CRII: CPS: Bilateral Adaptation between Models for Human-Perceived Safety/Comfort and Autonomous Driving Controllers

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https://sites.google.com/site/cucralab/crii

Objective: The proposal aims to investigate human perceived safety and comfort in autonomous vehicles and develop bilateral adaptation approach to improve the human perceived safety/comfort while retaining the technical safety and efficiency.

Challenges

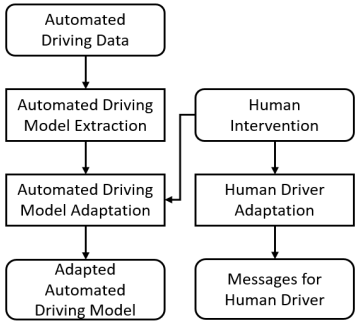
- Technical safety/comfort of AVs is not equivalent to human perceived safety/comfort
- Need to understand and improve human perceived safety/comfort in AVs

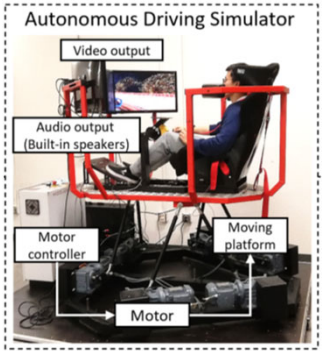
Scientific Impact

- Understand and model human driving controller and autonomous driving controller
- Bilateral adaptation methodology to adapt the two controllers to migrate them to consistency

Technical Approaches

- An inverse model predictive control (IMPC) approach to understand and model human driving controller and autonomous driving controller
- A bilateral adaptation approach to adapt the controllers of human and AV to migrate them to consistency while retaining the safety and efficiency of AVs
- Data collection and experimental evaluations in a high-fidelity autonomous driving simulator with a 6-DOF motion base





Impact on Society

- Help increase the user acceptance of autonomous vehicles and facilitate the deployment of autonomous vehicles in real world
- The research on improving the safety and comfort of autonomous driving is transferable to other human-autonomy interaction applications

Impact on Education and Outreach

- 2 PhD, 5 master, and 1 undergraduate. One college outstanding graduate researcher award.
- 2 courses related to autonomous vehicles
- Annual K-12 summer camp since 2018

Quantitative Impact

- Published 6 papers and 3 papers are under review.
  - L. Guo and Y. Jia*, "Inverse Model Predictive Control (IMPC) based Modeling and Prediction of Human-Driven Vehicles in Mixed Traffic," *IEEE Transactions on Intelligent Vehicles*, 2020.
  - L. Guo and Y. Jia*, "Predictive Control of Connected Mixed Traffic under Random Communication Constraints," *IEEE/RSJ IROS*, 2020.
  - Y. Jia* and B. Ayalew, "Cyber-Human-Physical Heterogeneous Traffic Systems for Enhanced Safety," *IEEE International Conference on Connected and Autonomous Driving*, 2020.
  - D. Bolduc, L. Guo and Y. Jia*, "Multi-Model Approach to Personalized Autonomous Adaptive Cruise Control," *IEEE Transactions on Intelligent Vehicles*, 2019.
  - L. Guo and Y. Jia*, "Modeling, Learning and Prediction of Longitudinal Behaviors of Human-Driven Vehicles by Incorporating Internal Human Decision-Making Process using Inverse Model Predictive Control," *IEEE/RSJ IROS*, 2019.
  - X. Wang, L. Guo and Y. Jia*, "Road Condition based Adaptive Model Predictive Control for Autonomous Vehicles," *ASME DSCC*, 2018.

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