Alma Mater Studiorum Università di Bologna
Department of Electrical, Electronic and Information Engineering

Master's Degree in Automation Engineering

# Control of an autonomous aerodynamic airshield for training Olympics 100m sprint athletes

*Candidate:*
Giulia Cutini

*Advisor:*
Prof. Giuseppe Notarstefano

*Co-Advisors:*
Prof. Melanie Zeilinger
Dr. Andrea Carron
Ing. Lorenzo Sforni


Bologna, 18 March 2024

ETH Zürich

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# Introduction

## Motivations

In athletics, the **overspeed training** makes possible to enhance the competition performances.

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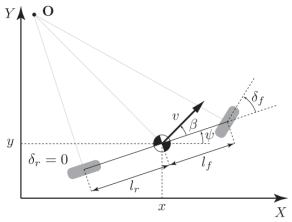
## Contributions

- Model of the system: the autonomous go-kart with the airshield attached
- Design a controller for the system to regulate it with respect to the runner
- Test the controller

# Modeling of the go-kart with the aishield attached




**Non linear kinematic byclicle model**

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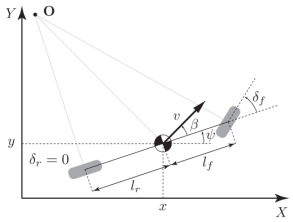


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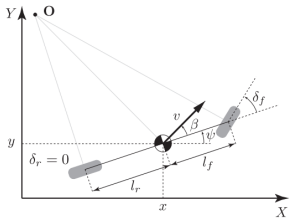


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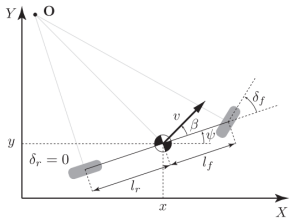


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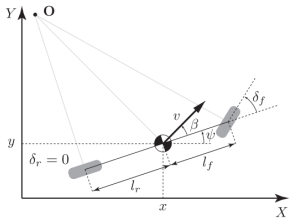


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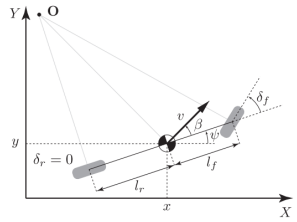


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The non linear term can be removed

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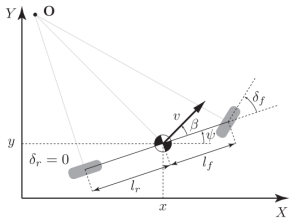


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$$x_{k,t+1} = \begin{bmatrix} p_{k,t+1} \\ v_{k,t+1} \end{bmatrix} = \begin{bmatrix} 1 & dt \\ 0 & 1 - dt\frac{C_f}{m} \end{bmatrix} x_{k,t} + \begin{bmatrix} 0 \\ dt\frac{C_{m1}}{m} \end{bmatrix} u_t$$
$$= A\, x_{k,t} + B\, u_t$$

**Linear time-invariant system**

# Gain Scheduling Linear Quadratic Regulator

# Model Predictive Control

# Offset-free Model Predictive Control

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# Simulation tests and Controllers comparison

# Hardware-in-the-loop tests