Numerical Optimal Control for Vehicles

Announcing a one-day tutorial that will be held on June 15 at Eindhoven University, Netherlands. This is a pre-symposium tutorial at the 11th IFAC Symposium on Advances in Automotive Control (AAC2025).

Tutorial Outline

This one-day tutorial is an introduction to using numerical optimal control to study vehicular control. The basics of numerical optimal control are presented with the perspective of how to use it. Simple examples are studied in a first hands-on interactive session using the available software CasADi. Models, methods, and results in optimal vehicle maneuvers are then presented. In the second hands-on interactive session such problems are studied. Alternatively, in this session you may formulate, discuss, and perhaps even solve a problem from your own research around vehicles. The overall goal of the tutorial is to illustrate numerical optimal control, and add it as a useful engineering tool for the course participants.

Target Group

This course is intended for engineers, PhD students, and Master's students that have a basic engineering background in modeling, control, and vehicles.

Instructors

Lars Nielsen, Linköping University

Professor, Dept. Electrical Engineering

Since 1992 he is professor of Vehicular Systems holding the Sten Gustafsson chair at Linköping University. His main research interests are automotive modeling and control, and autonomous driving.

Björn Olofsson, Lund University

Associate Professor, Dept. Automatic Control

His research interests include motion control for robots and vehicles, with particular focus on methods based on optimal control and optimization. He has been working with numerical optimal control for 15 years.

Course Content

This tutorial builds on experience from a PhD course given twice, and focuses on numerical optimal control as a tool in vehicular control. It is now, in many different fields, an efficient tool to find control principles and limiting cases of performance. The optimization methods and tools are first illustrated by simple examples. Then these methods are used for optimal vehicle maneuvers. The ambition is that PhD students from any field of automotive control should benefit from the tutorial (and may even take the opportunity to study their own problems).

The pre-symposium tutorial has three main objectives:

1. To introduce tools for numerical optimal control and their practical use.
2. To present their use in vehicle maneuvers.
3. To perform hands-on exercises (bring your own computer; we will provide dynamic models and code templates to get started).

Preparations

As preparations before the tutorial, the participants should:

- Download and install the latest version of CasADi on your own computer according to the instructions on https://web.casadi.org .
- Run a simple test example provided by the organizers before the tutorial.
- Bring your computer with CasADi installed to the tutorial.

Tentative Schedule of Tutorial

- Introduction to numerical optimal control, and how to use it
- Hands-on Exercise I

  Lunch Break
- Models, Methods, and Results from Optimal Vehicle Maneuvers
- Hands-on Exercise II
- Feedback control, summary, and outlook