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 explore the knowledge of human perceived safety and comfort in autonomous vehicles and investigate bilateral adaptation mechanisms in order to improve the autonomous driving safety and comfort.

Challenges

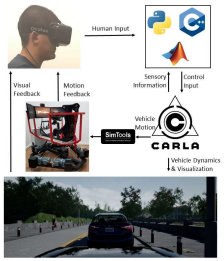
- Understand factors affecting the human perceived safety and comfort and investigate how to quantify human perceived safety and comfort using physiological signals.
- Investigate appropriate bilateral adaptation strategies in autonomous driving in order to improve the driving safety and comfort.
- Evaluate the effectiveness of the proposed research outcomes in an autonomous driving simulator.

Scientific Impact

- New knowledge to understand what autonomous driving factors may affect the human perceived safety and comfort and investigate computational models to online quantify the human perceived safety and comfort levels in autonomous vehicles;
- Methodologies to model and bilaterally adapt autonomous driving and human driving behaviors according to human interventions in order to improve the driving safety and comfort.

Technical Approaches

- Empirical studies in autonomous driving simulator; Autonomous driving feature extraction for perceived safety and comfort; Physiological model of human perceived safety and comfort using wearable devices.
- Model predictive control (MPC) based modeling of human/autonomous driving; Inverse MPC to learn both models from demonstration and intervention; Bilateral adaptation of both models to enhance safety and comfort
- Experimental evaluations on an 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
- Create a dataset for perceived safety and comfort of autonomous driving for the society
- The research on improving the safety and comfort of autonomous driving is transferable to other human-autonomy interaction applications

Impact on Education and Outreach

- Develop a popular course: AuE 893 Autonomous Driving Technologies; Hold student autonomous driving competitions; Teach autonomous driving at local high schools; Involve students in lab research on autonomous vehicles

Quantitative Impact

- Support 1 PhD student, 2 Master students, and 1 high school student in research
- Publish 3 peer-reviewed papers:

– D. Bolduc, L. Guo and Y. Jia*, "Multi-Model Approach to Personalized Autonomous Adaptive Cruise Control," *IEEE Transactions on Intelligent Vehicles*, vol. 4, no. 2, pp. 321-330, 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 International Conference on Intelligent Robots and Systems (IROS)*, 2019.
– X. Wang, L. Guo and Y. Jia*, "Road Condition based Adaptive Model Predictive Control for Autonomous Vehicles," *ASME Dynamic Systems and Control Conference (DSCC)*, 2018.

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