CSE 468/568 Lab 4: Grid Localization using Bayes Filter

The objective of this assignment is to make you familiar with Grid Localization which is a variant of discrete Bayes Localization. In addition you will learn how to create your own messages in ROS and how to use them. Also you will get your hands on working with rosbag files.

NOTE: This lab will be worth 15% of your total grade in the class. The other labs were worth 10%.

Grid Localization

Grid Localization is a variant of discrete Bayes Localization. In this method, the map is an occupancy grid. At each time step, the algorithm finds out the probabilities of the robot presence at every grid cell. The grid cells with maximum probabilities at each step, characterize the robot's trajectory. Grid Localization runs in two iterative steps — Movement and Observation.

After each movement, you should compute if that movement can move the robot between grid cells. For each observation, you should find the most probable cells where that measurement could have occurred.

ROSbag files

Rosbag is used for dumping the messages published on certain topics to files. For this assignment, we have provided a bag file for you which includes the movements and observation information from one scenario. You need to read the bag file to simulate your localization algorithm running on a robot executing this scenario. For this purpose, read through the Rosbag tutorials. After that go through the following steps.

- Create a ROS package named `lab4` and create two messages in the package
  Motion.msg
  ```
  int32 timeTag
  geometry_msgs/Quaterninon rotation1
  float64 translation
  geometry_msgs/Quaternion rotation2
  ```

  and Observation.msg
  ```
  int32 timeTag
  ```

```
int32 tagNum
float64 range
geometry_msgs/Quaternion bearing
```

- Use `rosbag info` command to find the required information for the given bag file. This tutorial may be helpful

- Using the tutorials and acquired information, write code to read the bag file

Motion Model, Observation Model and Map

For localization, you need a map. There are six landmarks in the robot map, and they are at the following locations:

- Tag 0: x=1.25m, y=5.25m

- Tag 1: x=1.25m, y=3.25m

- Tag 2: x=1.25m, y=1.25m

- Tag 3: x=4.25m, y=1.25m

- Tag 4: x=4.25m, y=3.25m

- Tag 5: x=4.25m, y=5.25m

The robot moves in the area within these landmarks, observing some at any given time. You should make a grid for 7m*7m coverage. Your cell size should be 20cm*20cm. You also should assume a dimension for the robot's heading. So your grid is 3 dimensional. The third dimension covers the robot's heading. You can discretize that with your desired value (10 degree, 20 degree or more). The initial pose of your robot within the grid is (12, 28) and the first heading is 200.52 degree. The robot's first pose in the 3rd dimension depends on your selected discretization size. For example, if your discretization size is 90 degrees, the cell number in 3rd dimension will be 200.52/90+1 = 3. So the robot's initial pose is (12 , 28, 3). (Notice that I have assumed there is no cell with index zero).

As you may have noticed, the motion model of this robot is (rotation, translation, rotation) and the observation model is (range, bearing). In Grid Localization, for the purpose of moving robot between cells, the motion and observation noise should be adjusted. You need a translation and rotation noise for movement and range and bearing noise for your observation. A good selection for this purpose is half the cell size. So for the example of 20*20 cells and 90 degree discretization, range and translation noises are 10cm, and bearing and rotation noises are 45 degrees.

Submission Instructions

You will submit lab4.tar.gz, a compressed archive file containing the lab4 folder. The folder should contain a launch file which running it should read the bag

file, run the grid localization algorithm and draw the final trajectory as a marker line in Rviz. The folder should compile if I drop it into my catkin workspace and call `catkin_make`. Please take care to follow the instructions carefully so we can script our tests, and not have to dig into each submission. Problems in running will result in loss of points. Please use the submit script for submission using the syntax *submitcse*468*lab4.tar.gzor* submit cse568 lab4.tar.gz depending on whether you are taking cse468 or cse568 respectively.

Details on the usage of the submit script can be found here.

The assignment is due Thursday, Nov 17 before class. This lab involves learning various concepts. And this lab will be worth 15% of the total grade (rest of the labs were worth 10%). So, I highly recommend getting started early.