

## Sheet 7

Topic: Grid Maps

Due: December 15, 2022

### 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:

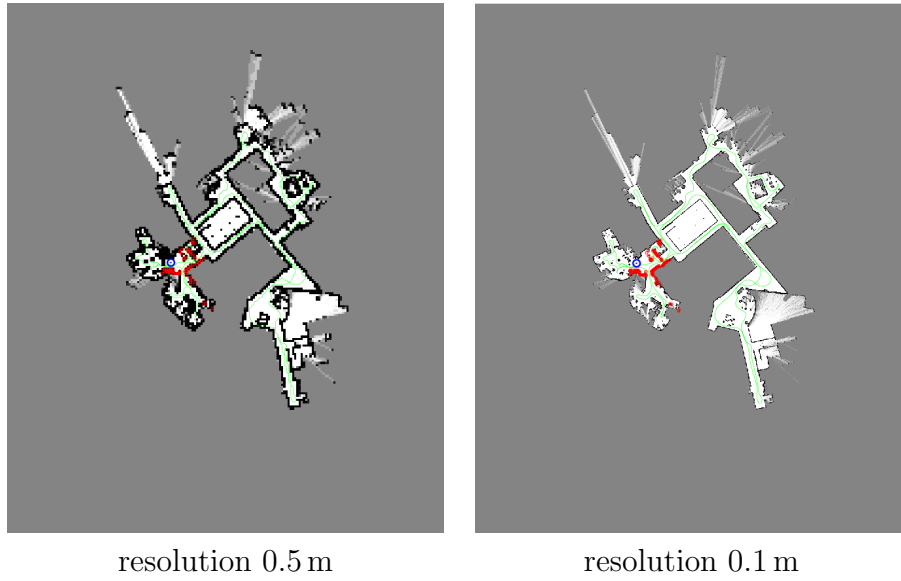


Figure 1: Examples for the final result of the occupancy mapping algorithm.

- 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.