

Introduction to Lateral Control

Course 1, Module 6, Lesson 1



UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

Learning Objectives

- In this module, you'll
 - Explore lateral vehicle control definitions
 - Design two geometric path following controllers
 - Discuss model predictive control for autonomous driving
- By the end of this video, you'll be able to...
 - Define different types of reference path
 - Compute heading and crosstrack errors

Lateral Control Design

不考虑滑动

- Lateral control for an automobile
 - Define error relative to desired path
 - Select a control law that drives errors to zero and satisfies input constraints
 - Add dynamic considerations to manage forces and moments acting on vehicle



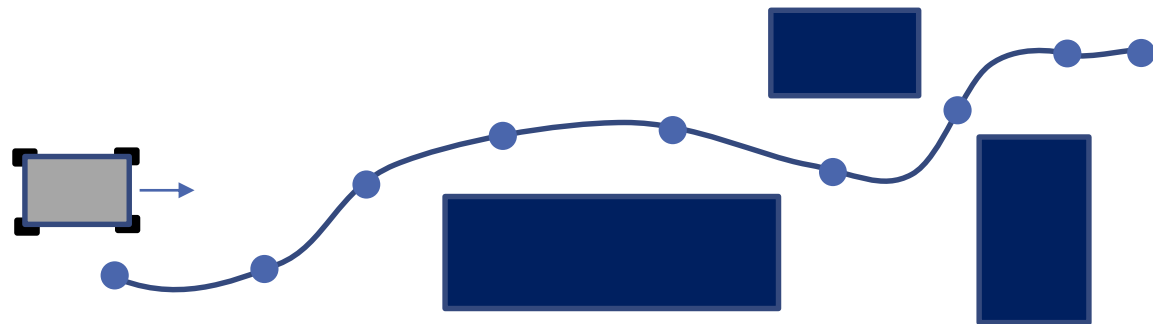
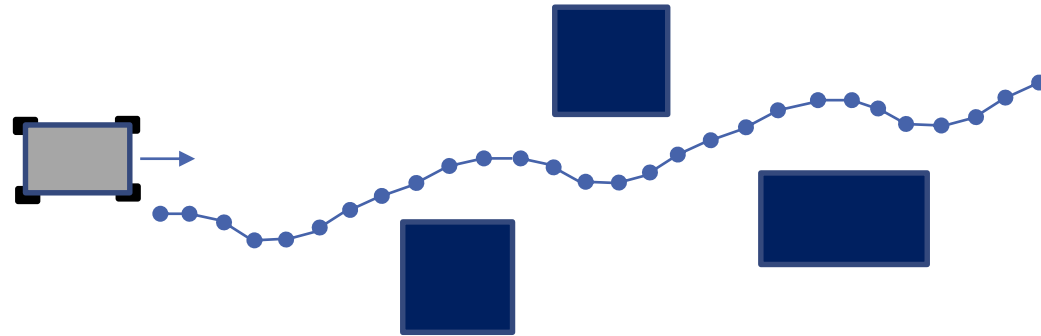
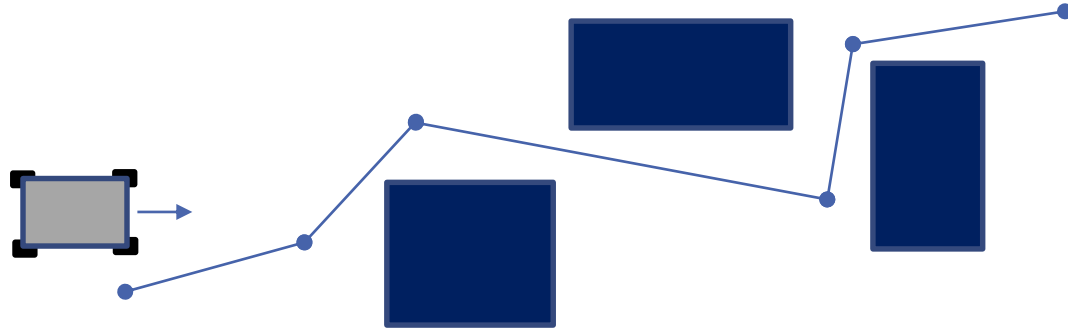
The Reference Path

- Track

- Straight line segments
- Waypoints
- Parameterized curves

- Main goals:

- ☆ {
 - Heading path alignment
 - Elimination of offset to path



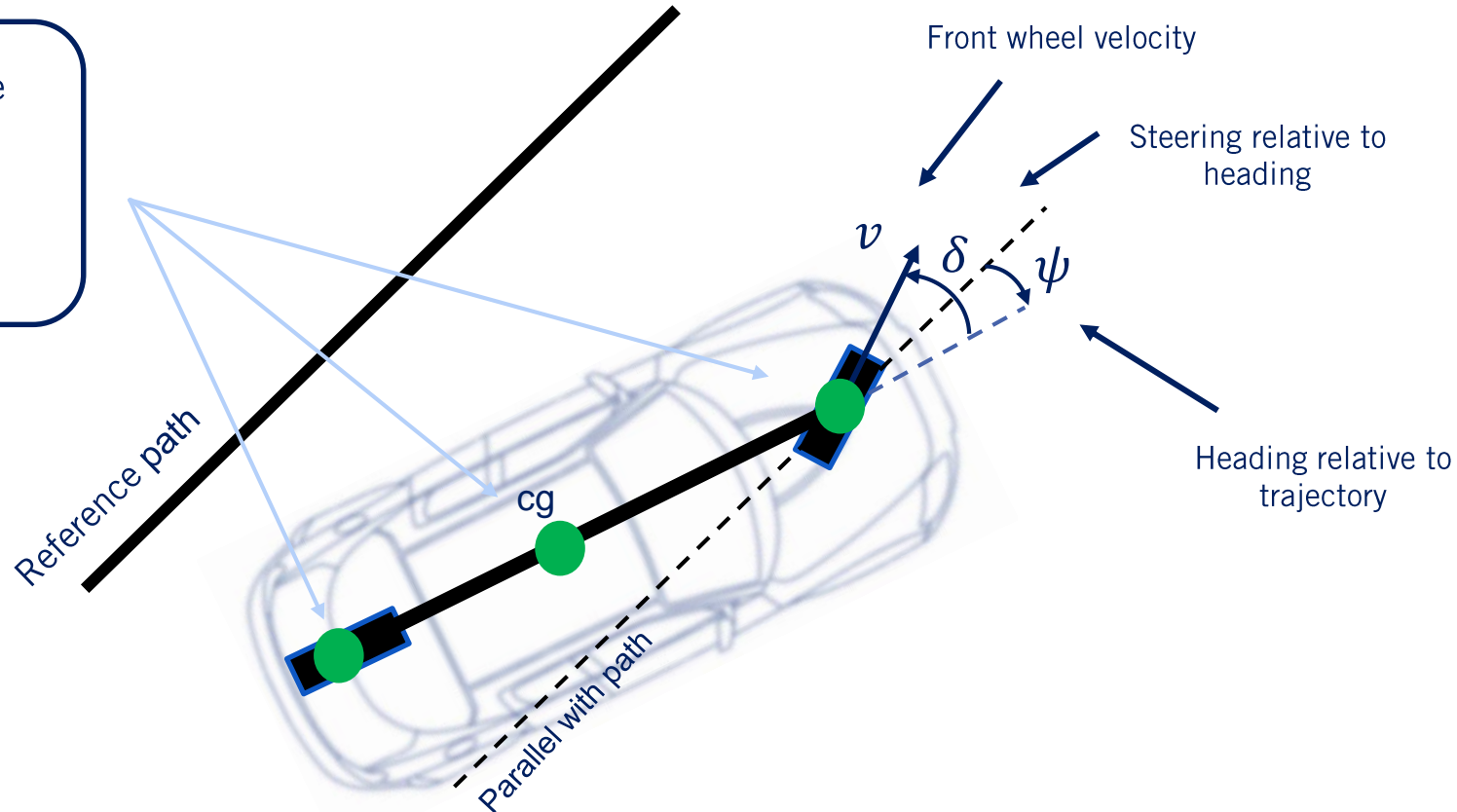
Two Types of Control Design

- Geometric Controllers 依赖所需路径的几何形状和坐标。
 - Pure pursuit (carrot following)
 - Stanley 斯坦利控制器
- Dynamic Controllers
 - MPC control
 - Other control systems
 - Sliding mode, feedback linearization

Plant Model

- Vehicle (bicycle) model & parameters
 - All states variables and inputs defined relative to the centre of front axle

Main vehicle reference frame for lateral control can be at:
The center of front axle
The center of gravity (cg)
The center of rear axle



Driving Controller

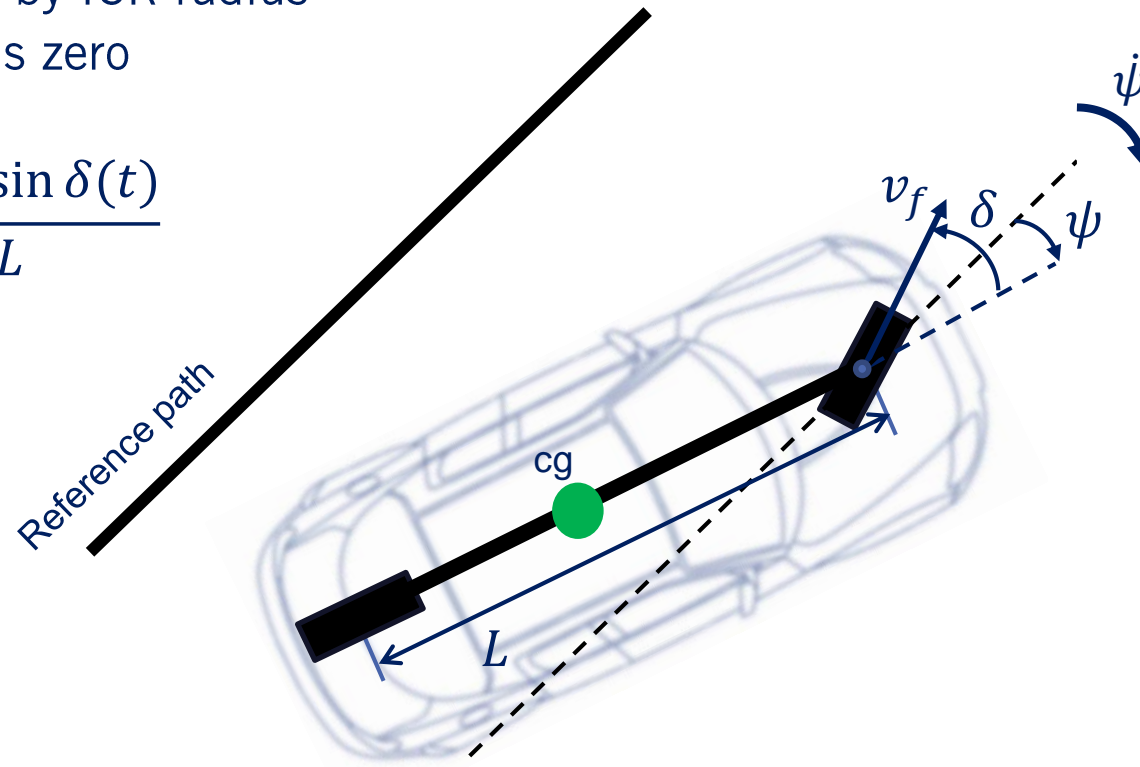
- Controller error terms
 - Heading error
 - Component of velocity perpendicular to trajectory divided by ICR radius
 - Desired heading is zero

参考轨迹为直线时, 角度变化率为0

$$\dot{\psi}_{des}(t) - \dot{\psi}(t) = \frac{v_f(t) \sin \delta(t)}{L}$$

↓

$$\dot{\psi}(t) = \frac{-v_f(t) \sin \delta(t)}{L}$$



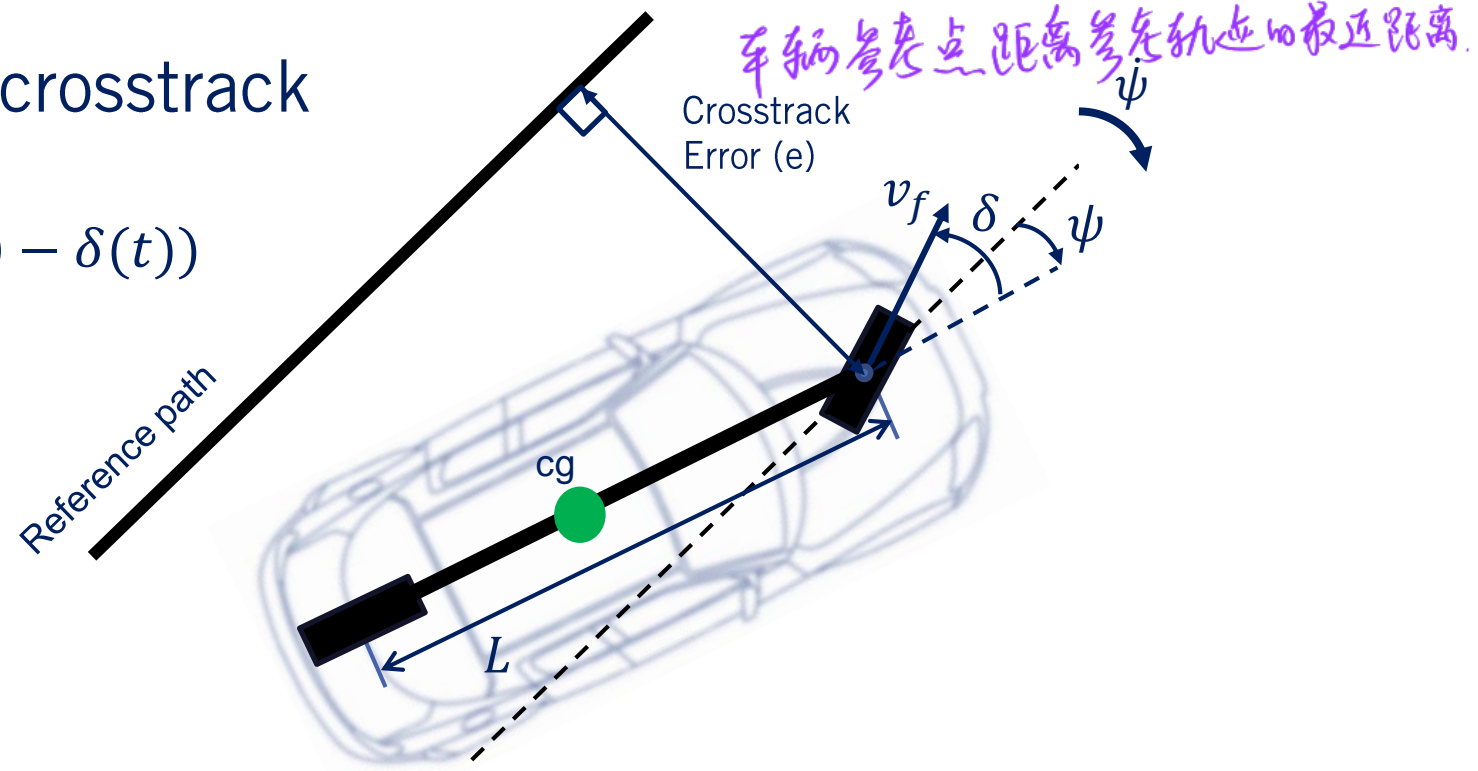
Driving Controller

- Crosstrack error (e) :
 - Distance from center of front axle to the closest point on path

对于曲线需要找到它的最近参考点。

- Rate of change of crosstrack error (\dot{e})

$$\dot{e}(t) = v_f(t) \sin(\psi(t) - \delta(t))$$



Summary

What we have learned from this lesson:

- Basic concept in lateral vehicle control which will be used in all lateral control development

What is next?

- We will start defining the pure pursuit (carrot following) control strategy