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

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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.

Research Challenges/Work

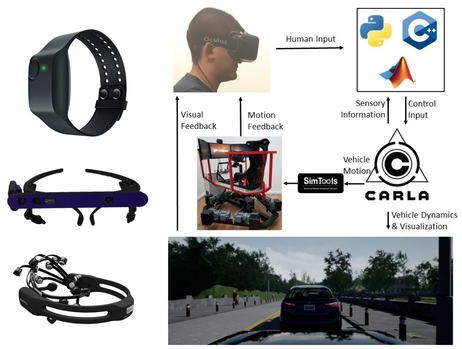
- **Thrust 1:** Understand factors affecting the human perceived safety and comfort and investigate how to quantify human perceived safety and comfort using physiological signals.
- **Thrust 2:** Investigate appropriate bilateral adaptation strategies in autonomous driving in order to improve the driving safety and comfort.
- **Evaluations:** Evaluate the effectiveness of the proposed research outcomes in an autonomous driving simulator.

Scientific Contributions:

- 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:

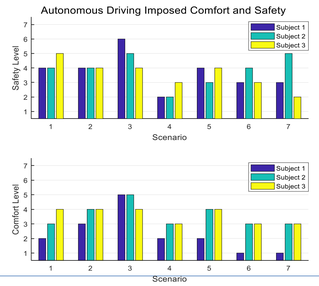
- Empirical studies in autonomous driving simulator → Autonomous driving feature extraction for perceived safety and comfort → Physiological model of human perceived safety and comfort using wearable devices.
- Model predictive control (MPC) based modeling of human/autonomous driving → Inverse MPC to 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



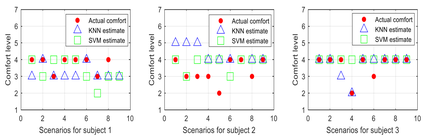
Current Research Outcome

- Human perception on safety and comfort of autonomous vehicles are dramatically different for the same scenarios.

Scenario	Description
1	Lane keeping - more defensive
2	Lane keeping - more aggressive
3	ACC - more defensive
4	ACC - more aggressive
5	Lane switching - more defensive
6	Lane switching - more aggressive
7	Roll through stop sign (right turn)

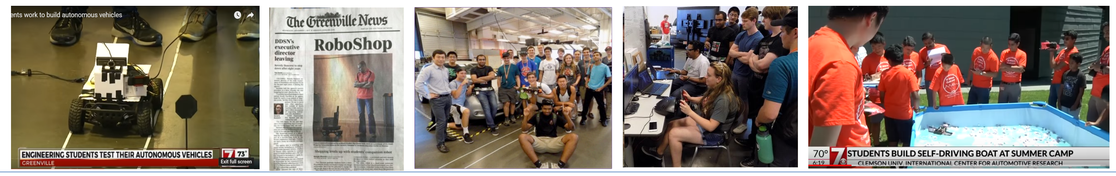


- Human comfort can be quantified using physiological signals including heart rate, blood pressure, skin conductance response, and skin temperature,



Broader Impacts and Current Outcome

- **Research:** Help increase the user acceptance of autonomous vehicles and facilitate the deployment of autonomous vehicles; Create a dataset for perceived safety and comfort of autonomous driving
- **Education:** Autonomous driving courses (graduate, undergraduate and online certificate)
- **Outreach:** Competition-based autonomous driving hands-on summer programs for K-12 students
- **Dissemination:** Keynotes and seminars at BMW, Ford, TARDEC and SAE World Congress



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