CISC 3060 Introduction to Robotics

Lab Assignment #3 Fall 22

Step 1: Bringing up the Turtlebot3. (T3) Team members 1 and 2 should work concurrently and communicate as indicated in the instructions. Use the hardboard partitions to build a square enclosure to test your robot in if one is not already built for you. Note that each robot is paired to just one laptop (the one beside it at your workstation); you can't use your computer or any other laptop. If there are more than 2 members on your team, then rotate through the positions.

Team member 1:

a. Make sure that your enclosed space on the lab floor is roughly square and enclosed.
b. Disconnect the white plug on the T3 from the blue charger – gently. Leave the charger on the desk.
c. Turn on the power switch on the T3 – which is on 'level 2' of the platform, on the front between two metal column spacers (Fig. 1)
d. Place the T3 gently into the enclosure and wait until the laser ranger on top begins to spin.
e. **Tell** Team member 2 the T3 is ready to communicate.
f. **Tell** Team member 2 the number written on top of the turtlebot

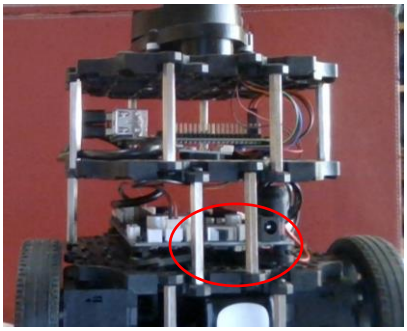

Figure 1: T3 On/Off switch circled in red

Team member 2:

a. Log into the laptop – the username is 'bot' and the password is 'visionrobot'
b. Bring up **five** terminal windows, laid out from left to right for convenience, and 'cd' in each to the 'CISC3060' folder in the home directory of bot
c. In the first window type `roscore -p1131x` where x is the port number written on your T3. Minimize this window when roscore starts.
d. **Wait** until Team member 1 indicates the T3 laser ranger has started spinning and tells you the number from the robot.
e. Pick the next leftmost terminal window and use it to ssh into the T3 as follows. Type `ssh pi@10.10.3.<number>` The password is 'turtlebot'
f. When the command prompt on the T3 appears, type
`roslaunch turtlebot3_initialize-t.launch`
You should see several screenfuls of messages, ending with 'Calibration End'.
g. Pick the next leftmost terminal window, and type
`roslaunch turtlebot3_initialize-lnr.launch`
You will see a smaller amount of diagnostics. Wait until it finishes (a second or two).
h. Go to the next (4th) leftmost terminal window from the left and type 'rostopic list'. You should see a list of the T3 active ROS topics, including /odom, /scan and /cmd_vel. If you don't, then ask for help.

i. Take a screen dump of the laptop now (CTRL-ALT-PrtScr) and save it to the name LR2F1.png when prompted by the dialog box. You need this for your report to document Step 1. **ALSO make a written list** of the topics for Step 3. You can mimimize the first three windows (don't kill them, just minimize them).

Step 2: Bringing up Rviz. Team members switch position. Brief each other on what you did.

Team Member 1:

a. Sketch the enclosure and number the corners in such a way that you can uniquely determine them
b. **When asked** by Team member 2, place the T3 in location 1 and reply done.
c. **Repeat this** for each of the other corners (just so you know which corners are which)
d. **Repeat this, but take turns with Team member 2 to use the teleoperation interface to move the robot to each corner in turn**

Team Member 2:

a. ONLY IF RViz is NOT UP:

a. Go to the third terminal window from the left on the laptop (coordinate with Team member 1 if you don't know which one was third from the left)
b. Bring up RViz to visualize the ROS topics from the T3. Type the following VERY CAREFULLY

```
rosrun rviz rviz -d `rospack find turtlebot3_description`/rviz/model.rviz
```

IF Rviz is already up:
The RVIZ interface should come up full screen. You should see the robot in the center and you should see the red dots from the laser ranging around the robot

b. Do a screen dump (CTRL-ALT-PrtScr) and save it to the name LR2F2.png when prompted by the dialog box. You need this for your report to document Step 2.
c. **Ask** Team member 1 to move the robot to corner 1 (or teleoperate, see above)
d. **When done** do a screen dump and save to LR2F3.png
e. **Repeat** this for the other 3 corners generating LR2F4 to 6.

Step 3: Port the wander behavior to the T3 and evaluate.

Download a copy of the Wander.py program on Blackboard for the Gazebo simulation and store in as a file called wander.py in the CISC3060 folder on the laptop. You will need to modify this file and get it working on the robot. Most of the code does not need to be changed when moving from a simulation to a real robot – you only need to change the ranges for distances and velocities.

1. Identify the lines in the laser callback function that control
    a. the number of laser rays in front of the robot that are checked for proximity (numRays/6) and
    b. the proximity distance (0.5 m)
2. Identify the lines in the wander_node function that

a. select the lvel (0 to 0.5) and avel (-.1 to .1) velocities for wandering
b. on a proximity detection set linear velocity (-0.1) and angular velocity (-1 to +1) to avoid the obstacle.

You may not need to change 1(a), but 1(b) is very large for such a small enclosure, maybe 0.1 is better? Linear velocity should never be more than 0.2 or so, again for such a small area. You ned to select these values by experimentation.

Please identify how you will change (if just one change) or vary and evaluate (if you have to try a few values) and write a procedure for each team member – one of whom will monitor and move the T3 as necessary, and one of whom will make the algorithmic changes. Make a record of these procedures for your report.

Some suggestions: how close to the wall should the T3 get, what angular velocity to turn with, what range of linear velocities to travel forward?

***Note: If you find that the T3 is not moving smoothly or is moving in fits, then kill RViz. If this does not fix it, then speak with me.

Step 4: Divide into Team Member 1 and 2 again and carry out the experimentation you propose. **Document by writing notes and taking a picture** when appropriate (phone camera is fine) the response of the T3 to each of your changes. **Explain** the response.

Once you have established wandering behavior similar to the simulation, use your phone to record a short video of the T3 approaching and moving away from obstacles. Take screen snapshots that show RViz for points in execution corresponding to some of the photos.

Writing your lap report:

Each team member should write a **separate** report, so please exchange all your notes and sketches electronically.

In your introduction section, please use the information from

https://emanual.robotis.com/docs/en/platform/turtlebot3/overview/

to write a short overview of the T3 robot

Include sections for each of the steps in the lab. Include and refer to each of the screen dumps, sketches and photographs you took.

In step 2, explain the laser range data on the screendumps in terms of the sketch and notes of the numbered corners.

In step 3 include **all your change comments** and procedures and explain why you proposed them.

In step 4 document and explain the behavior of the T3 to all your changes as well as the final behavior and use the photos and RViz screendumps as evidence.