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UTC Spotlight

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The Potential of Side Camera Systems to Reduce Bus Side Collisions

Blind zones—those areas directly around a vehicle that the operator cannot see while driving—are a particular problem for transit drivers while changing lanes or turning.

Side camera systems have been successfully used on Recreational Vehicles (RVs) for some years. This project, funded by the National Center for Transit Research, focused on applying similar aftermarket systems to transit buses and developing specifications needed for deployment. Aftermarket systems usually include two side cameras and one or two monitors that present a wide angle view. The Center's research was conducted in two phases.

Phase 1

This phase tested the feasibility of replacing the side mirrors with the side camera system. Drivers' abilities to estimate distances and identify objects using only the camera systems were then tested.

Literature reviews of previous research on sensor-based systems that only gave audible warnings of imminent hazards showed these systems had some success, but many shortcomings. A major issue was that the sensors missed objects, didn't provide continuous feedback, and gave a high level of false alarms.

Earlier tests by the research team showed that blind zones were greatly reduced or eliminated by sideview video systems using wide angle cameras. Volumetric measurements of blind zone reduction from this study showed that the camera-based system with a 60 degree lens (no distorted image) reduced the blind zones of a flat mirror system by about 64% and the blind zones of a combined flat and convex mirror system by 43%. But use of a wide angle (100 degree) lens on both sides of transit buses could completely eliminate blind zones.

Hence, available aftermarket side view systems with 100 degree horizontal wide angle lens were tested in this study.

The camera-based technology for transit buses to reduce blind zones is fairly new, so there are no crash data associated with the technology. The approach selected in Phase 1 was to


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The two monitors installed to the left and right of the steering wheel in a standard transit bus. Each monitor presents the side camera view to the driver.

closely evaluate the aftermarket sideview video system using a controlled driving test that simulated real-life scenarios and a driver survey to collect feedback from the drivers who participated.

The participating drivers performed the controlled driving test twice: once with the camera system, and once with mirrors only. The result of the test from the 28 drivers was positive on distance/depth perception and lane change maneuvers with the system.

Drivers were able to adapt to the sideview video system and quickly learn how to use the system to drive. While the bus was in motion, the drivers could perceive motion much like they did while using mirrors. By using the sideview system, drivers could also see vehicles in the side blind zones. In addition the drivers could see at least two lanes next to the bus, providing them the opportunity to avoid situations where a lane change maneuver would potentially result in a sideswipe crash.

The driver survey confirmed that the majority of bus drivers in the controlled driving test liked the sideview video system and valued its benefits, with some reservations about its reliability due to unfamiliarity with the system or distortion of wide angle views. The majority of the bus drivers agreed that the mirrors become less effective during rainy weather and that it is difficult to identify a person with them at night. The majority of bus drivers agreed that the sideview video system could be useful in helping them observe vehicles in the lane next to them during lane changing maneuvers, see passengers better, and minimize or eliminate side blind zones. The testing verified that the sideview video system could perform better than the mirrors in rain and in dark conditions due to infrared sensors. Overall, it showed positive results for sideview video systems and the potential for further implementation.

Phase 2

During the second phase of the research, an integrated camera-mirror system (hybrid system) was developed, tested, and evaluated. The second phase veered away from the concept of replacing mirrors because of the potential difficulty in acceptance from drivers and transit agency officials. The developed camera system had 65-degree horizontal view, which was adequate to cover the side blind zones. The initial system was tested in a controlled driving test with 29 bus drivers who used the system to drive and identify objects placed around the bus. Comparison was performed with the mirrors only vs. the hybrid system.

Statistical analysis showed that with the hybrid system, drivers had a 96–98% correct identification of the location of the object vs. 70–78% with the mirrors only. Also, drivers were faster in identifying objects using the hybrid system, even though two additional search locations (monitors) were present with the hybrid system. Driver feedback also showed that the majority of drivers agreed that the system can eliminate blind zones, and thus help drivers reduce side collisions by providing better side views.

Driver feedback was taken into account when finalizing the system for the longer field deployment that occurred in the second part of Phase 2. Due to exposure to weather, the hybrid system must meet stringent criteria for use in the field. For the Type A bus, the most common transit bus with a low floor, a weatherproof housing was developed for the cameras to protect them from water, dust, and other environmental factors. For the cutaway bus, a smaller bus used for paratransit services, a system obtained from a company that specializes in mirror-camera integration was used.

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Vehicle visible with video system, but not with mirrors.

A transit agency in Florida was recruited to participate in the field deployment and evaluation for the hybrid system. The participating bus drivers were overall positive about the experience, even though there were initial problems with fogging that were quickly overcome. After a 1- to 2-month deployment, the majority of drivers agreed that the hybrid system reduced or eliminated the blind zones and could be effective in the reduction of side crashes. One of the reported problems of the system is that during nighttime driving the headlights of passing vehicles tended to be distracting due to light bleed-through the camera. In Phase 2 of this study, participating drivers seemed to recover relatively fast from this effect. Further research on this problem is recommended, which might shed light on effective solutions to minimize the reported problem at night.

Both the driving test and field deployment helped identify major factors to aid in the development of specifications for such systems. Using the results from the testing and literature review, recommendations for specifications on the integrated camera-mirror system were compiled to help practitioners, industry professionals, and operating managers when choosing such hybrid systems for their fleets.

About This Project

The National Center for Transit Research (NCTR) is located at the Center for Urban Transportation Research (CUTR) at the University of South Florida, Tampa. Joel Volinski (Volinski@cutr.usf.edu) is NCTR Director. This project was partially funded by the Florida Department of Transportation (FDOT). Pei-Sung Lin, Ph.D., ITS Traffic Operations and Safety Program Director at CUTR is the principal investigator. His team includes: Achilleas Kourtellis, Ph.D., Research Associate, CUTR, Chanyoung Lee, Ph.D., Senior Research Associate, CUTR and Matthew Wills, Engineer, CUTR. Students: Meeta Saxena, CUTR. Mrs. Erin Schepers, Program Manager of the FDOT Public Transit Office was the project manager for Phase I, and Mr. Victor Wiley, Transit Safety Programs Manager of the FDOT Public Transit Office was project manager for Phase II. A copy of the final report can be found at http://www.nctr.usf.edu/2012/12/evaluation-of-camera-based-systems-to-reduce-transit-bus-side-collisions-phase-ii/.