



Preparing Our Nation's Roadways for Advanced Vehicle Technologies

Exploratory Advanced Research . . . Next Generation Transportation Solutions



The past few years have seen a steady increase in automation in America's cars. Many modern vehicles include partial automation technologies, such as adaptive cruise control and lane keeping assist. A small, select number of fully automated vehicles are in pilot use, and in the future that number will grow, bringing with it numerous benefits, including increased safety through a significant reduction in vehicle crashes, smoother traffic flow, and increased mobility for seniors and disabled people.¹

Even with the increase in autonomous vehicles on the road, there will still be vehicles driven by humans as well as other road users such as pedestrians and bicyclists. Researchers need to study this interaction between human drivers and autonomous vehicles, since it is not yet known how human drivers will respond to more autonomous vehicles on the road.

In collaboration with the National Science Foundation (NSF), the Exploratory Advanced Research (EAR) Program at the Federal Highway Administration (FHWA) is supporting two research projects, one led by the University of Texas at Austin and a second led by the University of Wisconsin-Madison, which explore how to use automated vehicles to increase road safety and improve traffic flow and efficiency.

Smart Intersections for Automated and Legacy Vehicles

Automated vehicles create a challenge for traffic at signalized intersections. A reservation system, where vehicles enter an intersection at a specified time, can increase the free flow of traffic. This system could allow for signalized traffic control at intersections that have no physical traffic signals.

If there were only fully automated vehicles, an intersection could, in theory, greatly reduce wait times and traffic congestion. Yet even one manually driven vehicle can greatly reduce these benefits. Legacy vehicles will be on the road for years to come, so researchers at the University of Texas at Austin are examining how to accommodate both fully automated and manually driven vehicles on the road in their research project, "Collaborative Research: Synergy: Augmented Reality for Control of Reservation-Based Intersections with Mixed Autonomous-Nonautonomous Flows."

The researchers will use an intersection control system to transmit a time reservation to fully automated vehicles and use augmented reality and a heads-up display, such as a projection on the windshield, to notify the human drivers to either speed up or slow down to drive through the intersection at their appointed time. This smart intersection concept would also incorporate nonmotorized travelers, who would be connected through augmented reality goggles or their smartphones. These devices would then communicate to the pedestrian or the bicyclist when to cross.

The researchers will develop algorithms based on human behavior that will help guide vehicles and humans through the intersection safely and efficiently. The next phase of the research project will involve experimenting with these algorithms with human participants outfitted with augmented reality devices in vehicles and on their person.

Exploring Human Behavior and Trust with Autonomous Vehicles

Current research with automated vehicles and human occupants has focused on how humans rely on automation, e.g., feeling comfortable enough to take a nap while the vehicle is in motion. Yet little research has examined when



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© University of Texas at Austin. Transportation researchers are developing smart intersection technology that will allow both autonomous and legacy vehicles to cross an intersection without the use of physical traffic signals.

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© University of Wisconsin-Madison. Researchers at the University of Wisconsin-Madison are studying when and why humans erroneously mistrust autonomous vehicle behavior.

humans feel discomfort and mistrust with vehicle automation and the resulting impact on traffic.

One example of this mistrust would be a human occupant in an automated vehicle which is traveling in the middle of a platoon of

automated vehicles. The platoon may decide to slow down, but the human occupant in the middle car may decide the automated vehicle is not braking enough and decide to take over control and apply the brakes harder. The result of this action could cause a chain reaction within the platoon, as well as outside of the platoon, tying up traffic.

For the research project, "Identifying, Characterizing, and Shaping Multi-Scale Cyber-Human Interactions in Mixed Autonomous/Conventional Vehicle Traffic," researchers at the University of Wisconsin-Madison are exploring what makes human drivers lose trust in vehicle automation, leading the driver to intervene unnecessarily. The researchers are exploring scenarios that include human drivers in both fully automated and manually controlled vehicles and how erroneous human interventions could negatively impact traffic flow. With more automated vehicles on the roadways in the upcoming decades, researchers are interested in increasing trust in automated vehicles which would then help improve traffic flow.

In the first phase of the project, the researchers are using a driving simulator and software to simulate traffic, providing the capability to test automated vehicle algorithms and human-driven vehicle simulations safely and efficiently.

EXPLORATORY ADVANCED RESEARCH



What Is the Exploratory Advanced Research Program?

The EAR Program addresses the need for longer term, higher risk research with the potential for transformative improvements to transportation systems. The EAR Program seeks to leverage advances in science and engineering that could lead to breakthroughs for critical, current, and emerging issues in highway transportation by experts from different disciplines who have the talent and interest in researching solutions and might not do so without EAR Program funding.

To learn more about the EAR Program, visit <https://highways.dot.gov/research/exploratory-advanced-research>. The website features information on research solicitations, updates on ongoing research, links to published materials, summaries of past EAR Program events, and details on upcoming events.

For the next phase of this project, the researchers are designing experiments to include human participants in controlled field tests.

Learn More

For more information about these EAR Program projects, contact Gene McHale, FHWA Office of Operations Research and Development at 202-493-3275 (email: gene.mchale@dot.gov).