Eyes on the Road

Developing a Dynamic Model of Driver Vision

Exploratory Advanced Research . . . Next Generation Transportation Solutions

Driving at night is substantially more dangerous than driving during the day—the fatality rate is three to four times higher. A novel approach to studying how roadway features can improve night-driving safety is the focus of "Development of Methodologies to Evaluate Nighttime Safety Implications of Roadway Visual Scene Under Cognitive Task Loads," an Exploratory Advanced Research (EAR) Program study awarded by the Federal Highway Administration (FHWA) in 2008.

Building a Dynamic Model of Driver Vision

Although standards and installation criteria for the use of roadway features—signs, lights, pavement markings—are based on research, empirical information on how these features actually affect driver perceptions and reactions under real-world conditions is lacking. This EAR study has been deploying new technology and developing a new framework within which the variables that affect nighttime driving visibility and driver behavior can be measured and analyzed more accurately. Investigators at the Virginia Tech Transportation Institute, the Texas Transportation Institute, and Franklin & Marshall College are collaborating on the project.

"This research will provide a better foundation for evaluating the impact of different roadway features on safety," comments Carl Andersen of FHWA's Office of Safety Research and Development. "With new data collection and analysis methods, we can understand more clearly how lighting levels, pavement markings, and roadway signage affect the perceptions and reactions of drivers. The study will advance research into human visual performance, safety analysis, and roadway design."

Drivers process data through two visual modes—focal and ambient—at the same time. It is not yet fully understood how these two ways of seeing, and the driver in turn, are influenced by changes in the driving environment. Focal vision allows drivers to read signs, recognize objects and pedestrians at the side of the road, and distinguish images in rear-view mirrors while ambient vision is providing information about speed and direction that allows the driver to guide the car intuitively. One danger of nighttime driving is that although focal vision is confined to the narrow, short area lit by headlamps and any overhead lighting, ambient vision is relatively unimpaired. The driver's continued sense of competence in guiding the vehicle masks the danger of seriously diminished focal vision. This study is exploring whether various roadway features and driving conditions affect these two ways of viewing the environment differently.

The current research will provide information on when and where drivers place their attention and how their driving is affected by what they see. Learning how low light, aging eyesight, and external stimuli affect a night driver's perceptions is a particularly important aspect of the study as the average age of road users is increasing.

Capturing Data on Looking and Lighting

"A major challenge for researchers is to capture information simultaneously about the driving environment and driver reactions," Andersen says. To this end, investigators have married two innovative technologies—a luminance camera system developed at the Virginia Tech Transportation Institute and an infrared eye-tracking system purchased and modified by the Texas Transportation Institute—to create a single, noninvasive system that can measure the luminance of objects, pavement markings, and signage while tracking drivers' eye movements.

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By using this integrated monitoring system, investigators have been gathering data on Virginia Smart Road and Texas Transportation Institute test tracks. Two age groups have been enrolled in the tests, representing younger (ages 16–34 years) and older (ages 64 years and above) drivers. To examine other variables, researchers have been collecting data under two levels of overhead lighting (none and high-pressure sodium), two types of signs at varying locations, two types of objects (such as pedestrians and obstacles), glare and nonglare conditions, and two types of pavement marking. By observing drivers' speed, steering variability, and lane-keeping accuracy, the investigators will draw inferences about the impact of roadway features under varying conditions. Trends and probabilities will be calculated for a variety of roadway environmental elements.

Future Efforts

After the project data have been analyzed, FHWA and the research team will convene an expert peer-review panel for a real-world demonstration and model review. On the basis of the expert review and additional data collected, the investigators will revise the model and formulate future directions for continuing research. Those directions will likely include developing a complete driver visual model; carrying out factor testing on other variables, such as weather conditions, cognitive loading, and fatigue levels; and conducting rural and urban testing under varying conditions.

Learn More

For more information on this EAR Program project, contact Carl Andersen, FHWA Office of Safety Research and Development, at 202-493-3366 (email: carl.andersen@dot.gov).

EXPLORATORY ADVANCED **RESEARCH**

What Is the Exploratory Advanced Research Program?

FHWA's Exploratory Advanced Research (EAR) Program focuses on long-term, high-risk research with a high payoff potential. The program addresses underlying gaps faced by applied highway research programs, anticipates emerging issues with national implications, and reflects broad transportation industry goals and objectives.

To learn more about the EAR Program, visit the Exploratory Advanced Research Web site at www.fhwa.dot.gov/advancedresearch. The site 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 additional information, contact David Kuehn at FHWA, 202-493-3414 (email: david.kuehn@fhwa.dot.gov), or Terry Halkyard at FHWA, 202-493-3467 (email: terry.halkyard@fhwa.dot.gov).

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