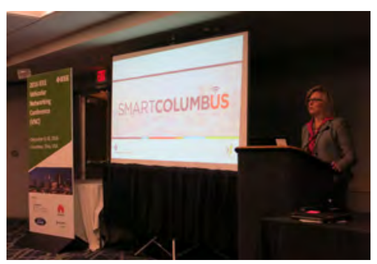
2016 CrIS UTC Annual Meeting

The CrIS UTC annual meeting was held in Columbus, OH on September 22-23, 2016. The meeting was attended by over 40 participants from member universities and institutions. The first day was a technical workshop where CrIS UTC students and faculty gave presentations that highlighted their current research findings and progress. The second day was a business meeting with members from the external advisory board and leadership team, providing feedback and opportunities of direction for the future. You may find more information of the projects that were presented on our website: citr.osu.edu/CrIS/.

The next annual meeting will be held on September 22, 2017.

2016 IEEE Vehicular Networking Conference

The 2016 IEEE Vehicular Networking Conference was held in Columbus, OH on December 8-10, 2016. The conference brought together researchers, professionals and practitioners to present and discuss recent developments and challenges in vehicular networking technologies and their applications, including many safety systems within the domain of CrIS UTC.



Eylem Ekici, professor, Electrical & Computer Engineering served as a general co-chair, while Arda Kurt, research assistant professor, Electrical & Computer Engineering served as the local arrangements chair. On the second day of the conference, Umit Ozguner, director, CrIS UTC, gave the keynote presentation on Communication Needs in Collaborative Driving.

Kurt attends third annual Safety Summit

The third annual Summit of University Transportation Centers for Safety was held on April 6, 2017 in Washington, DC. Hosted by the Carnegie Mellon University T-SET Center, the one-day summit focused on panels and open discussion of a diverse set of topics including infrastructure for improved safety, safe deployment of automated and connected vehicles and issues affecting rural transportation. The event brought together UTC researchers with government, industry and community transportation safety practitioners. CrIS UTC researcher, Arda Kurt, attended the summit and presented a sample set of the latest research developments to the CrIS member institutions.

Ekici named 2017 IEEE Fellow

Eylem Ekici, professor, Electrical & Computer Engineering (ECE) was named the latest Institute of Electronics and Electrical Engineers (IEEE) Fellow for 2017, bringing the total number of Ohio State ECE department fellows to 20.

The IEEE Fellowship status is considered the highest grade of membership, recognized by the technical community as a prestigious honor and an important career achievement. Ekici received the honor based on his "contributions to algorithms, protocols and architectures of multi-hop wireless networks."

Ekici's current research interests include cognitive radio networks, vehicular communication systems and next generation wireless systems, with a focus on algorithm design, medium access control protocols, resource management and analysis of network architectures and protocols.

Keynote presentation: John Lee, University of Wisconsin-Madison

John Lee, PhD, professor, Emerson Electric Quality & Productivity at the University of Wisconsin-Madison was a keynote speaker at 2017 IEEE Conference on Cognitive and Computational Aspects of Situation Management on March 30, 2017. He spoke on the topic "Trusting Increasingly Autonomous Cars."

Abstract: Increasingly autonomous cars are transforming what it means to drive, and this transformation is emblematic of changes in other domains: finance, military operations, healthcare, manufacturing and the home. Driving is a microcosm of autonomy. As in other domains, technology does not substitute for people, but transforms their roles. Increasingly these roles are not as a supervisor of automation, but as a partner in a network of interacting agents. This role means considering people's world view and their assumptions regarding the persistence of the natural and moral order that guides the evolution of trust and situation awareness. Rather than focusing on how automation reliability influences reliance, it may be more productive to focus on how automation collegiality influences cooperation. To promote appropriate trust we need to move beyond creating transparent automation that displays its purpose, process, performance to creating responsive and responsible automation that has controls for aligning its goals, adapting its strategies and adjusting its behavior. The dimensions of autonomy most relevant for these considerations might not be levels of automation, but depth and breadth of span of the control and time constant of interaction. This talk will link these theoretical considerations to research directions and design principles.

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CrIS UTC news

THE OHIO STATE UNIVERSITY Spring 2017

Message from the Director

Our Department of Transportation sponsors occasionally ask for information on the progress of our projects. These requests come with short (sometimes very short!) deadlines, but usually leave me with the desire to share my report with others. This time the request came fairly close to our newsletter, so I am copying my summary here. Note that these are only projects directly supported through our UTC funding.

Driver Models for Both Human and Autonomous Vehicles with Different Sensing Technologies and Near-crash Activity
CrIS UTC researchers are studying different methods of capturing driver behavior in computational and functional models. These models are developed as tools for understanding and quantifying human driving behavior, to be used in partial/full automation applications and advanced active safety systems.

Working on safety-critical case scenarios, they developed a lane change behavior classification approach to detect dangerous cut-in behaviors on highways based on HMMs. Following this study, Ohio State researchers investigated the automated stabilization problem of a convoy of vehicles, using control methods that benefit from the behavior modeling and estimation schemes described above. The researchers developed theoretical foundations of the problem, which involves the study of a class of spatially decoupled systems by applying distributed model predictive control (DMPC) with switched cost functions.

The probabilistic and fuzzy driver models are trained using naturalistic driving study data and smaller local data sets, and the active safety and control components of the work are extensively simulated as the team prepares experimental verification on full-scale vehicles.

Human Cognitive Modeling for Driver Re-Engagement in Automated Vehicles
The focus of this project is to improve the state-of-the-art in human cognitive modeling in order to more accurately describe the human-machine interfaces that take place in the pre-crash scenarios. This project develops a cognitive attention model that provides a fundamental understanding and analysis capability for driver attention. In particular, the model will be used to understand how drivers respond to vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) information cues in pre-crash scenarios. It also addresses how to re-engage a driver who may be partially or completely disengaged from key attention elements while operating a semi-autonomous vehicle. We seek to understand driver engagement over a range of human physiological and behavioral factors, including age and drowsiness.

Utility of Technology Advances in Connected and Automated Vehicles
This project is a collection of small subprojects based on recent technology advances and utility.
Subproject 1: We study the value of V2I and V2V communications for improving pre-crash safety. We consider the "value of information" we study scenarios in which location and heading information for nearby vehicles is used and we will test its value in averting crashes in specific scenarios like lane change and merge.
Subproject 2: We study the impact of both intra-vehicle and inter-vehicle communication cybersecurity on pre-crash scenarios. A number of issues are of concern: external "snooping"; injection of false information externally; and "hacking" the vehicular software. Several countermeasures are being developed, including key generation and filtering. Our focus is on the implications of cyber-threats on pre-crash safety. For example, cybersecurity countermeasures result in data latency; we will investigate how this latency degrades safety margins. As a second example, inaccurate information, including false warning indicators that may result from either compromised security or communication noise reduce driver trust in the data, and result in a change of driver behavior in response to these indicators.
Subproject 3: We have initiated an investigation of modeling of pedestrian and crowd behavior with slow, autonomous platforms (including automated wheelchairs) in their midst. This has applications in Smart City environments.

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THE OHIO STATE UNIVERSITY
CENTER FOR AUTOMOTIVE RESEARCH

INSIDE THIS ISSUE:

Lane change demo

A team of CrIS UTC graduate students and faculty members designed, developed and conducted a multi-vehicle collaborative automation experiment scenario involving a small team of longitudinally automated vehicles in which the on-board computers and drive-by-wire interfaces are in charge of individual vehicle speeds, while the human drivers maintain the steering wheel control and therefore the lateral motion of the vehicle. With dedicated short range equipment and the developed collaborative adaptive cruise control algorithms, a minimal convoy of two vehicles was controlled with a third vehicle trying to merge into the convoy, as illustrated in the experiment snapshot (above).

The two vehicles that are already in a leader-follower operation open up a gap when they detect and negotiate a merger request from the third vehicle and the merging vehicle aligns itself longitudinally with the newly-opened gap and signal the human driver for a lane change. As the lateral motion is under driver control, this scenario also involves the interaction of the machine autonomy and the human driver in a vehicle. Distributed decision making, gap opening and gap acceptance, human-in-the-loop lane changes and vehicular messaging are among the technical challenges that were addressed through this experiment. Using LIDAR data collected on individual vehicles, the next phase of the research will move towards information/map fusion for vehicular collaboration.

Samuel presents SaferSim webinar

On April 25, 2017, Siby Samuel, research assistant professor and co-director, Arbella Human Performance Lab, University of Massachusetts-Amherst co-presented a SaferSim webinar on "The Impact of Vehicle Automation on the Safety of Vulnerable Road Users (Pedestrians & Bicyclists)."

Abstract: Autonomous systems are capable of transforming society with their ability to reduce risks and costs and improve efficiency. However, there are several challenges associated with the deployment of such autonomous systems largely stemming from the unknown parameters. Semi-automation or partial automation has been existent for years starting with the installation of intelligent transportation systems (such as lane assist systems, collision warning systems and braking stability control systems) in vehicles. Literature notes the benefits of partial automation as well as the costs associated with such automation, indicating subtle limits on the smooth transfer of control (TOC) between the human and the automation.

Considering that full and extensive vehicle automation is almost a reality, a pre-emptive look at how the TOC parameters associated with the engagement and disengagement of such systems affects the drivers' ability to detect and respond to vulnerable road users is warranted. Currently, we have evaluated and identified the minimum TOC alerting time which is the minimum time the user requires prior to assuming safe control of the car to retain sufficient and necessary situational awareness. We also examined age-related differences in the minimum time to TOC. The webinar presented four driving simulator studies examining several questions involving both low level and mid-level automation modes and the role of the human driver. It also explored the use of various alerts at improving the time to situation awareness. All the studies use the measure of latent hazard anticipation ability as a proxy for situation awareness as measured using an eye tracker.

UMass update

The Umass Amherst team is currently conducting research utilizing networked connected simulations. There is literature centered around the use of connected simulation towards the study of conflict situations involving several users. While there are several potential applications for connected simulation, the most critical application might perhaps be that of studying and addressing multiple user conflicts (80% of all collisions as of 2015). Two-vehicle conflicts accounted for nearly 35 percent of all passenger vehicle crashes. Further, multivehicle crashes involving three or more vehicles accounted for 6.5% of all such crashes (Guarino & Champaneri, 2010). Several factors can lead to multiple user conflicts including distraction, drowsiness and detrimental weather (such as fog, rain). The processes that result in near collisions are known to have much in common with the processes that preceded an actual collision (Hyden, 1987). Hancock and Ridder (2003) helped pioneer the first reported results utilizing connected simulation to understand the science behind behavioral avoidance, particularly the preliminary analysis of response in the final seconds preceding a collision. The results of their research further posited that in order to design situation-specific collision avoidance mechanisms, there exists a critical need to account for mutual viewing times of the users. Sun et al. used multiple driving simulators to experimentally examine lane change maneuvers and crossing behaviors (Sun, Ma, Ni & Liu, 2015). Further, researchers at Linkoping University networked four simulators to study the behaviors of multiple human drivers and autonomous drivers. However, no multiple user conflict situations were examined (Yasar, Berbers, & Preuveneers, 2008).

The current state of research examining multiple user conflicts and associated factors are insufficient in that: on-road studies do not offer sufficient experimental control while existing non-connected simulator platforms only allow a single user while the other interacting users are all scripted or static objects. Without the use of connected simulations, one can study the behavior of one user involved in a conflict situation. However, in a multiple user conflict situation, there are multiple perspectives to consider and it becomes essential to capture the interaction behavior of the other users involved in the conflict.

Advantages of Connected Simulators
Connected simulations offer at least three distinct, yet related advantages. First, a strong sense of immersion, high environmental fidelity and positive interaction offered by a connected simulation environment allows for a controlled, systematic study of the processes preceding conflict situations. Second, the introduction of multiple human users (passenger car drivers, commercial truck drivers, pedestrians and bicyclists) into the simulation environment in a single virtual world will create more valid contextual situations, particularly when the roadways will be shared by various vehicles and vulnerable road users. Additional complications are introduced when potential crash situations involve not just passenger vehicles, but also other vulnerable road users such as bicyclists and pedestrians. The differences in vehicle dynamics, human decision making, and response times between manual vehicles, automated vehicles and vulnerable road users are sufficiently large that solutions offered for typical vehicle conflict situations might be inappropriate. Third, the use of vehicle trajectories, subjective indices and surrogate measures allow for the measurement of momentary driver response in multiple entity conflict situations. Rarely has the human behavioral response in the critical seconds and milliseconds preceding a collision been reported in a controlled fashion. Although the SHRP2 Naturalistic driving data provides some insight into this, studies conducted in a laboratory setting provide the ability to control extraneous variables and develop explanatory mechanisms leading to engineering and training interventions.

Human Subject Experiment using Connected Simulators
The current experiment involves the human subject testing of driver behavior in specific scenarios designed to elicit behavioral differences in multiple vehicle conflict situations. As an example, based on crash datasets, our experiment is designed to incorporate three scenarios (rear end, head on, t-bone conflicts at intersections) to understand avoidance behaviors in the final seconds preceding a multiple vehicle conflict (or a multiple user conflict). The experiment utilizes a between subject design where one group of drivers will undergo training and a second group will be administered placebo training prior to being evaluated across two driving simulators equipped to communicate with each other. Eye movements will be collected from both drivers, and vehicle profiles will also be considered in the analysis. Various questionnaires will be utilized to collect subjective responses from drivers that can inform our knowledge of multiple user conflicts. The experiment is anticipated to be completed by the end of summer 2017.

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