TÉCNICO LISBOA

Robotics

P2, Winter, 2022

Departamento de Engenharia Electrotécnica e de Computadores

2nd lab assignment – v 1.0

Autonomous Cars

(Due by January 28, 2022)

1 Introduction

This lab assignment aims at developing a simulation of an autonomous car operating inside a well defined environment, i.e., the IST Alameda campus. The car must be able to move between any two arbitrary configurations along trajectories entirely contained inside the road areas normally reserved for vehicles.

2 Syllabus

A car-like kinematics, as shown in figure 1, can be used to simulate the car.

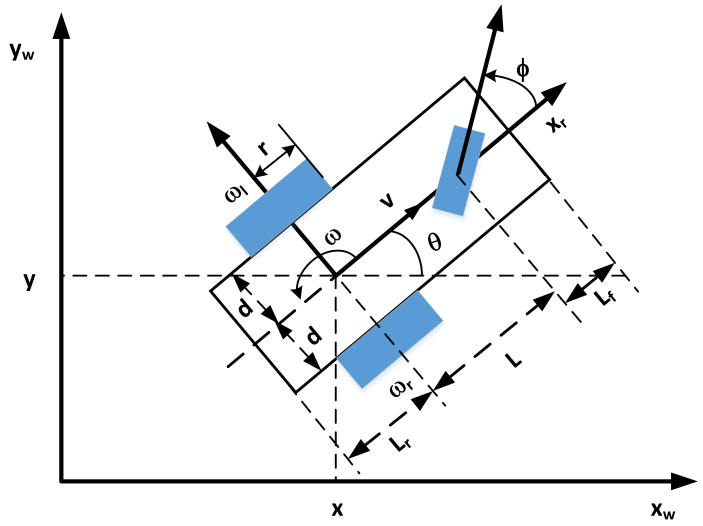

Figure 1: Kinematics of a car-like robot

However, if the goal is to achieve truly realistic behavior then a dynamics model of the type studied in the theory classes has to be used,

$$\tau = M(\theta)\ddot{\theta} + V(\theta, \dot{\theta}) + G(\theta)$$

Which model to use is at discretion of the students and must be duly justified in the report.

Table 1 shows the specs of a real car to be used in this lab.

The map for the selected environment must be obtained from Google Maps (in the report, do not forget to indicate the precise coordinates of the area).

Figure 3 below shows a diagram with a (very) simple architecture of the system to be developed.

The lab assignment addresses, at least, the robot and the trajectory controller blocks.

The car must move according to an energy budget, i.e., the vehicle will have a limited (and fixed) amount of available energy to go between any two arbitrary configurations; this budget will be set before the simulation starts.

Figure 2: Example of an admissible environment – IST Alameda campus. A world frame is marked with tick black lines (real dimensions are indicated for scaling purposes).

L	2.2 m
L_r	0.566 m
L_f	0.566 m
d	0.64 m
r	0.256 m
Length	3.332 m
Width	1.508 m
Mass	810 Kg

Table 1: Vehicle specs

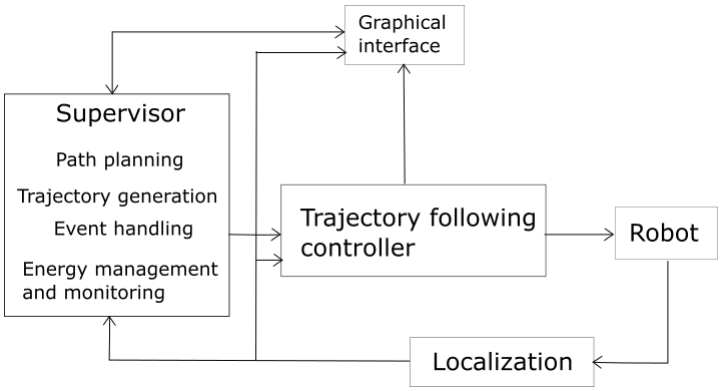

Figure 3: Simplified architecture for the Robotics-Lab autonomous car

For a car robot of mass M, moving with velocity $v(t)$, the amount of energy used during an interval Δt is given by

$$\Delta E = (|F(t)|\,|v(t)| + P_0)\ \Delta t = (M\,|\dot{v}(t)|\,|v(t)| + P_0)\ \Delta t$$

where P_0 is a constant value (to model the cost of having the vehicle in operation but not moving, e.g., as when stopped for pedestrians to cross the road).

The number of collisions and energy spent must be displayed during the simulation.

3 Expected outcomes

Students must deliver a zip/rar file containing all the software developed, tests ran, and adequate pdf documentation explaining, clearly, the project and how to use the software.

4 Bonus points

Bonus points may be awarded if a dependability demonstration for the overall system, i.e., a proof that the car is trustworthy, is presented.