2021 NSF CYBER-PHYSICAL SYSTEMS PRINCIPAL INVESTIGATORS' MEETING

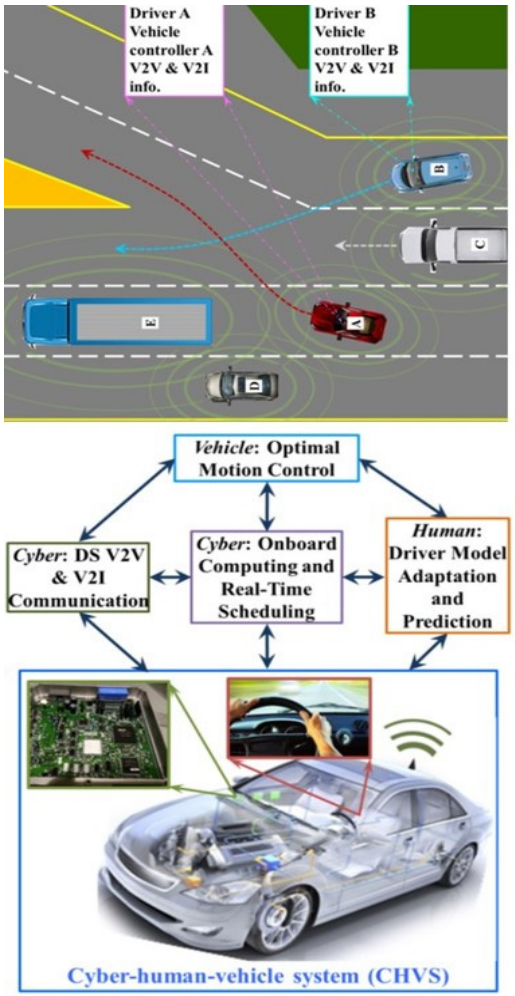
CPS: Synergy: Real-Time Cyber-Human-Vehicle Systems for Driving Safety Enhancement

Challenges:

- How to best accommodate the significant driving characteristics variations among different human drivers
- How to maximize the effectiveness of vehicle active control systems for individual driver-vehicle pairs
- How to conduct real-time scheduling on multi-core onboard embedded computers such that various vehicle motion control computation tasks can be completed in a timely and optimal manner
- How to optimally conduct real-time V2V communications and coordinate the motion controls of involved vehicles to minimize the chance of collisions

Solutions:

- Multi-disciplinary and synergistic innovations at the intersection of vehicle control, onboard real-time computation & communications, and human factors for effectively utilizing the newly available vehicle cyber resources to elevate the likelihood of real-world driving accident avoidance
- Use driving simulation systems to study human drivers' attentional allocation and driving behavior
- Develop personalizable driver models that can be optimized based on individual human drivers' historical driving data and predict his/her behavior in emergency driving situations
- Develop driver-specific and driver-adaptive vehicle active control systems to achieve personalized vehicle motion control
- Develop resource-aware and prioritized real-time computational task scheduling methods for driver-specific vehicle control algorithms
- Design multi-channel V2V communication frameworks that monitor all the available channels and dynamically select the best one for real-time safety message transmission



Scientific Impact:

- Studies on the onboard-adaptable driver models and driver model adaptation methods will provide new knowledge and tools for better understanding and cooperating with individual human driving characteristics
- The driver-specific vehicle active control systems can break new ground in the field of vehicle control by enabling individually-optimal vehicle control systems
- The research on dynamic onboard real-time computation task-scheduling and prioritized real-time V2V communications and their integrations with the driver-specific vehicle active controls can create innovative approaches to effectively utilize the onboard computation and communication resources for enhancing driving safety and collision-avoidance
- The research findings from this project can have transformative impacts on other cyber-human-physical interactive systems by realizing optimal cyber-human-machine syntheses and interactions

Broader Impact:

- The research may produce new methods for making active vehicle safety control systems collaborate with individual humans effectively to enhance driving safety
- Hosted K-12 Summer Camp activities with Ohio State University Women-in-Engineering Program
- Recruited undergraduate student REUs working on this research in collaboration with graduate students at UT-Austin
- Published 11 journal articles and 8 conference papers
- Delivered more than 15 invited talks relevant to the project
- Graduated 3 Ph.D. students

Award #: 1901632 (transferred from 1645657 in 2018); Project duration: Oct. 2016 – Sept. 2021
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