SURFACE HAULAGE TRUCK RESEARCH

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BACKGROUND

Between 1989 and 1991, the greatest number of accidents in surface coal and metal/nonmetal mines involved haulage trucks. In 1995, the most frequently cited factor contributing to the 100 fatalities in these mines was powered haulage. In 1996, over 50% of the 84 fatalities in mining that year were in surface mining. Because some of the world's largest mobile equipment is used in surface mines, and this equipment is involved in so many accidents and fatalities, new technologies are needed to alert truck drivers and people in spaces around the truck to the possibilities of collisions.

METHODS

NIOSH studies have focused on off-the-shelf technologies that would enable mine haulage truck drivers to "see" objects and people behind and to the side of a moving vehicle. This paper discusses two types of systems currently available: proximity warning devices and charge-coupled device (CCD) cameras having closed-circuit television (CCTV) monitors.

RESULTS

Off-the-shelf Doppler radar alarm units were evaluated as to their effectiveness when mounted on large trucks. Laboratory and field tests were conducted to simulate mounting and operating the units on large haulage vehicles. Field tests were then conducted using 240-ton mining trucks at a truck manufacturing facility. Various mounting and aiming schemes were tried to examine how sensitive the units were to detecting a pickup truck and/or people behind the truck. Since the detectors can only see 5 ft left and right of the centerline of focus, two units were needed to cover the 20-ft width of the haulage trucks. In the first configuration, two backup alarms were attached with magnetic base plates to the rear light alarm bracket (figure 1) at a height of 8 ft above the ground. The units were focused from 20° to 25° off horizontal and were aimed so that the beams crossed or diverged. When the backup tests commenced, there were false alarms resulting from changes in the road surface, rotation of the rear wheels, and surrounding buildings and other structures.

Because earlier laboratory tests demonstrated better results with higher gains when the sensors were 11 to 12 ft above the ground, the sensors used in the field test were moved higher on the truck, to 14 ft above the ground on the hinge point for the dump body. The radar units were focused over the tire toward the "footprint" directly in back of each unit and downward 30° from horizontal. They were then adjusted to about 50 pct gain. In this position, the units were able to sense the pickup truck at distances of 21 to 24 ft behind the haulage truck. No false alarms went off in this configuration.

A second proximity warning system currently being investigated is a radio frequency identification (RFID) tag system. This system transmits radio signals that are picked up by a receiver (tag) on a person or object. Current designs for this system require that a continuous alarm sounds when the units are within 40 ft of the tag. All utility vehicles, personnel, or other objects requiring sensing would need to be tagged. Results are forthcoming.

Another system being evaluated is a video camera and monitor that display the blind areas directly behind and to the right side of the truck. Project personnel visited a surface mine where a black-and-white CCTV system was installed on a 190-ton haulage truck. The rear-mounted camera successfully withstood a year's cycle of loading, hauling, and dumping, and desert heat and cold. The mine's truck shop staff fabricated a floor-mounted frame to hold a 6- by 7-3/4-in CCTV monitor as well as a two-way radio and a truck-monitoring terminal (figure 2). The camera was mounted on the rear axle of the frame (figure 3), and the camera monitor was wired into the dash light system to reduce glare on the monitor during night shifts. The screen is black until the truck's headlight switch is on and the truck is shifted into reverse. There is also a manual mode that leaves the monitor on continually. Since the initial test, the mine has installed cameras on all 190 of its trucks and is testing a second camera on the right front deck railing to capture the right-hand blind side view. The monitor can be toggled to switch views from the right to the rear-facing cameras.

CONCLUSIONS

After numerous shakedown tests, including locating, positioning, aiming, adjusting, testing, tuning, and evaluating various proximity warning systems, we concluded that Doppler radar backup alarms and RFID tag systems appear to show promise for sensing objects within the blind areas of vehicles. Significant efforts must be made to achieve acceptable performance without false alarms. The Doppler radar discriminating alarm is not a "bolt-on and plug-and-play" unit that is easy to adapt to various situations. During the tests, it was shown that mounting the units to achieve optimum sensing ability without interference and false alarms from other systems was, at the very least, a tedious and time-consuming job.

The RFID tag system is currently undergoing antenna design modifications to improve its effective range. This system needs to be designed so that it does not sense more than the desired 40-50-ft range.

The black-and-white CCTV system successfully withstood a year's cycle of loading, hauling, and dumping, as well as the rigors of desert heat and cold. The floor-mounted frame isolated the unit from cab vibrations and offered the driver a single location for visual and verbal communication.

Another technology, the blind area viewer, which was based on the use of fresnel lenses and an assortment of back-up mirrors, is no longer manufactured. However, rectangular convex mirrors are standard safety equipment.