University of Technology Nuremberg
Lecture: Introduction to Mobile Robotics
Held at the Technical University of Munich
Winter term 2022/23

Department of Engineering

Prof. Dr. Wolfram Burgard
Michael Krawez
Reihaneh Mirjalili

# Sheet 2

Topic: Sensing

**Exercise 1**

A robot is located at $x = 1.0\,\text{m}$, $y = 0.5\,\text{m}$, $\theta = \frac{\pi}{4}$. Its laser range finder is mounted on the robot at $x = 0.2\,\text{m}$, $y = 0.0\,\text{m}$, $\theta = \pi$ with respect to the robot's frame of reference.

The distance measurements of one laser scan can be found in the file `laserscan.dat`, which is provided on the website of this lecture. The first distance measurement is taken in the angle $\alpha = -\frac{\pi}{2}$ (in the frame of reference of the laser range finder), the last distance measurement has $\alpha = \frac{\pi}{2}$ (i.e., the field of view of the sensor is $\pi$), and all neighboring measurements are in equal angular distance (all angles in radians).

Note: You can load the data file and calculate the corresponding angles in Python using

```
import math
import numpy as np
scan = np.loadtxt('laserscan.dat')
angle = np.linspace(-math.pi/2, math.pi/2,
    np.shape(scan)[0], endpoint='true')
```

(a) Use Python to plot all laser end-points in the frame of reference of the laser range finder.

(b) The provided scan exhibits an unexpected property. Identify it an suggest an explanation.

(c) Use homogeneous transformation matrices in Python to compute and plot the center of the robot, the center of the laser range finder, and all laser end-points in world coordinates.

Note: You can equally scale the $x$ and $y$-axis of a plot using

```
plt.gca().set_aspect('equal', adjustable='box')
```