

United States Intelligent Transportation Systems (ITS) Program

Transmitted by the Representative of the United States of America

Background and Review

The Intelligent Vehicle Initiative (IVI) is the vehicle-based safety focus of the ITS program. The theme of the IVI is "Saving Lives through Advanced Vehicle Safety Technology." The mission of the IVI is the prevention of highway crashes and the fatalities and injuries they cause. The IVI addresses three driving conditions where there is the greatest opportunity to improve safety:

Normal driving conditions; by encouraging the design of in-vehicle communications and information systems that drivers can operate without distraction;

Degraded driving conditions; such as conditions of reduced visibility or driver fatigue, by encouraging accelerated commercialization of advisory systems; and

Imminent crash situations; by encouraging accelerated commercialization of crash avoidance warning systems.

The IVI program addresses four classes of vehicle platform:

Light vehicles (passenger vehicles and light trucks and vans),

Commercial vehicles (heavy trucks and interstate buses),

Transit vehicles (intra-city buses), and

Specialty vehicles (highway maintenance vehicles and emergency response vehicles).

There are two main objectives of the IVI program. One is the development of performance specifications for effective safety-enhancing systems. The second is development of, and application of, methodologies for evaluating the safety impact of in-vehicle advanced-technology systems.

Normal Driving Conditions

Distraction and Driver Workload

One underlying aspect of normal driving is driver workload. Workload is the combination of physical and cognitive effort needed to drive a vehicle in a safe manner. Workload increases as environmental conditions, such as congestion and distraction, increase.

One current project is studying various aspects of driver workload. The project is a cooperative agreement between USDOT and a consortium that is led by Delphi Delco Electronics. Other members of the consortium include Ford, General Motors, the University of Iowa, and the University of Michigan Transportation Research Institute. The project will include comprehensive human factors research to derive distraction and workload measures for use in adaptive interfaces, development of evaluation procedures for assessment of safety benefits, advancement of the deployment of adaptive interface technology countermeasures for distraction-related crashes, and enhancement of collision warning system effectiveness by optimizing alarm onset based on driver's workload or distraction.

Another project is searching for laboratory experiments that can serve as surrogates for driving on public highways as a means of understanding the effect of various systems on driver workload. This work is being done cooperatively with a consortium that includes Ford, General Motors, Nissan, and Toyota. It is currently at the point of collecting data from on-road tests and from laboratory tests. Analysis of the data will be complete by the end of the year.

Degraded Driving Conditions

The problem of fatigued drivers is being addressed in a field operational test of a driver drowsiness advisory system. The system that will be tested is the result of several previous laboratory, simulator, and field studies that have focused on validating the measurement of fatigue and technologies that can be used to sense driver

fatigue in real time. This project will utilize a fleet of heavy trucks that are in revenue service. The project began last year and will continue for the next three years.

Imminent Crashes Situations

Crash Warning Systems

Preliminary performance specifications have been developed for systems that warn drivers of imminent crashes and unsafe driving conditions. The types of crash that have been addressed in these specifications include:

- Rear-end crashes
- Drowsy driver related crashes
- Road departure crashes
- Lane change crashes
- Intersection crashes

An important part of the IVI program is the series of field operational tests that are being done. These tests use instrumented vehicles that are in service on the public roads. The purpose of the tests is to gather information about the safety performance of drivers when they have assistance from crash avoidance systems. Analysis of the data that is gathered during these tests provides insights and improved understanding of how each crash avoidance system helps drivers avoid crashes that would otherwise occur.

There are currently two field operational tests of light vehicles underway.

One is evaluating the safety performance of a rear-end crash warning system. The vehicles will also include an adaptive cruise control system. This project is being done cooperatively with General Motors. Other members of the development team include AssistWare, Delphi Delco Electronics, and the University of Michigan Transportation Research Institute. This fleet will consist of 10 vehicles that are equipped with a sophisticated data collection system in addition to the crash warning system. The crash warning system includes a state-of-the-art forward looking radar, a forward looking camera, a differential global positioning system (GPS) receiver, and a digital map data base as well as extensive monitoring of in-vehicle controls. Any warnings for the driver will be provided through a head-up display and through auditory messages. Volunteer drivers will use the vehicles in their normal day-to-day driving for a one-month period. They will drive the first week with the system turned off, followed by two or three weeks of driving with the crash warning system turned on. Data collection will start in March of this year and will continue for a one-year period.

The second field operational test will evaluate the safety performance of a road-departure crash warning system. This project is being done in cooperation with the University of Michigan Transportation Research Institute and Visteon. The system will provide warnings if the driver is following a path that will lead to a departure from the paved roadway or if the driver is approaching a curve at a speed that is excessive for that curve. The system will utilize a forward-looking camera, a radar that looks forward and a second radar that looks to the side, a GPS receiver, and an advanced digital map. The design of the system is complete and construction of prototype test vehicles is underway. Data collection will begin later this year and will continue for one year.

There are also three field operational tests underway with heavy trucks.

One of these is being done in cooperation with Freightliner Corporation. The trucks in this test are equipped with a rollover advisory and control system. The test has been completed and the analysis of data shows that a system such as the one used in this test could reduce the number of rollovers due to excessive speed in a turn for heavy trucks by twenty percent.

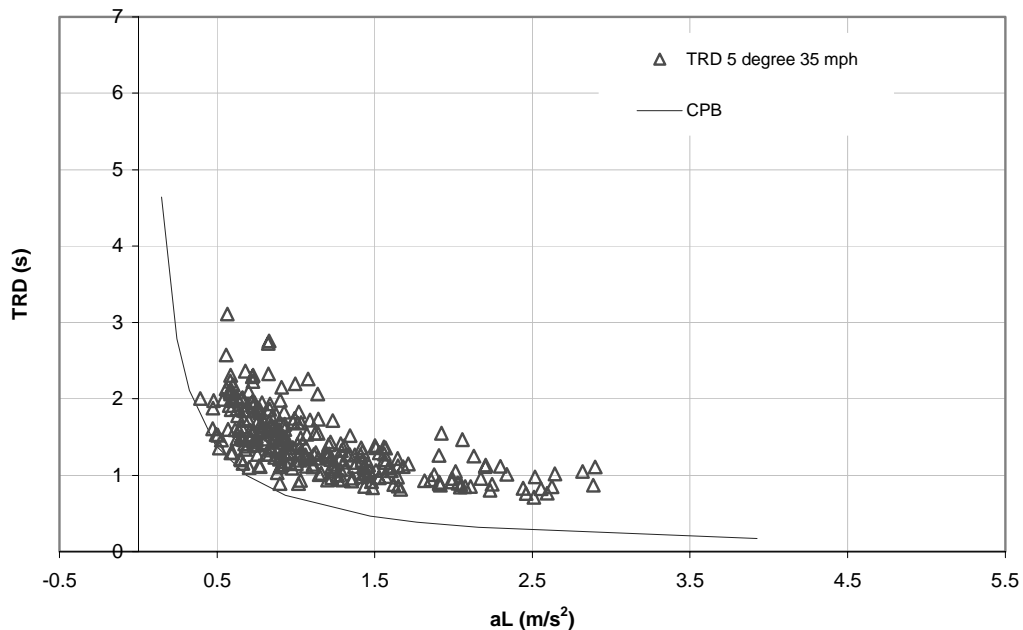
A second heavy truck field operational test is being done in cooperation with Volvo Trucks of North America. The trucks in this test are equipped with a rear-end crash warning system, an adaptive cruise control system and electronically controlled disc brakes. The data collection phase is almost complete. Results on effective should be available later this year.

The third heavy truck field operational test is being done in cooperation with Mack Trucks, Inc. The trucks in this test are equipped with a lane departure warning system and an infrastructure assisted hazard warning system. This fleet of trucks is still in the data collection phase. Analysis and results will be available next year. Another major problem area being addressed in the light vehicle program is crashes at intersections.

Three new projects have recently been initiated to study vehicle-based systems to address this problem area. One addresses signal and stop-sign violations, a second addresses left-turn-across-path crashes, and the third addresses lateral-gap-acceptance related crashes. These projects are coordinated with parallel projects that are studying infrastructure issues. The projects are jointly developing performance requirements for cooperative communication between vehicles and the infrastructure for systems that address this problem.

Evaluation of safety benefits

In addition to developing performance requirements and evaluating the safety impact of pre-production crash warning systems, there is a need to develop new analytical methodologies for analyzing data. One such new methodology is called the crash prevention boundary. This methodology separates the space of driver performance into a region of performance that avoids a crash and a region of performance that results in a crash. This methodology provides new insights into the safety impact of technologies. The methodology is described in more detail in papers at several recent technical conferences. One example drawn from a road departure experiment is shown below. The line separates performance into no-crash and crash zones, and the points indicate the performance of individual drivers during the experiment. In this case no drivers crashed.



Best Fit Lateral Acceleration Vs Best Fit Time to Road Departure (TRD)
Approach Angle 5 degrees, and 35 mph.

Another project that is providing insights into how drivers avoid collisions is a naturalistic driving study. In this project, a data acquisition system will be added to the vehicles of volunteer drivers. Data will be continuously collected as the drivers go about their daily routines. The data will be analyzed to develop a better understanding of how drivers react to impending crashes and near-crashes. There will be 100 vehicles in the fleet of these vehicles. The first 20 have been outfitted with the data acquisition system and data collection has begun. The project will run for one year. At the end of that time a plan will be developed for a similar larger scale naturalistic driving project.

Systems and technologies

Systems that are being developed and/or are entering the US market:

Systems	Initial systems available to consumers	Systems that are more effective and/or acceptable to consumers being developed	Research and Development underway
Adaptive cruise control	X	X	
Rear-end crash warning systems	X	X	X
Infra-red night vision systems	X		
Drowsy driver detection and warning system			X
Road departure crash warning systems			X
Lane change crash warning systems	X		
Driver distraction detection system and adaptive interface			X
Rear object detection system	X		
Intersection crash warning systems			X

The systems in the above table use a variety of technologies. Some of these are:

- Millimeter-wave microwave radar
- Scanning laser range finders
- Visible-spectrum charge-coupled device (CCD) cameras with real-time image processing
- Infrared CCD cameras with direct image presentation to the driver
- On-board digital maps with global positioning system (GPS) location estimates
- Active matrix liquid crystal head-up displays
- Near-infrared illuminators with CCD cameras and real-time image processing
- Dedicated short-range communications

Additional information

Internet sites that contain information about USDOT ITS activities include:

<http://www.its.dot.gov/guide.html>

<http://www-nrd.nhtsa.dot.gov/vrtc/ca/its.htm>

<http://www-nrd.nhtsa.dot.gov/departments/nrd-12/IntelligentTransportationSystems.html>

http://www-nrd.nhtsa.dot.gov/departments/nrd-12/pubs_rev.html

<http://www.volpe.dot.gov/apd/owcoll.html>

<http://www.volpe.dot.gov/apd/techpapers.html>

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