Robot Mapping lecture
University of Freiburg
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Sheet 7

Topic: Grid Maps

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Exercise: Occupancy Mapping Algorithm Implementation

Implement the occupancy grid mapping algorithm as presented in the lecture. To support this task, we provide a small Octave framework on the course website. The framework contains the following folders:

data contains the recorded laser scans and known robot poses at each time step.

octave contains the grid maps framework with stubs to complete.

plots stores the resulting images.

The below mentioned tasks should be implemented inside the framework in the directory `octave` by completing the stubs:

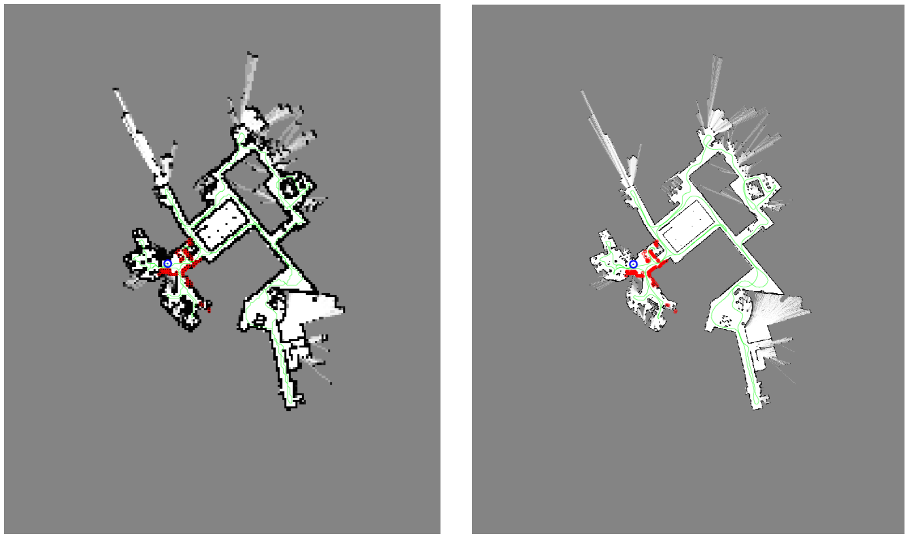
- Implement the functions in `prob_to_log_odds.m` and `log_odds_to_prob.m` for converting between probability and log odds values.
- Implement the function in `world_to_map_coordinates.m` for converting the (x, y) world frame coordinates of a point to its corresponding coordinates in the grid map. You might find the Octave functions `ceil` and `floor` useful.
- Implement the function in `inv_sensor_model.m` to compute the update of the log odds value of each cell in the map for a particular laser scan measurement.

After implementing the missing parts, you can run the occupancy grid mapping framework. To do that, **change into the directory `octave`** and launch Octave. Type `gridmap` to start the main loop (this may take some time). The script will produce plots of the state of the resulting maps and save them in the `plots` directory. You can use the images for debugging and to generate an animation. For example, you can use ffmpeg from inside the plots directory as follows:

```
ffmpeg -r 10 -i gridmap_%03d.png -b 500000 gridmap.mp4
```

Figure 1 depicts the example images of the resulting maps using grid sizes of 0.5 m and 0.1 m.

Some implementation tips:



resolution 0.5 m　　　resolution 0.1 m

Figure 1: Examples for the final result of the occupancy mapping algorithm.

- Use an inverse sensor model corresponding to laser range finders (see lecture slides). The corresponding p_{free} and p_{occ} values are specified in the `gridmap.m` script. Use p_{occ} to update the occupancy value of cells that laser beam endpoints hit and p_{free} for all other cells along the beam. Use the function `robotlaser_as_cartesian.m` to compute the Cartesian coordinates of the endpoints of a laser scan. The provided `bresenham.m` function can be used for computing the cells that lie along a laser beam in map coordinates.
- Compute all occupancy value updates in log odds (not probabilities) so they can be added directly to the map.
- Test your implementation with a grid size of 0.5m. Once you are satisfied with your results, you can run the algorithm with an increased resolution (e.g. 0.1m), as this will take considerably more time.
- While debugging, run the algorithm only for a few steps by replacing the `for`-loop in `gridmap.m` by something like `for t = 1:10`.
- Many of the functions in Octave can handle matrices and compute values along the rows or columns of a matrix. Some useful functions that support this are `sum`, `log`, `sqrt`, `sin`, `cos`, and many others.