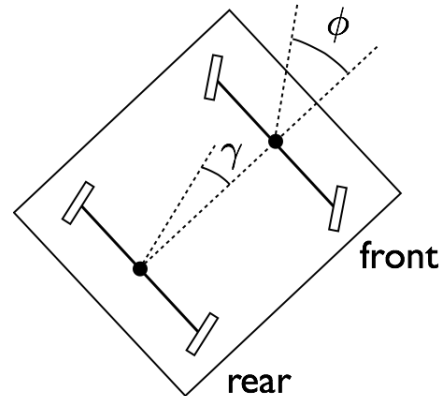


Autonomous and Mobile Robotics

Midterm Class Test, 2015/2016

Problem 1

The Cycab is an autonomous electrical vehicle developed in France by INRIA.



From a kinematic point of view, it is a robot with four orientable wheels, arranged in pairs on a front axle and a rear axle. Each pair of wheels can be steered independently. This results in a higher maneuverability with respect to a car-like robot.

1. Derive a kinematic model of the Cycab for the case of rear-wheel drive.
2. *Optional:* Prove that this kinematic model is controllable.
(*hint: one may exploit the fact that the car-like robot is controllable...*)

Problem 2

Using the obtained kinematic model of the Cycab, design a feedback control law such that the robot orientation θ asymptotically tracks a time-varying reference value $\theta_d(t)$. Discuss the conditions under which the controller achieves its objective.

(*hint: identify the output variable to be controlled and try input-output linearization...*)

Problem 3

Assume that the Cycab is equipped with wheel encoders and a laser range finder that can measure the distance to a charging station. For simplicity, suppose that (1) the sensor is located above the midpoint of the rear wheel axis (2) the sensor can always see the charging station. Build a localization system for estimating the configuration of the robot. Provide both its equations and a block scheme to clarify where sensor data are used in the localization process.