Chair of Cyber-Physical Systems in Production Engineering
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Reactive method - "Follow the gap"

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Objectives

So far, you have implemented two different ways to act on the actuator (i.e. the car motor and steering angle). A non-autonomous directly controlled by you (i.e. the `keyboard` node) and the other, autonomous, but dumb. In the present lab, we will implement a simple, yet efficient, way to navigate autonomously through a track using the Lidar sensor.

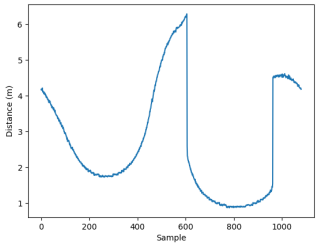
Reminder

The "follow the gap" strategy relies on a simple and intuitive rule: the car should go/point where the distance between him and its environment is the biggest. In order to verify that this intuitive approach works, let us consider the case where the car would be located in the center of a hallway. In such a situation, it is clear that the walls are the closest object of the environment to the car and the free space in the hallway (i.e. possibly where we want the car to go), the furthest elements in the environment.
In order to strengthen this idea, look at the Fig. 1. In the latter, for three different car's locations, you have the corresponding Lidar's measurements (i.e. (1a, 1d), (1b, 1e), (1c, 1f)). It is easy to observe that the area we want the car to go coincide with the largest distance in our measurements.**Note:** the plots (1d, 1d, 1d) must be read from right to left.

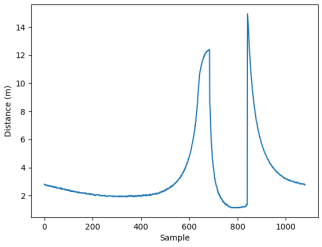
(a) Simulator - start position

(b) Simulator - second position

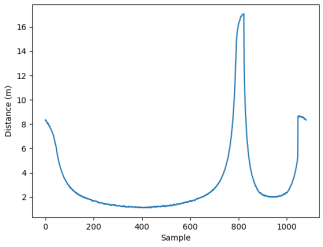
(c) Simulator - third position



(d) Distances - start position



(e) Distances - second position



(f) Distances - third position

Figure 1: Different positions of the car in the race track with the Lidar's measurements

8.1

In the present lab, you are asked to implement the *follow the gap strategy*. Typically, you will have to listen to the `\scan` topic and exploit the measurements to deduce the appropriate steering angle. The result must be posted on the `\drive` topic. You might assume a fixed car's velocity (e.g. $0.5\frac{m}{s}$).

Verify that your car can perform a complete lap without crashing. If it cannot, where does it fail and what in your opinion is the underlying reason. Discuss and implement.

The behaviour of the car might not be the most appropriate in some situations for a "out-of-the-box" implementation of the strategy. Discuss any transformation required to smooth the controller's decision and guarantee that the car can take turns.

Try to push the velocity to the car as far as possible such that a complete lap can be performed by the car. What is this value ? Does it require any changes ? Can you sustain a constant high speed when taking a turn ? Discuss.

Try to find an intuitive policy to adapt the car speed dynamically.