UNIVERSITY TRANSPORTATION CENTER

RESEARCH BRIEF

Data-Driven Motion Control of Autonomous Vehicles in GPS-Unreliable Environments

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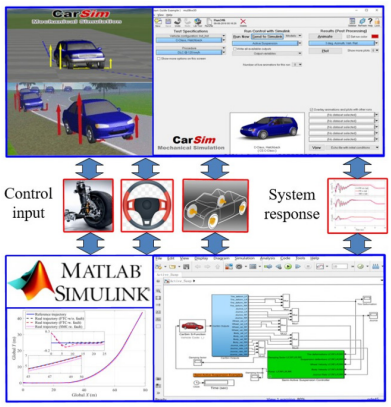
Background

The main purposes of developing autonomous vehicles (AVs) are to improve transportation safety, increase roadway utilization, and reduce energy consumption and mobility cost; among these, driving safety is the most essential motivation for AV use. Among different AV functionalities, the control and actuation functions under different road conditions and driving scenarios are paramount to ensure vehicle stability and safety. High-performance motion control is of great significance in AVs for dealing with practical issues associated with vehicle dynamics, sensors, actuators, and other modules in self-driving vehicles.

Path-tracking control, a foundational control function for AVs, refers to stabilizing the two path-tracking errors to zero. The positioning and navigation are critical for achieving path-tracking for AVs, where GPS has been the prevalent technology. However, GPS signals might be unavailable or unreliable in certain circumstances or rural areas. In addition, the AV path-tracking issue also involves the vehicle state or parameter estimations, which is subjected to the effects caused by the unreliability of GPS signals in a hostile environment. Once GPS is not available, it is generally difficult to measure certain types of the vehicle states. Considering specifically Alaska's harsh environment, the tire-road friction coefficient is also critical, as slippery road conditions directly exert adverse effects on the control performance.



Research Project

In this project, a novel data-driven strategy will be proposed for AV motion control when a GPS signal is not reliable. In recent years, data-driven approaches such as reinforcement learning (RL) and adaptive dynamic programming (ADP) algorithms have been widely adopted in solving dynamic programming problems. However, there is seldomly any related application in AV control systems when a GPS signal is not reliable, where technical difficulties occur due to the unavailability of the vehicle location, orientation and certain critical vehicle states.

To this end, this project will develop an enhanced ADP approach for AV motion control when the GPS signal is not reliable, based on the estimation results for the sideslip angle and tire-road friction coefficient. The dependable inputs will be signals collected/measured from on-board sensing results. The innovations of this research are: 1) An adaptive and cost-efficient estimation scheme will be proposed to estimate the tire road friction coefficient and sideslip angle simultaneously based on on-board sensors; 2) A novel learning-based adaptive motion control strategy will be proposed based on the sensing results and obtained estimation results to solve the tracking control with guaranteed prescribed performance.

ABOUT THE AUTHORS

The research team consisted of Chuan Hu of the University of Alaska Fairbanks.

ABOUT THE FUNDERS

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EXPECTED DATE OF COMPLETION

March 2022

FOR MORE INFORMATION

https://depts.washington.edu/pactrans/research/projects/data-driven-motion-control-of-autonomous-vehicles-in-gps-unreliable-environments/