DRISI
Caltrans Division of Research, Innovation and System Information

Research Results

Implementation and Evaluation of the Snowplow Driver Assistance System

Install a Global Positioning System (GPS)-based Driver Assistance System (DAS) on two snowplows and one snow blower, to help with snow removal operations on the Donner Pass corridor of Interstate 80 (I-80). The system provides a high-accuracy GPS map of the roadway that is displayed on a head-up display inside the cab of the vehicle.

Maintenance

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Project Title:
Implementation and Evaluation of the Snowplow Driver Assistance System

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WHAT IS THE NEED?

Snow clearing during whiteout storms along I-80 at Donner Pass can be a difficult operation for snowplow operators and directly affects the traveling public. During these conditions, snowplow operators have to navigate slowly and with extreme caution because of low visibility. The snow clearing operations during these storms can cause major traffic delays for both the travelling public and the commercial traffic that use I-80. Using the DAS would enable snowplow operators to travel at normal plowing speeds during these extreme low-visibility conditions. The system has the potential to help open the roads sooner during winter-related road closures, which would contribute to significant savings to both Caltrans and the traveling public.

WHAT WAS OUR GOAL?

The main goal of this research was to evaluate the GPS-based DAS on its ability to increase safety and efficiency during snow removal operations on the Donner Pass section of I-80.

WHAT DID WE DO?

Caltrans Division of Research, Innovation and Systems Information in partnership with the Advanced Highway Maintenance and Construction Technology (AHMCT) Research Center at UC Davis installed three DAS systems on Caltrans snow removal equipment: two on snowplows, and one on a snow blower. The technology used in the DAS was developed at the University of Minnesota (UM) through the U.S. Department of Transportation's Intelligent Vehicle Initiative. This technology has been used in Alaska on Thompson Pass since 2003. This

technology was licensed by UM to a company called MTS Systems Corporation (MTS). AHMCT purchased these three DAS systems from MTS and had them installed on the Caltrans snow removal equipment.

One of the first things done in this research was to set up the GPS base station. This base station was installed at the Caltrans Kingvale maintenance station Command Center in the summer of 2012. This base station provides differential GPS data to the GPS receiver that is on the snowplow and the snow blower, enabling the system to be accurate to within a few inches. AHMCT staff installed the GPS base station antenna and cellular modem antenna on the exterior of the Kingvale Command Center.

The snowplow DAS functions include lane position indication, lane departure warning, and forward collision warning. Lane lines, stored in a geospatial database, and lane position information are displayed on a head-up display (HUD), shown in Figure 1. This image is projected onto the HUD by an LCD imager (Figure 2). The DAS Collision Warning System uses a single radar, shown in Figure 3, to detect vehicles and other inorganic objects. Radar data allows the system to map detected obstacles to their lateral location, and projects these obstacles onto the HUD. The system also stores the location of fixed roadside objects in the geospatial database to eliminate false positive collision warnings. Vehicle position is provided by the GPS receiver, which has an accuracy of a few inches. The solution is calculated in real time by the snowplow's GPS when it receives the differential base station data in real time through a cellular radio modem, shown in Figure 3. The GPS and radar data is all processed by a DAS computer that is installed underneath the passenger seat, as shown in Figure 4.

WHAT WAS THE OUTCOME?

During the initial testing of the DAS, there was occasional buildup of ice on the front fascia of the radar enclosure. The thin water layer trapped on the radar enclosure absorbed a majority of the radar signal, rendering the radar ineffective. This water layer buildup and signal attenuation problem was not reported by Alaska or Minnesota during their use of similar systems, and is attributed to the type of snow prevalent in the Sierras. The phenomenon was new and unexpected to UM, MTS, and AHMCT researchers.

A significant part of the research effort and time was spent developing a radar icing solution. A viable solution (heated enclosure plus wiper with heated blade) was developed toward the end of the research. The development process was slow due to the lack of heavy snow storms in the past few years.

The GPS data provided an accurate solution for the DAS in the overwhelming majority of the test area. However, there were small gaps in a few areas where the solution was not sufficiently accurate for the DAS. During these gaps, the system provides display symbols on the HUD that let the operator know the system is not providing accurate lane position. It is essential that operator training includes clear discussion of the meaning of the various display symbols.

AHMCT is working with Caltrans DRISI and Maintenance to perform continued testing of the DAS, due to the radar icing issue and the lack of heavy snow storms that prevented a complete evaluation of the DAS. The current plan is to test the existing systems through the winter of 2015 – 2016, with the hope that a sufficient number of heavy storms with whiteout conditions are available. Under this planned work, AHMCT will train operators to use the system, perform ride-

alongs to evaluate the system and its use, and solicit operator feedback. With proper testing conditions, this should allow final assessment of the functionality and utility of the system.

WHAT IS THE BENEFIT?

The benefits of the snowplow DAS to Caltrans are still being evaluated, and there is need to continue this evaluation. The system's potential benefits to Caltrans include the following:

- Allowing snowplow operators to keep roads open in whiteout conditions
- Improve safety for the traveling public and operators
- Reduce driver stress

LEARN MORE

The final report documenting this research is available at:
http://ahmct.ucdavis.edu/pdf/UCD-ARR-15-08-30-01.pdf

Figure 1: UM DAS HUD combiner

Figure 2: UM DAS HUD LCD imager

Figure 3: Radar, modem and GNSS antenna installed on top of a snowplow cab protector

Figure 4: UM DAS computer installed underneath passenger seat