

# CrIS UTC News

CrIS UTC News at THE OHIO STATE UNIVERSITY

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## Message from the Interim Director



I have been serving as the interim director of the CrIS UTC this summer while Umit Ozguner transitions through The Ohio State University retirement process. He will be resuming his role as director, along with returning to Ohio State and continuing other research activities with the new title of Faculty Emeritus, in September. We wish him well during his time off and as he begins this next step in his life and technical career.

It has been my pleasure during these few months to get to know our faculty and student participants in a much deeper way, and I am thankful for the opportunity to communicate and share with all of them during this time. I am also pleased to present to you this latest edition of our newsletter, introducing you to our new program manager, Theresa Gordon, as well as providing the highlights of our UTC activities over the past months. I hope you enjoy receiving it, and we welcome hearing from you if you would like to receive further information or are interested in collaborating with us in these activities.

We are also looking forward to an annual CrIS UTC meeting on September 24, casting a spotlight on the wide range of activities among our research partners and exploring our collaboration as we continue into our third year. We welcome you to join us.

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## SMOOTH: Smart Mobile Operation: Ohio State Transportation Hub

Researchers at the Center for Automotive Research are looking to develop a solution to a common mobility issue for many Americans: a lack of access to public transportation, and a lack of mobility from that mode of transport to the individual's final destination. Many people in the U.S. do not live or work close to a public transportation access point, and these points are not always close to where they are looking to ultimately arrive.

The proposed solution to this issue is a network of on-demand automated vehicles, which will be installed as part of the Smart Mobile Operation: Ohio State Transportation (SMOOTH) pilot project proposed to take place on The Ohio State University's Columbus campus.

These shuttles will be equipped with GPS technology, a map database to help in routing and vehicle to vehicle (V2V) communication modems, along with vulnerable road user detection technology, which will be useful in areas congested with pedestrians. With Ohio State's extensive bus routes, line, and pedestrian crossings, the campus will make an ideal location for this smart city pilot study. Program organizers hope the SMOOTH endeavor will ultimately benefit Columbus in later phases of its operation.

While operating in these areas, the automated shuttles will also implement accident avoidance maneuvers in a way that respects the personal space of nearby pedestrians, while actively maneuvering out of accident situations with manual drivers.

Alongside the Center for Automotive Research, participating entities in the SMOOTH endeavor include Battelle, City of Columbus and Mid-Ohio Regional Planning Commission (MORPC).



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## CrIS UTC Seminar Series 2015

CrIS UTC successfully launched its seminar series in April with guest speaker and Ohio State alumna Lina Fu, whose work is now based at the Xerox Research Center in Rochester, New York. The CrIS UTC seminars address a broad set of scientific and technical themes in automated and connected vehicle research. In May, Professor Tulga Ersal, an assistant research scientist at the University of Michigan in Ann Arbor, was the second guest speaker for the autonomous vehicles discussion. Professor Hitay Ozbay, a former faculty member of Ohio State, concluded the series in June.

Lina Fu, Xerox Research Center, Rochester, New York

Fu's presentation, "Measuring transit network connectivity: a spatial-temporal view," explored one of the major goals of public transit agencies: increasing ridership. More riders bring in more revenue, promote healthy system growth and relieve congestion. However, agencies face a challenging discrepancy; they track dozens of metrics, yet none of the metrics can provide them with effective decision support towards that goal. Fu's team suggests that a connectivity measure, synthesizing the spatial route design, service schedules and travel time reliability, will give insight on how the transit system serves its riders, and be an effective tool in understanding ridership. Of the three aspects, Fu's team argues that travel time reliability is an indispensable component; it can play an important role when a traveler is deciding between transit and his/her personal vehicle. The team explores both stop level and system level connectivity measures, and shows what researchers can learn from these measures using detailed transit data from a mid-sized city.

Tulga Ersal, University of Michigan, Ann Arbor, Michigan

Ersal's presentation, "Pushing autonomous vehicles to their dynamic limits: A predictive control formulation for obstacle avoidance in high speed," discussed a model predictive control based obstacle avoidance algorithm for autonomous ground vehicles in unstructured environments without a prior knowledge about the obstacle locations. Obstacles are detected using a light detection and ranging (LIDAR) sensor onboard the vehicle and an optimal control problem is formulated to optimize the speed and steering commands within the detection range. Acceleration capability of the vehicle and stability and handling concerns such as tire lift-off are taken into account as constraints in the optimization problem, whereas the cost function is formulated to navigate the vehicle as quickly as possible towards a given target with smooth control commands. Thus, a safe and quick navigation is enabled without the need for a preloaded map of the environment.

Hitay Ozbay, Bilkent University, Ankara, Turkey

Ozbay's presentation, "Computational and Implementation Issues in Robust Controller Design for Time Delay Systems," detailed that time delays appear in many control applications such as tele-operations and transport systems, communications, biological and chemical processes, and more. It is well known that, for systems with transport delay, all stabilizing controllers have a certain predictor structure. This is true for robust controllers for a more general class of retarded and neutral time delays. His talk focused on the numerical computational issues and implementation of such controllers.

## Robots and Ohio State graduate students add a spark to the WiE RISE summer camp

Ohio State graduate students Danielle Fredette, Michael Vernier, Menna El-Shaer and Sarah Yasseen Al-Shareeda spent this summer doing more than just research. These students volunteered their time to share their enthusiasm for engineering with 36 female high students through Ohio State's Women in Engineering's WiE RISE summer camp. Sponsored by the GM Foundation and Shell, WiE RISE is a six-day, residential summer camp designed to introduce female high school juniors and seniors to Ohio State's undergraduate engineering majors and related career fields.

This year's camp took place from July 12-17 and participants came from 32 different high schools from Ohio and beyond. Throughout the week, the students participated in fun and educational activities that included department demos, hands-on engineering and team building projects, movie nights, flying airplanes and playing real-life battleship. The bulk of their hands-on learning took the form of a week-long programming project, which culminated in a robot competition at the end of the week.

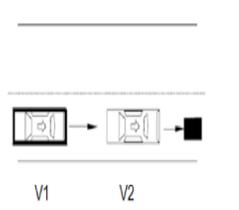
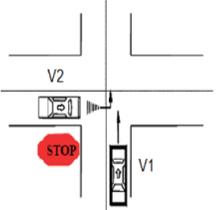
The very popular robotics project was developed and taught by students associated with the Center for Automotive Research and the University Transportation Center. It consisted of two to five laboratory hours per day of the camp, where the students learned basic programming concepts and completed daily challenges for points.

The projects for each day were all based on autonomous vehicle concepts, such as navigation, obstacle avoidance, lane change, line following, convoying and intersection handling. The final challenge was a road-like obstacle course that included two intersections, a convoying section, obstacle avoidance and decision making using ultrasonic sensors and black-on-white line following, which had to be completed with complete robot autonomy. The students quickly learned many sophisticated control concepts and were very competitive. Danielle Fredette commented that working with this group "was a fun and rewarding experience." It is hopeful that we see some of these aspiring students in Ohio State's College of Engineering in the coming years.

This Women in Engineering summer program will begin accepting applications in January. Currently, acceptance is limited to 36 participants that meet the required academic criteria and are rising juniors and seniors. The program is exploring accepting rising sophomores in future years, while still offering some type of experience for 12th graders.

## Analyzing CIREN scenarios to determine patterns of injury mechanism

The Injury Biomechanics Research Center at The Ohio State University is using Crash Injury Research and Engineering Network (CIREN) data to investigate trends of injury mechanisms for defined crash scenarios using medical and engineering evidence [1]. These trends are often compared using two key variables: abbreviated injury scale (AIS) severity\* and vehicle component contact. Two crash scenarios were preliminarily investigated for patterns of injury mechanisms: lead vehicle stopped (LVS) and near-side impact (NSI) (Table 1).

Table 1. Criteria for Choosing Cases within the CIREN database		
	Lead Vehicle Stopped (LVS)	Near Side Impact (NSI)
Principal degree of force ranges (degrees)	340-0, 0-30	30-90 right side impact
Scenario illustration (Case vehicle is bolded)		
Common Case Criteria	-dry road surface -occupant age 16+ -only injuries directly caused by impact, with, or by V2	-front airbags on case vehicle (V1) -discernible injury causation

The two case scenarios were analyzed separately for unique injury mechanisms. Each case contained a description of one occupant, one crash scenario, and a group of injuries and their associated point of contact in the vehicle. Multiple injuries can occur per occupant; no injuries were counted twice. The analysis was focused on cases with an AIS severity score of three to six, which correspond to injuries ranging from serious to maximum when considering threat to life of the occupant.

Occupant body regions with the highest prevalence and highest AIS injury severity were chosen for our injury mechanism analyses. For example, out of eight possible body regions, thorax injuries accounted for over 25% of the injury outcomes in the LVS scenario group. Approximately a quarter of these injuries were AIS four or five. AIS three injuries were found to be caused predominantly by energy absorbing structures and restraints (e.g. seat belt restraint and webbing). Injuries with severities above three, however, were due to primary or secondary impacts of the occupant with the interior of the motor vehicle. Injury outcomes within this variety of crash vary with the type of vehicle struck (V2). For example, truck under-riding by the case vehicle (V1) caused more serious to critical injuries compared to case vehicles (V1) collisions with stopped cars.

In the NSI scenario group, thorax injuries were found to account for over 16% of the injury outcomes. Over a quarter of these injuries were AIS four, five, or six severity. Over 50% of the total thorax injuries were rib injuries (with or without hemo- or pneumothorax). These injuries were predominantly caused by door or striking vehicle (V2) intrusion into the near-side of the case vehicle (V1).

Research is ongoing to determine more in depth injury mechanisms for other regions of interest. Once injury mechanisms are elucidated, the data will be analyzed to find ways to mitigate these injury mechanisms.

\*The AIS severity scale ranges from 1 to 6, with 1 being most benign and 6 being most life threatening. AIS severity scales used are from the 1998 and 2005 NHTSA coding manuals.

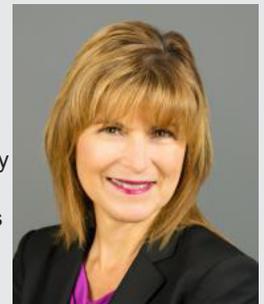
[1] <http://www.nhtsa.gov/CIREN>

## CrIS presents at T-SET Safety Summit

Technologies for Safe and Efficient Transportation (T-SET) at Carnegie Mellon University (CMU) recently hosted a two-day summit to bring together multiple safety-focused United States Department of Transportation University Transportation Centers, along with government and industry leaders, to review current UTC safety research and education efforts; governmental safety research and education interests; and industry safety and education needs. A partnership between CMU and the University of Pennsylvania, T-SET is a US DOT National University Transportation Center for Safety. CrIS UTC Director Umit Ozguner was one of thirteen UTC directors nationwide to make a presentation in the session on UTC Safety Research and Education Overviews. The goal of this session was for summit attendees, particularly government, industry and community partners, in addition to other UTCs, to learn about the safety research and education initiatives of each UTC. Professor Ozguner's presentation highlighted the safety research and education initiatives of CrIS UTC.

## CrIS Industry to academia: Carla Bailo becomes new assistant vice president and CrIS UTC Internal Advisory Board Member

The Office of Research and the College of Engineering is proud to announce the appointment of Carla Bailo as the assistant vice president for mobility research and business development. In this role, Ms. Bailo will help the university achieve substantial research growth in sustainable mobility. As she collaborates with university faculty and internal and external experts, Ms. Bailo will work to integrate mobility-related research and education across Ohio State's academic units. She will also work to enhance the university's energy and environment Discovery Theme, and increase and expand Ohio State's corporate, foundation, state and federal partnerships.



Bailo brings to this position considerable experience as a leader in engineering and vehicle program management. Prior to joining Ohio State, she served as senior vice president of research and development for Nissan North America Inc., where she was responsible for all of Nissan's vehicle engineering and development operations in Michigan, Arizona, Mexico and Brazil. While in this position, she improved the efficiency of Nissan's R&D functions as she managed a \$500 million budget and 2,500 employees. Bailo was previously based in Japan where she served as OEM business unit divisional general manager for Nissan Motor Ltd. In this role, she was responsible for overall operations, revenue and profitability of Nissan's OEM relationships for vehicle, powertrain, technology and intellectual property business worldwide.

Ms. Bailo has agreed to join the CrIS UTC Internal Advisory Board.

"CrIS continues to lead the way in research related to ADAS [Advanced Driver Assistance Systems], connected and autonomous mobility. With the current escalation of development, the role of CrIS is vital to provide the breakthroughs needed," said Ms. Bailo.

## Summer graduate student exchange program

For the first time, The Ohio State University Crash Imminent Safety University Transportation Center, along with collaborating universities, held a graduate student exchange program on driving simulator training from June 20 to 27. Allan Anzagira and Saina Ramyar from North Carolina A&T State University and Peng Liu from Ohio State attended the program, which this year was hosted by Professor Don Fisher's group at the Arbella Insurance Human Performance Lab (HPL) at the University of Massachusetts Amherst. Throughout the week, students learned about constructing scenes and scenarios on the Real Time Technologies driving simulator, using eye trackers to gather information critical to safety, and designing experiments on the simulator which can answer particular questions that researchers develop.

The students also had individual practice sessions with the technologies followed by meetings with Professor Fisher and the UMASS HPL faculty. At the meetings, students discussed how to apply what was learned to their research on modeling human drivers and reaching driving safety. The students found these individual sessions to be very useful to consolidate the complicated topics, and obtain useful advice about experiment design and scientific methods.



## CrIS UTC hires new program manager

Theresa Gordon joined the CrIS UTC in late May as the new program manager. Theresa is a long-time Ohio State employee and was the former program manager for the university's Aerospace Research Center and Nanoscale Science and Engineering Center. She holds a master's degree in zoology from Ohio State. Theresa will serve as the point of contact for the center and will facilitate center operations. Welcome, Theresa!

## Recent publications and presentations

Al-Shareeda, S., Ozguner, F. Confidentializing Sensitive Data Transfers in Vehicular Adhoc Networks. Submitted to IEEE Transactions on Vehicular Technology.

Al-Shareeda, S., Ozguner, F. (2014) Secure Pairwise Key Establishment in Vehicular Networks. Submitted to the 3rd International Conference on Connected Vehicles & Expo (ICCVE 2014), Vienna, Austria.

Amsalu, S., Homaifar, A., Afghah, F., Ramyar, S., Kurt, A. (2015) Driver Behavior Modeling near Intersections Using Support Vector Machines based on Statistical Feature Extraction. Submitted to the Intelligent Vehicles Symposium (IV). (Accepted in press).

Borowsky, A., Horrey, W., Lian, Y., Garabet, A., Simmons, L. and Fisher, D. The Effects of Momentary Visual Disruption on Hazard Anticipation and Awareness in Driving. Traffic Injury Prevention. (Accepted).

Borowsky, A., Horrey, W., Liang, Y., Simmons, S., Garabet, A. and Fisher, D. (2014). The Role of Working Memory in Driving Related Hazard Anticipation. Submitted to the Proceedings of the Human Factors and Ergonomics 2014 International Annual Meeting, Chicago, Illinois.

Fredette, D., Ozguner, U. (2014) EEG and Lane Change Intent in Driving Simulator. CrIS Internal Report.

Han, Y., Ekici, E. (2015) Study of MAC Issues for Vehicle-to-Vehicle Safety Communications in Cognitive Vehicular Networks. In preparation.

Liu, M., Chien, S., Chen, Y. (2015) Improve Road Safety Using Combined V2V and Pre-Collision Systems. Submitted to the 2015 ESV conference organized by NHTSA.

Liu, P., Kurt, A., Homaifar, A., Ozguner, U. (2015) Driver Behavior Classification using Decisive

Feature Detection. Submitted to the Proceedings of IEEE 2015 Intelligent Vehicle Symposium, Seoul, Korea.

Opoku, D., Homaifar, A., Tunstel, E. (2014) RFID-Augmentation for Improving Long-term Pose Accuracy of an Indoor Navigating Robot. Submitted to the 2014 IEEE International Conference on Systems, Man, and Cybernetics (SMC2014), pp. 796-801.

Ramyar, S., Sefidmazgi, M., Amsalu, S. B., Anzagira, A., Homaifar, A., Karimodini, A., Kurt, A. (2015) Modeling Driver Behavior at Intersections with Takagi-Sugeno Fuzzy Models. Submitted to the Proceedings of IEEE 2015 Intelligent Vehicle Symposium, Seoul, Korea.

Samuel, S., Fisher, D. (2015) Evaluation of the Minimum Forward Roadway Glance Duration Transportation Research Record. (Accepted).

Samuel, S., Fisher, D. (2015) Evaluation of the Minimum Forward Roadway Glance Duration Critical to Latent Hazard Detection. Submitted to the Transportation Research Board 94th Annual Meeting (No. 15-1707).

Samuel, S., Horrey, W.J., & Fisher, D. (2015). A Predictive Model of Driver Response in a Level 2/3 Autonomous Environment. Submitted to the Proceedings of the Human Factors and Ergonomics Society Annual Meeting.

Sefidmazgi, M., Kordmahalleh, M., Homaifar, A., Karimodini, A. (2015) Switched Linear System Identification based on Bounded-Switching Clustering. Submitted to the American Control Conference (ACC) (Accepted in press).

Takahashi, M., Yamani, Y., Dündar, C., and Fisher, D. (2015). Evaluating Effectiveness of Partitioning Complex Visual Displays on Glancing Behavior Inside of Vehicle. Submitted to the Proceedings of the Transportation Research Board 94th Annual Meeting, Washington, D.C.

Tang, B., Chien, S., Chen, Y. (2014) Obtain a Simulation Model of a Pedestrian Collision Imminent Braking System Based on the Vehicle Testing Data. Submitted to the 17th International IEEE Conference on Intelligent Transportation Systems, Qingdao, China.

Yamani, Y., Horrey, W., Liang, Y. and Fisher, D. Sequential In-Vehicle Glance Distributions: An Alternative Approach for Analyzing Glance Data. Human Factors. (Accepted).

Zhao, X., Chien, S., Li, L., Chen, Y. (2015) Message Protocol for V2V-PCS DSRC. Submitted to 2015 IEEE International Transportation Systems Conference.

An invited presentation, (2015) Use PreScan to Simulate the Integration of V2V and PCS. Will be given to the PreScan Users Group Meeting on April 20, 2015.