4. Assignment, Introduction to Robotics WS17/18 - Ver. 1.00

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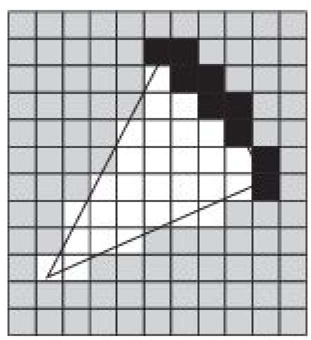
Submission: online until Tuesday, 21 Nov 2017, 11:55 a.m.

Please summarize your results (images and descriptions) in a pdf-document and name it, e.g., "RO-04-<surnames of the students - group name>.pdf".
Submit your python code
Only one member of the group must submit the necessary files.
Do not copy solutions to other groups.
Every group must contain two people.
Only submissions via KVV will be accepted.

1. (3 Points)

Write a ROS node which subscribes to the /scan topic of the lidar. In your subscriber's callback function create and publish an occupancy grid: (http://docs.ros.org/api/nav_msgs/html/msg/OccupancyGrid.html).



Cells which contain one or more measurement of the laser scan shall be marked as "occupied", "otherwise", if the laser did pass them without any they have to be marked as "free", if they could not have been observed, they shall be marked as "unknown". Find a good resolution and grid size to have a high similarity to the LaserScan visualization of the /scan topic in RViz.

You can use the following template: uebung7_scan_grid.tar.gz
which shows you how to use the grid and how to publish it.
Put some obstacles in the proximity of your mobile car.

Take a screenshot from your created occupancy grid shown in RViz and paste it into your Pdf. Upload the python code, too.

2. (7 Points)

Calibrate the steering angle of the car (bicycle model) by using the lidar scan of a wall. Place the car to the wall, facing the wall. To be more precise, calculate the angle of the car w.r.t. the wall by using distance measurements of two scans (plus and minus alpha; choose alpha, e.g. 10 degrees), as shown in Sketch 1.

Then set a steering value (0°, 30°, 60°, 90°, 120°, 150°, 179° servo motor scale → altogether 7 values) and drive some centimeters backwards.

Calculate the turning radius R with respect to the center of the rear axle (for simplicity assume the lidar is on the rear axle center).

Hint: Calculate the distance to the wall, and the angle of the wall w.r.t. the car using the law of cosine. Later, with the distance change w.r.t. the wall and the angular change you can calculate radius R, see sketches 1-3

a) Calculate the steering angle of the virtual front wheel, assuming that the lidar is on the center of the rear axle, as shown in sketch 4.

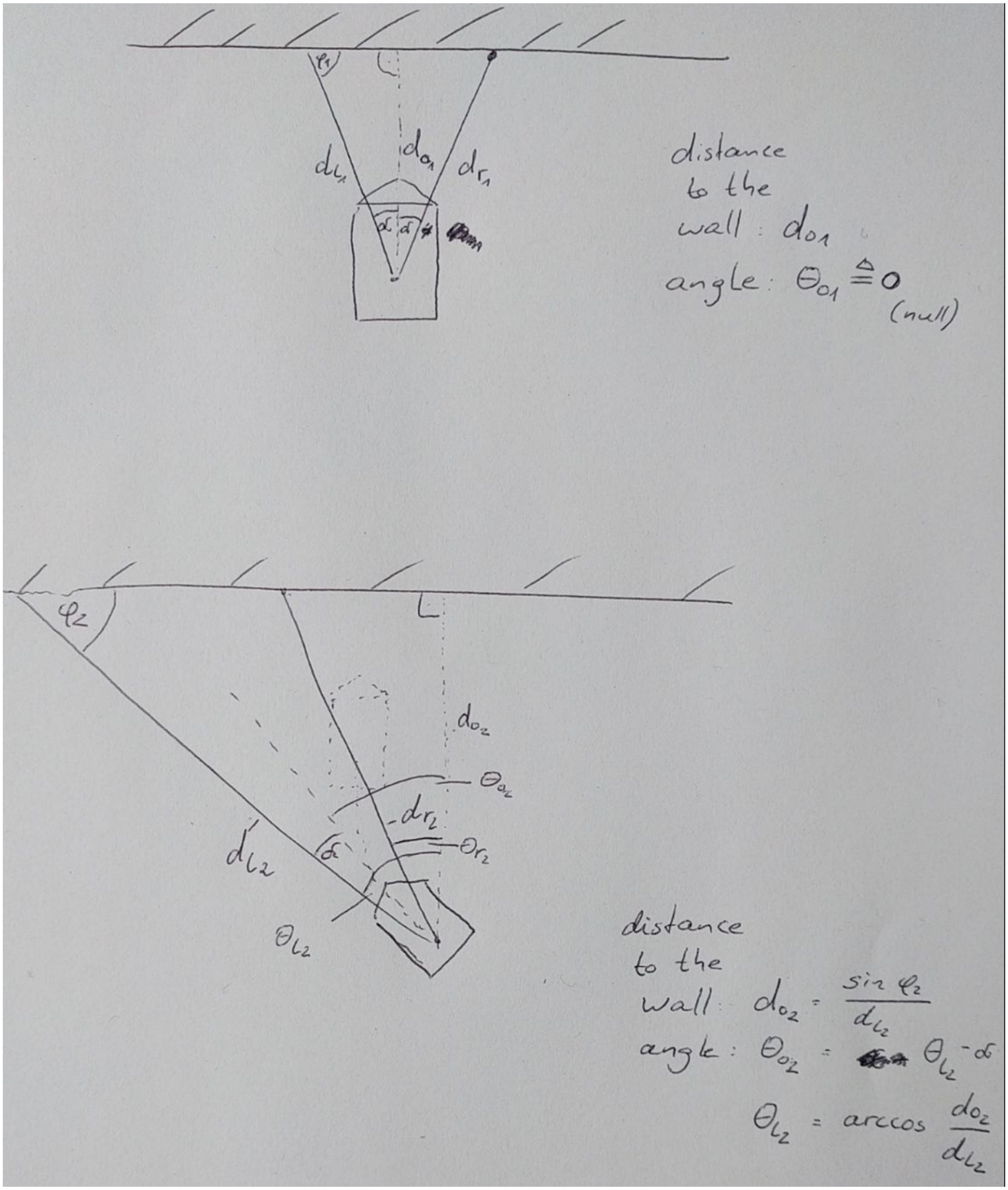
> Your code should allow the car to 1. take a measurement at the starting position, 2. to drive and 3. to take the second measurement, 4. finally to calculate the steering angle - all that without human interference.
> You will perform 7 experiments (for the 7 steering values 0, 30, ...), after each you can place back the car to its starting position.

Write the measured values into a table (step size 30° of servo motor degree value). The first column should contain the 7 steering values (0, 30, ...), the second column contains the measured steering angles. Paste that table into your Pdf.

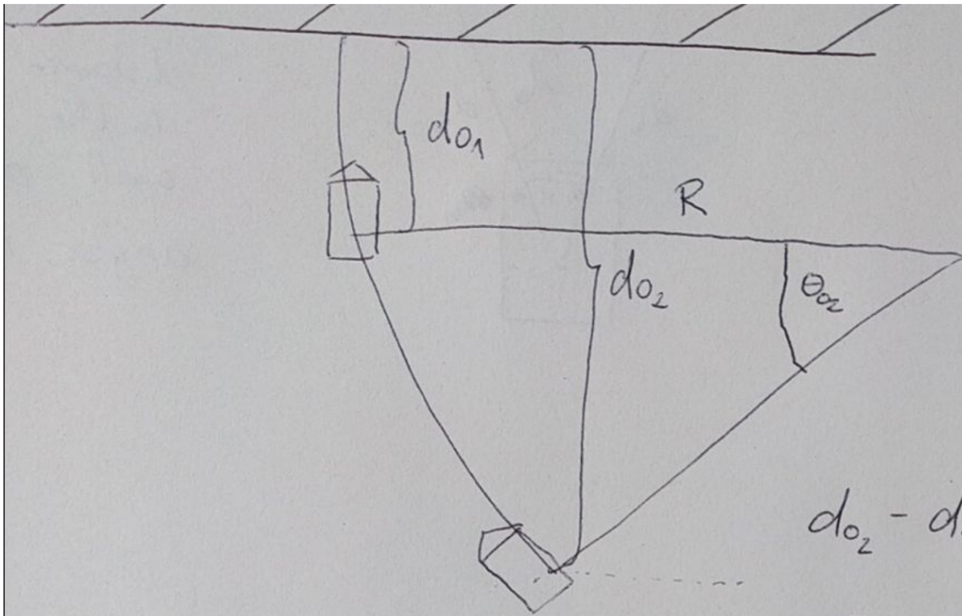
b)

Create a mapping function which gets angles of the front wheel in deg as an input and returns values from 0 to 179 . Upload the python code which performs the above experiments as well as the code which takes care of the steer angle mapping.

Sketch 1 and 2

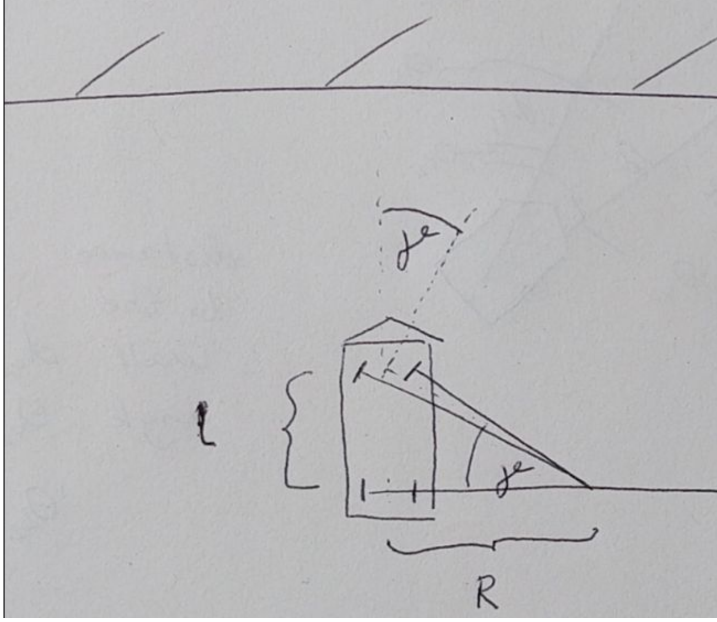


Sketch 3 and 4



$$d_{o_2} - d_{o_1} = \sin\theta_{o_2} \cdot R$$

$$R = \frac{d_{o_2} - d_{o_1}}{\sin\theta_{o_2}}$$



$$\gamma = \arcsin\frac{L}{R}$$