Truck 'N Trailer Project Overview

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Context

This project explores the optimization of a backward-driving truck–trailer system using Model Predictive Control (MPC). Since the dynamics of backward motion in such systems are inherently unstable, we adopt a simplified model to prevent overfitting and avoid unnecessary complexity. To address the problem effectively, we break it down into several key objectives.

Objectives

1. **Forward Driving:** Develop accurate modeling and control of the truck–trailer system during forward motion. This phase helps build familiarity with the fundamental physics and behavior of the system.

2. **Backward Driving:** Extend the modeling and control framework to backward driving along simple routes. This focuses on managing the instability and control challenges unique to reversing maneuvers.

3. **Static Objects:** Design and implement MPC strategies for tasks that involve stationary obstacles, such as parallel parking or navigating toward fixed destinations.

4. **Dynamic Objects:** Develop MPC for interacting with and tracking dynamic objects, such as other moving vehicles.

Learning Goals

- **Seongjae Ahn:** Throughout this project, my goal is to apply Model Predictive Control to realistic scenarios by creating random initial to goal paths, obstacles, and test environments. Design both typical and edge-case situations in simulation, and develop a model that can react robustly to each of them.

- **Yu-Wei Chang:** My goal is to apply optimization and Model Predictive Control (MPC) techniques to a real-world problem. The reversed truck–trailer system serves as an ideal case study because of its inherently unstable dynamics. Working with this system will also give me valuable experience in developing and adapting simplified models for complex, real-world applications.

- **Eric Chuang:** I want to learn how to set up a model and optimization problem for a task that can be solved with mpc.

- **Evan Grealish:** My goal is to take a real-world physics based problem, analyse and formulate its dynamics, constraints and cost functions and design and implement various Model Predictive Control techniques in order to solve problems of varying difficulty from driving in a straight line to complex problems such as driving around moving objects and parallel parking. Ensuring feasibility, stability and getting a sensible optimal solution will be a major challenge in this project.

- **Lennart Peus:** My goal is to get learn how a MPC is implemented in a fully working system and combine it with a new simulation model as well. Working with the actual code an seeing what goes into a real world application will help me understand the in class taught concepts even better.

- **Wayne Toh:** I aim to develop the ability to formulate, implement, and analyze Model Predictive Control strategies for complex, nonlinear vehicle systems. In our case, this is a backward-driving truck–trailer configuration. This includes building simplified dynamic models, designing stable MPC controllers for both forward and reverse motion before adding layers of complexity, and extending these controllers to handle real-world challenges such as in the robotics or autonomous vehicles industry.