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APPLICATIONS FOR THE ENVIRONMENT: REAL-TIME INFORMATION SYNTHESIS

GLIDEPATH PROTOTYPE APPLICATION

Together, the Intelligent Transportation Systems (ITS) Joint Program Office (JPO) and the Federal Highway Administration's (FHWA's) Turner Fairbank Highway Research Center (TFHRC) Office of Operations Research and Development implemented and successfully demonstrated the automated GlidePath prototype application. GlidePath is the nation's first application of a cooperative adaptive cruise control (CACC) system that leverages vehicle-to-infrastructure (V2I) communications to enable an equipped vehicle to communicate wirelessly with a traffic signal and controls a vehicle's speed in an eco-friendly manner.

Background

In 2012, the Applications for the Environment: Real-Time Information Synthesis (AERIS) team conducted a field experiment at TFHRC for the Eco-Approach and Departure at Signalized Intersections application. Successful experimentation showed up to 18-percent reductions in fuel consumption and carbon dioxide (CO^2) emissions for a single vehicle at a single, fixed, timed intersection. Drivers received speed recommendations using a driver-vehicle interface (DVI) incorporated into the speedometer. Recommended speeds were calculated based on the vehicle's location and signal phase and timing (SPaT) messages collected from the traffic signal. While the results were promising, the experiment identified potential driver distraction issues. As such, in 2014, the AERIS team undertook the GlidePath prototype application project—a first-of-its-kind prototype—which incorporated automated longitudinal control capabilities along with the eco-approach and departure algorithm.

The GlidePath Prototype Application

FHWA Office of Operations Research and Development staff, in cooperation with partners, built the onboard application and control software that provides a tablet-based driver interface and computes an optimum speed trajectory through TFHRC's intelligent intersection. Upon computing this trajectory and activation by the driver, the software takes control of the vehicle's accelerator and brakes to safely and smoothly drive through the intersection while respecting the traffic signal and local speed limit. As with any cruise control, the human driver is always in control of the vehicle and can disengage the automation by stepping on the brake or turning the cruise control feature off. When the vehicle approaches an intelligent intersection, it receives two distinct standard dedicated short-range communications (DSRC)

Objectives of the GlidePath Prototype Application Project

The objectives of the GlidePath prototype application were to:

- Develop a working prototype GlidePath application project with automated longitudinal control for demonstration and future research
- Evaluate the performance of the algorithm and automated prototype (specifically, the energy savings and environmental benefits)
- Conduct testing and demonstrations of the application at TFHRC.

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messages describing the SPaT and intersection geometry. With this information, and its current position and speed, the onboard computer computes its travel distance to the stop bar.

DSRC messages also provide the driver with SPaT data in illustration form, which indicates signal activity (i.e., when the signal will turn from green to yellow to red). With these data, the vehicle can then compute a speed profile that maximizes fuel economy by adjusting speed either up or down to avoid coming to a full stop at the intersection, if possible. In cases where a full stop is necessary, the software holds the vehicle at the stop bar until the signal turns green and the driver issues a "Resume" command, thus ensuring that it is safe to resume forward motion. The software then accelerates the vehicle to its desired cruise speed as it leaves the intersection. The software will work on any properly configured intersection and has many configurable parameters, some of which include cruise speed, roadway speed limit, decision point distances, and acceleration limits.

Results

Data collected in field experiments revealed that average fuel consumption was improved in vehicles equipped with the Eco-Approach and Departure application. As shown in the table below, results from August 2015 indicate that a driver with a DVI saw 7-percent fuel savings over uninformed drivers, while a driver with partial automation and the GlidePath application saw 22-percent fuel savings over the uninformed driver. These results show a 15-percent fuel improvement from a driver trying to follow a DVI speed recommendation to the partial automated GlidePath application. These improvements are due to minimizing the lag in speed changes to keep the optimal speed and approach.

Future Research Opportunities

This pioneering work has established a solid foundation for continued research and innovation involving variable signal timing, accommodating other vehicles in the intersection, and investigating multi-signal applications. The project will continue through the Crash Avoidance Metrics Partnership (CAMP), a consortium of 12 vehicle manufacturers who will first further investigate the feasibility of this application. Opportunities for future research with the GlidePath prototype include consideration of:

- Testing with multiple equipped vehicles, including integration of CACC capabilities between multiple vehicles
- Testing at multiple intersections (i.e., a corridor)
- Testing on a real-world corridor with traffic
- Testing with an enhanced algorithm that considers actuated traffic signal timing plans and queues at intersection.

To learn more about the AERIS research program and the GlidePath prototype application, visit: www.its.dot.gov/aeris.

Relative Savings in Fuel Consumption (%) between Different Driving Modes for the GlidePath Prototype Application

Phase	2	7	12	17	22	27	2	7	12	17	22	27	Average
DVI vs. Uniformed	-11.8	-11.8	7.6	5.2	7.6	12.1	25.1	37.8	-18.3	21.7	-0.6	13.5	**7.3**
Automated vs. Uninformed	4.7	7.6	35.3	20.9	20.3	31.7	32.7	47.9	-3.9	26.5	20.1	22.9	**22.2**
Automated versus DVI	14.7	17.3	29.9	16.6	13.8	22.4	10.1	16.3	12.2	6.1	20.5	10.8	**15.9**

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