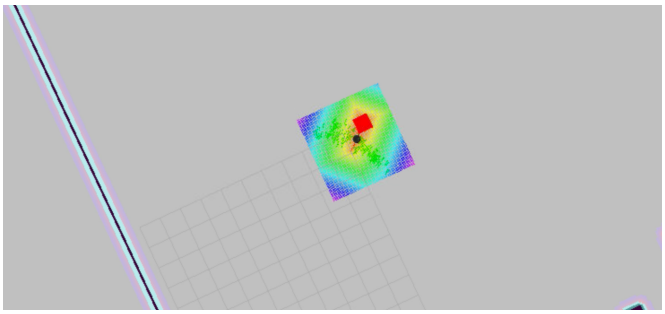
Results

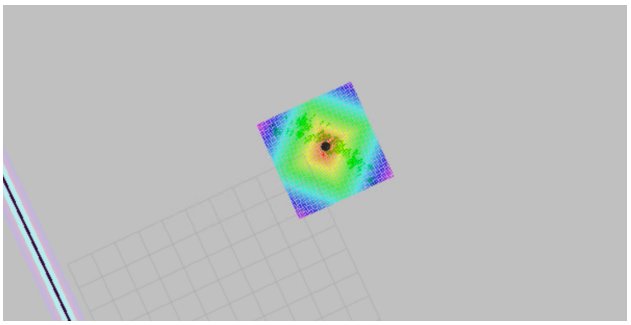
After running *home_service.sh* the robot works as expected. The marker is shown at pickup first. Robot drives to pickup location, the marker hides. After 5 seconds the robot drives to drop-off location and the marker is shown in new location. Here are some screen shots of the process:

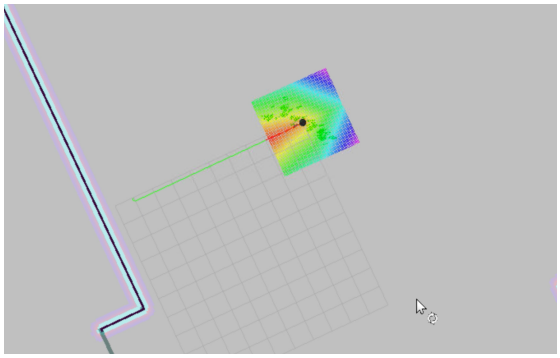


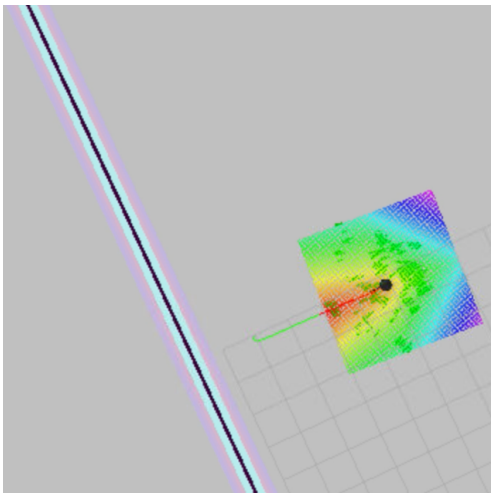


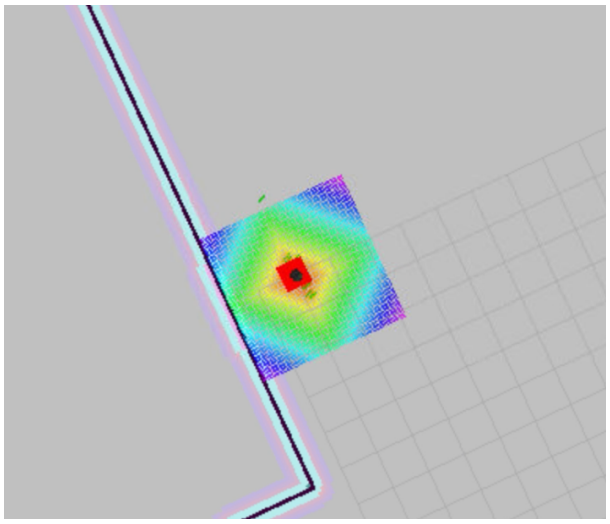


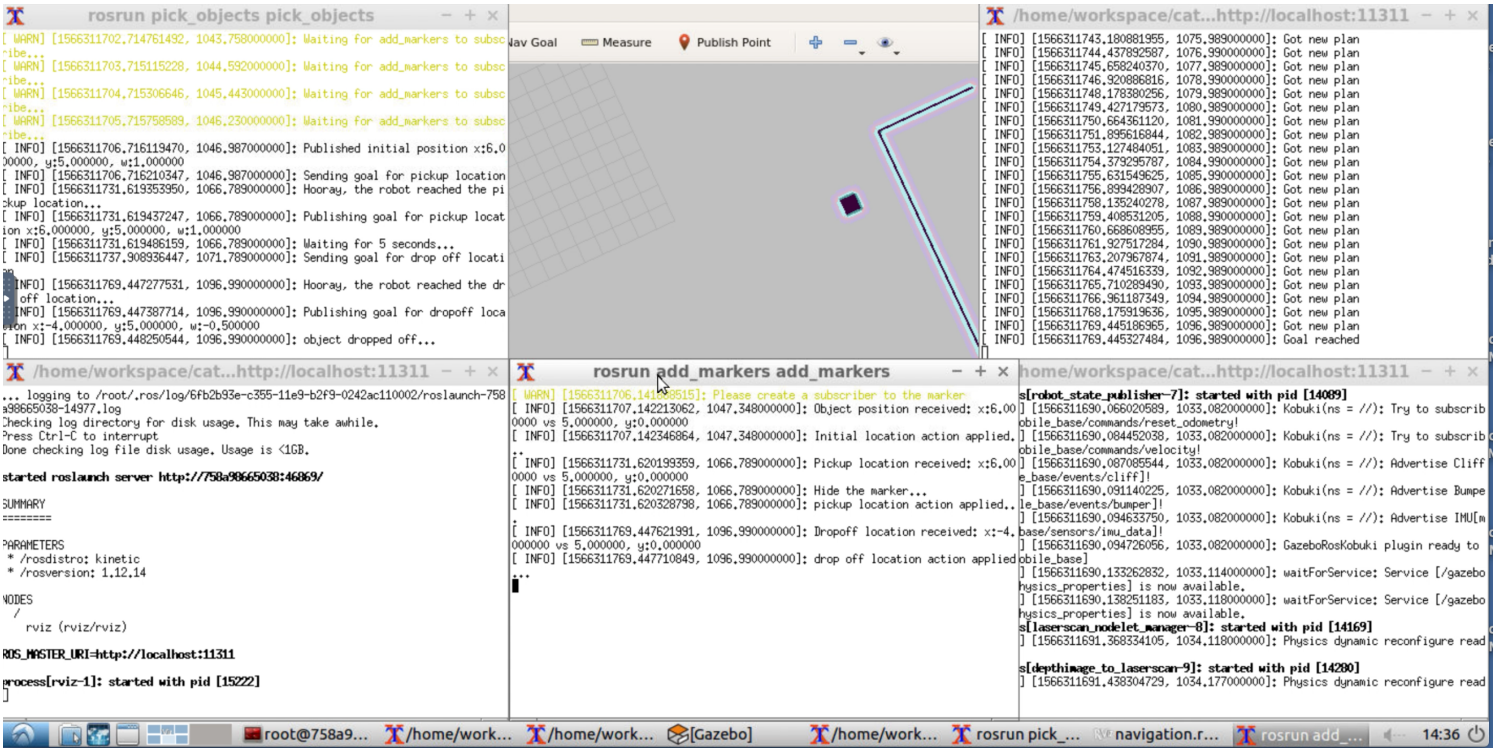











rosrun pick_objects pick_objects
[WARN] [1566311702.714761492, 1043.758000000]: Waiting for add_markers to subsc
ribe...
[WARN] [1566311703.715115228, 1044.592000000]: Waiting for add_markers to subsc
ribe...
[WARN] [1566311704.715306646, 1045.443000000]: Waiting for add_markers to subsc
ribe...
[WARN] [1566311705.715758589, 1046.230000000]: Waiting for add_markers to subsc
ribe...
[INFO] [1566311706.716119470, 1046.987000000]: Published initial position x:6.0
00000, y:5.000000, w:1.000000
[INFO] [1566311706.716210347, 1046.987000000]: Sending goal for pickup location
[INFO] [1566311731.619353950, 1066.789000000]: Hooray, the robot reached the pi
ckup location...
[INFO] [1566311731.619437247, 1066.789000000]: Publishing goal for pickup locat
ion x:6.000000, y:5.000000, w:1.000000
[INFO] [1566311731.619486159, 1066.789000000]: Waiting for 5 seconds...
[INFO] [1566311737.908936447, 1071.789000000]: Sending goal for drop off locati
on
[INFO] [1566311769.447277531, 1096.990000000]: Hooray, the robot reached the dr
op off location...
[INFO] [1566311769.447387714, 1096.990000000]: Publishing goal for dropoff loca
tion x:-4.000000, y:5.000000, w:-0.500000
[INFO] [1566311769.448250544, 1096.990000000]: object dropped off...
Nav Goal
Measure
Publish Point
/home/workspace/cat...http://localhost:11311
[INFO] [1566311743.180881955, 1075.989000000]: Got new plan
[INFO] [1566311744.437892587, 1076.990000000]: Got new plan
[INFO] [1566311745.658240370, 1077.989000000]: Got new plan
[INFO] [1566311746.920886816, 1078.990000000]: Got new plan
[INFO] [1566311748.178380256, 1079.989000000]: Got new plan
[INFO] [1566311749.427179573, 1080.989000000]: Got new plan
[INFO] [1566311750.664361120, 1081.990000000]: Got new plan
[INFO] [1566311751.895616944, 1082.989000000]: Got new plan
[INFO] [1566311753.127484051, 1083.989000000]: Got new plan
[INFO] [1566311754.379295787, 1084.990000000]: Got new plan
[INFO] [1566311755.631549625, 1085.990000000]: Got new plan
[INFO] [1566311756.899428907, 1086.989000000]: Got new plan
[INFO] [1566311758.135240278, 1087.989000000]: Got new plan
[INFO] [1566311759.408531205, 1088.990000000]: Got new plan
[INFO] [1566311760.668608955, 1089.989000000]: Got new plan
[INFO] [1566311761.927517284, 1090.989000000]: Got new plan
[INFO] [1566311763.207967874, 1091.989000000]: Got new plan
[INFO] [1566311764.474516339, 1092.989000000]: Got new plan
[INFO] [1566311765.710289490, 1093.989000000]: Got new plan
[INFO] [1566311766.961187349, 1094.989000000]: Got new plan
[INFO] [1566311768.175919636, 1095.989000000]: Got new plan
[INFO] [1566311769.445186965, 1096.989000000]: Got new plan
[INFO] [1566311769.445327484, 1096.989000000]: Goal reached
/home/workspace/cat...http://localhost:11311
... logging to /root/.ros/log/6fb2b93e-c355-11e9-b2f9-0242ac110002/roslaunch-758
a98665038-14977.log
Checking log directory for disk usage. This may take awhile.
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.
started roslaunch server http://758a98665038:46869/
SUMMARY
========
PARAMETERS
* /rosdistro: kinetic
* /rosversion: 1.12.14
NODES
/
rviz (rviz/rviz)
ROS_MASTER_URI=http://localhost:11311
process[rviz-1]: started with pid [15222]
rosrun add_markers add_markers
[WARN] [1566311706.141698515]: Please create a subscriber to the marker
[INFO] [1566311707.142213062, 1047.348000000]: Object position received: x:6.00
0000 vs 5.000000, y:0.000000
[INFO] [1566311707.142346864, 1047.348000000]: Initial location action applied.
..
[INFO] [1566311731.620199359, 1066.789000000]: Pickup location received: x:6.00
0000 vs 5.000000, y:0.000000
[INFO] [1566311731.620271658, 1066.789000000]: Hide the marker...
[INFO] [1566311731.620328798, 1066.789000000]: pickup location action applied..
.
[INFO] [1566311769.447621991, 1096.990000000]: Dropoff location received: x:-4.
000000 vs 5.000000, y:0.000000
[INFO] [1566311769.447710849, 1096.990000000]: drop off location action applied
...
/home/workspace/cat...http://localhost:11311
s[robot_state_publisher-7]: started with pid [14089]
] [1566311690.066020589, 1033.082000000]: Kobuki(ns = //): Try to subscrib
obile_base/commands/reset_odometry!
] [1566311690.084452038, 1033.082000000]: Kobuki(ns = //): Try to subscrib
obile_base/commands/velocity!
] [1566311690.087085544, 1033.082000000]: Kobuki(ns = //): Advertise Cliff
e_base/events/cliff]!
] [1566311690.091140225, 1033.082000000]: Kobuki(ns = //): Advertise Bumpe
le_base/events/bumper]!
] [1566311690.094633750, 1033.082000000]: Kobuki(ns = //): Advertise IMU[m
base/sensors/imu_data]!
] [1566311690.094726056, 1033.082000000]: GazeboRosKobuki plugin ready to
obile_base]
] [1566311690.133262832, 1033.114000000]: waitForService: Service [/gazebo
hysics_properties] is now available.
] [1566311690.138251183, 1033.118000000]: waitForService: Service [/gazebo
hysics_properties] is now available.
s[laserscan_nodelet_manager-8]: started with pid [14169]
] [1566311691.368334105, 1034.118000000]: Physics dynamic reconfigure read
s[depthimage_to_laserscan-9]: started with pid [14280]
] [1566311691.438304729, 1034.177000000]: Physics dynamic reconfigure read
root@758a9...
/home/work...
/home/work...
[Gazebo]
/home/work...
rosrun pick_...
navigation.r...
rosrun add_...
14:36