Indirect Visibility Safety

The Center for Truck and Bus Safety (CTBS) at the Virginia Tech Transportation Institute (VTTI) has been investigating Indirect Visibility Safety on both commercial vehicles and light vehicles since 2003. Most truck drivers have only mirrors to rely upon for obtaining the location of other vehicles and objects to the sides and rear of their truck. Although mirrors are useful in this regard, there are still many areas around the truck and trailer that are not visible.

Recent advances in video technology have heightened the prospect of improving commercial vehicle safety by improving drivers’ vision around the truck. For such video systems to be implemented on heavy trucks, the systems/driver interface should be demonstrated as viable through research.

In regards to light vehicle indirect visibility, advances in mirror technology have motivated the need for revisiting the question of how light vehicle drivers use their mirrors while driving. Blind spots are the common complaint of mirrors, and new designs have appeared in the United States and European markets to help improve overall visibility. Therefore, VTTI has conducted research investigating how drivers perform and accept various combinations of left and right outside planar, convex, and aspheric mirrors.

Development of a Performance Specification for Indirect Visibility Systems on Heavy Trucks

This study was funded by the National Highway Traffic Safety Administration (NHTSA) and Federal Motor Carrier Safety Administration (FMCSA). Approximately 26,000 crashes occurred involving large trucks between April 2001 and December 2003 as a result of making lane changes, merges, and turns (Starnes, 2006).

One contributing factor in these crashes is inadequate side and rearward visibility for truck drivers. Recent advances in video technology have heightened the prospect of improving Commercial Motor Vehicle (CMV) safety by enhancing the ability of the driver to perceive and respond safely to surrounding traffic.

As an alternative to mirrors (surrogate system), or to be used in combination with mirrors (enhancement system), the industry has been developing Camera/Video Imaging Systems (C/VISs).

For such systems to be implemented on heavy trucks, the systems/driver interface should be demonstrated as viable through research. This project was directed toward developing specifications that could potentially be included in Federal Motor Vehicle Safety Standard (FMVSS) #111 and used to standardize C/VISs if they are added.
to vehicles. Nine different C/VISs were developed and tested.

A total of 24 drivers with a Class-A CDL participated. Tests included typical highway driving tasks (light-vehicle clearance/overlap determination, passing and merging maneuvers), as well as three backing tasks (parked vehicle, loading dock, and S-curve) using a Peterbilt tractor/trailer and a Volvo tractor. Data analyses were performed on performance data, driver acceptance ratings, and eyeglances.

Results from the study indicated that highway driving performance can benefit from C/VISs both with and without a trailer. Enhancement and surrogate systems were beneficial in backing to fixed objects (e.g., parked vehicle and loading dock tasks), however no benefit was found for backing through an S-curve.

C/VISs were generally accepted by the drivers during most tasks. Eyeglance analyses showed that drivers relied heavily on the C/VISs when available. Overall, results indicate that C/VISs have the potential to be useful in improving CMV safety.

Enhanced Camera/Video Imaging Systems on Heavy Vehicles

The implementation of C/VISs is becoming more common on heavy vehicles. As a result, NHTSA and FMCSA contracted with Virginia Tech Transportation Institute (VTTI) to develop concepts and specifications for these systems and also to test them in realistic environments. The current project extended the work of the original C/VIS contract into less favorable environmental conditions, namely nighttime and inclement weather.

A three-camera/video imaging system was to be developed and tested: one system on each side of the heavy vehicle and one at the rear. Infrared illuminators in combination with infrared sensitive cameras were implemented in the system design in order to enhance the nighttime visibility. Also incorporated was post-processing and edge detection in order to enhance the visibility.

The purpose of this design was that the driver of the heavy vehicle would be better informed regarding the environment around the sides and rear of the heavy vehicle, that is, he or she would have better situation awareness. Currently this project is collecting data to establish the system’s performance in object detection tasks and clearance/overlap highway driving maneuvers on the Smart Road in nighttime conditions in rainy weather.

Study of Driver Performance/Acceptance Using Aspheric Mirrors in Light-Vehicle Applications

This study, funded by NHTSA, had the objective of comparing aspheric outside rearview mirrors on light vehicles to present-day standard mirrors. Other types of mirrors were also included in this study. Aspheric mirrors generally have a convex inner portion, and a compound outer portion with greater curvature. They are currently in use in the European Union (EU) to reduce outside mirror blind spots; however, these mirrors also produce distortion in their outer portions. Both performance and driver opinion were studied.

In addition, the effects of driver age on the above measures, as well as adaptability to the changeover, were examined. The study produced recommendations regarding the use of aspheric mirrors on new vehicles in the United States, and, if the mirrors are permitted, what the characteristics should be.

The results showed that aspheric mirrors do not cause substantive detrimental performance effects, but drivers found the distortion, uneasiness, and discomfort to be somewhat worse than for competing mirrors.

It is recommended that a fleet study should be performed over a substantial period of time prior to any change in the standard. The purpose would be to examine the longitudinal (that is, the time-related) effects of using aspherics.

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