ROAD SAFETY RESEARCH, POLICING AND EDUCATION CONFERENCE, NOV 2001

Title

Young pedestrians and reversing motor vehicles

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Abstract

We investigated a range of vehicle-related countermeasures to reduce the risk of young children being killed or injured by reversing motor vehicles, particularly those on private driveways.

There is a scarcity of information about the rearward field of view from motor vehicles and methods of improving this view. Theoretical analysis and trials of a range of vehicles, proximity sensors (parking aids) and visual aids were therefore conducted. These revealed the following: (a) most cars and 4WDs have very poor rearward visibility for detecting objects the size of toddlers; (b) proximity sensors alone cannot provide sufficient warning to drivers that a toddler is in the path of a reversing vehicle; (c) a video camera system can provide the driver with a good view to the rear except, possibly, for locations very close to the back of the vehicle; and (d) a combination of a video camera and a short-range proximity sensor would cover all critical blind spots at the rear of the vehicle.

Keywords

child pedestrian, reversing vehicle, childhood injury

Introduction

In recent years the problem of young children being struck by reversing motor vehicles has come to attention. Many of these accidents occur on private property and therefore are not recorded in road accident statistics. A special effort is needed to determine the number and characteristics of these accidents. Such an investigation was initiated by the Motor Accidents Authority of NSW (MAA) in response to initial findings of the Child Death Review Team. The results of those initial investigations are described by Henderson (1). Briefly, in New South Wales between January 1996 and June 1999, 17 children were killed by reversing motor vehicles on private driveways. Many were toddlers (2 to 4 years old) and the number of deaths in this age group was similar to the number occurring on public roads (in all types of pedestrian accidents - not just reversing motor vehicles) during the same period. In other words, private driveways are as hazardous as public roads for toddlers. Large four-wheel-drives (4WDs) and commercial vehicles appeared to be over-represented in the accidents.

A range of behavioural and environmental countermeasures have been suggested to reduce the risk of young children being run over by reversing motor vehicles. In addition the Henderson report identified vehicle-related countermeasures that might be utilised to address the problem. This includes proximity sensors that alert the driver when an object is detected within a certain distance of the rear of the vehicle and visual aids that give the driver an improved rearward field of view. The MAA therefore commissioned further research on vehicle-related countermeasures. This paper sets out the results of that research. The work is reported in detail by Paine et al (2).

Methods

The project involved the following activities:

a) A review of technology for proximity sensors and visual aids that might address the problem of children being run over by reversing vehicles.

Automotive engineering, sensor technology and occupational safety literature and websites were reviewed. Suppliers of potential equipment and researchers in the field were contacted for additional information.

b) Measuring the rearward field of view of a range of vehicles.

A vacant factory was leased. The floor and walls were marked with a distinctive grid. Arrangements were made for a total of nine vehicles to attend the site. For each, the rearward field of view from the driver's eye position was photographed and the extremities of that view were measured (as projected onto the factory wall or floor). The resulting co-ordinates were mathematically transformed into a contour map of the limits of visibility of objects of nominated height at the rear of the vehicle. For the analysis, object heights of 600mm, 800mm and 1 metre were chosen. Figure 1 shows the output for one case.

c) Theoretical investigation of the dynamics of the situation to establish required detection distances.

The analysis considered the initial speed of the vehicle, the distance at which the sensor detects an object (such as a child) and sounds the alarm, the time it takes the driver to react to the alarm and apply the brakes, and the braking distance. Using a technique described by Williams (3), a distribution of "alert" driver reaction times was used to derived "probability of collision avoidance" for a range of initial speeds and sensor detection distances.

d) Acquiring and evaluating sample proximity sensors and visual aids.

Three ultrasonic and one microwave ("radar") proximity sensors were acquired. These were evaluated using the grid on the factory floor - the tester approached the rear of the vehicle along marked longitudinal lines and noted when the alarm first sounded. This produced a horizontal detection pattern for each device. The vertical detection pattern was also evaluated.

Four types of visual aid were evaluated: two types of wide-angle lens that attach to the rear window, a convex mirror mounted externally over the rear window and a basic video camera and monitor with the camera mounted on the back window. The performance of each visual aid was evaluated using the grid on the factory floor and a 600mm high test cylinder (approximately the shoulder height of a young toddler).

e) Determining the improvement provided by these devices when fitted to motor vehicles.

For one of the test vehicles the data about rearward field of view was combined with data about the detection pattern for the best proximity sensor and the best visual aid (the video camera) to determine if all critical blind spots were covered. Figure 2 shows the results of this analysis.

Results

Very little research appears to have been done on vehicle-related countermeasures for reversing accidents. The few relevant studies relate to occupational safety in open cut mines. There is a scarcity of information about the rearward field of view from motor vehicles and methods of improving this view.

Theoretical analysis showed that, even for an alert driver, the detection distances were quite demanding. As a rule of thumb the reversing speed in km/h should be no more than twice the detection distance in metres. Therefore for a vehicle reversing at 8km/h the detection distance (at which the driver is alerted to an object in the path of the vehicle) should be no less than four metres.

Trials of a range of vehicles revealed that many have very poor visibility of critical areas at the rear of the vehicle. A test cylinder 600mm high was used to simulate a standing toddler. For the best vehicle that was tested the cylinder was only visible when at least 3 metres from the rear of the vehicle. For a popular large car it was only visible when 19 metres away. Large four-wheel-drives were no worse than some cars. Spoilers, rear seat head restraints, rear-door-mounted spare wheels and some high-mounted brake lights can greatly increase these distances.

Proximity sensors that are mainly intended as a parking aid while reversing have been touted as a child safety device but their effectiveness for this purpose is questionable. Ultrasonic and microwave devices are commercially available and range in price from AU$60 to AU$700, but price does not necessarily reflect performance.

Trials of proximity sensors revealed that their detection distances were between one and three metres - too short for typical driveway situations. Although, in some cases, sensitivity could be increased, this is likely to result in too many false alarms and drivers would tend to ignore the warning.

Trials of wide angle lenses and a convex external mirror revealed severe limitations with the field of view and quality of image. These devices are unsuitable for avoiding collisions with toddlers. However, a trial of a video camera system showed it had the potential to give the driver a good view of critical areas at the back of the vehicle.

A combined system that included a proximity sensor and a video camera would cover all critical blind spots at the rear of the vehicle.

Discussion

No complete detection system was available for evaluation. Potential components of such a system were evaluated separately and the results were combined to give an estimate of the performance of a complete system.

More work is needed on ergonomic aspects of the system, including the location and size of a video monitor and types of warning alarms. It is important that drivers are not overloaded with spurious information and that they heed a valid warning.

It is considered that a combined camera and proximity sensor system would be a very effective countermeasure to the problem of children being run over by vehicles reversing in private driveways. The commercial development of these systems should therefore be encouraged, subject to the development of a performance specification so that consumers could be confident that the system worked as intended. Such a system would also provide benefits in other situations when the vehicle is reversing.

Irrespective of the availability of devices on vehicles, driver and child carer education will be needed to reduce the risk of toddlers being run over. The main vehicle-related messages should be that toddlers are extremely difficult to see if they are behind a typical car or 4WD and that drivers need to be very cautious and reverse very slowly, even if proximity alarms are fitted.

Given the poor rearward field of view of popular cars it appears that poor rearward visibility is not a significant factor in the apparent over-representation of 4WD vehicles in fatal accidents. Other factors might be the increasing popularity of 4WDs as "family" vehicles and the increased risk of a child being crushed by the large wheels of a 4WD.

Conclusions and recommendations

Our main conclusions are:

- Most cars and 4WDs have very poor rearward visibility for detecting objects the size of toddlers
- Proximity sensors (parking aids) alone cannot provide sufficient warning to drivers that a toddler is in the path of a reversing vehicle.
- A video camera system can provide the driver with a good view to the rear except, possibly, for locations very close to the back of the vehicle.
- A combination of video camera and short-range proximity sensor would cover all critical blind spots at the rear of the vehicle. Such a system should cost no more than $1000 installed.

It is recommended that the commercial development of a combined system of proximity sensor and video camera be encouraged and that the voluntary fitting such systems be promoted. More work is needed on the ergonomic characteristics of such systems to ensure that drivers respond to appropriate warning and that they are not overloaded with spurious information and false alarms. The outcome of our research should be taken into account in the preparation of educational material aimed at reducing child accidents on driveways.

References

1. Henderson J.M., Child Deaths and Injuries in Driveways, October 2000, Motor Accidents Authority of NSW (available at www.maa.gov.au)

2. Paine M.P. and Henderson J.M., Devices to Reduce the Risk to Young Pedestrians from Reversing Motor Vehicles, March 2001, Motor Accidents Authority of NSW (available at www.maa.gov.au)

3. Williams H., Microwave Motion Sensors for Off-Road Vehicle Velocity Data and Collision Avoidance, December 1999, *Sensors* (Journal), (available at www.sensormag.com)

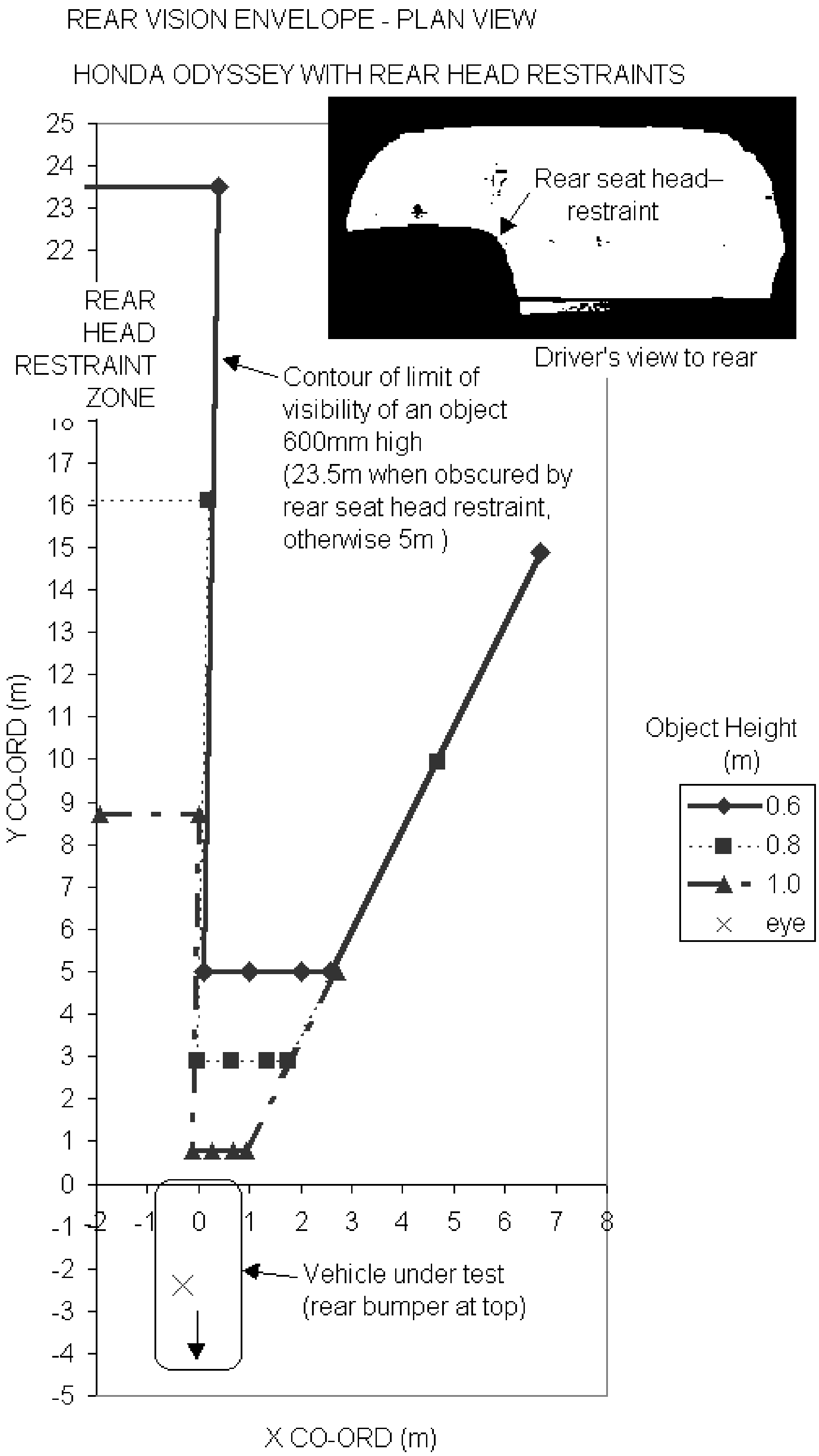

Figure 1. Rearward field of view for a Honda Odyssey passenger van.

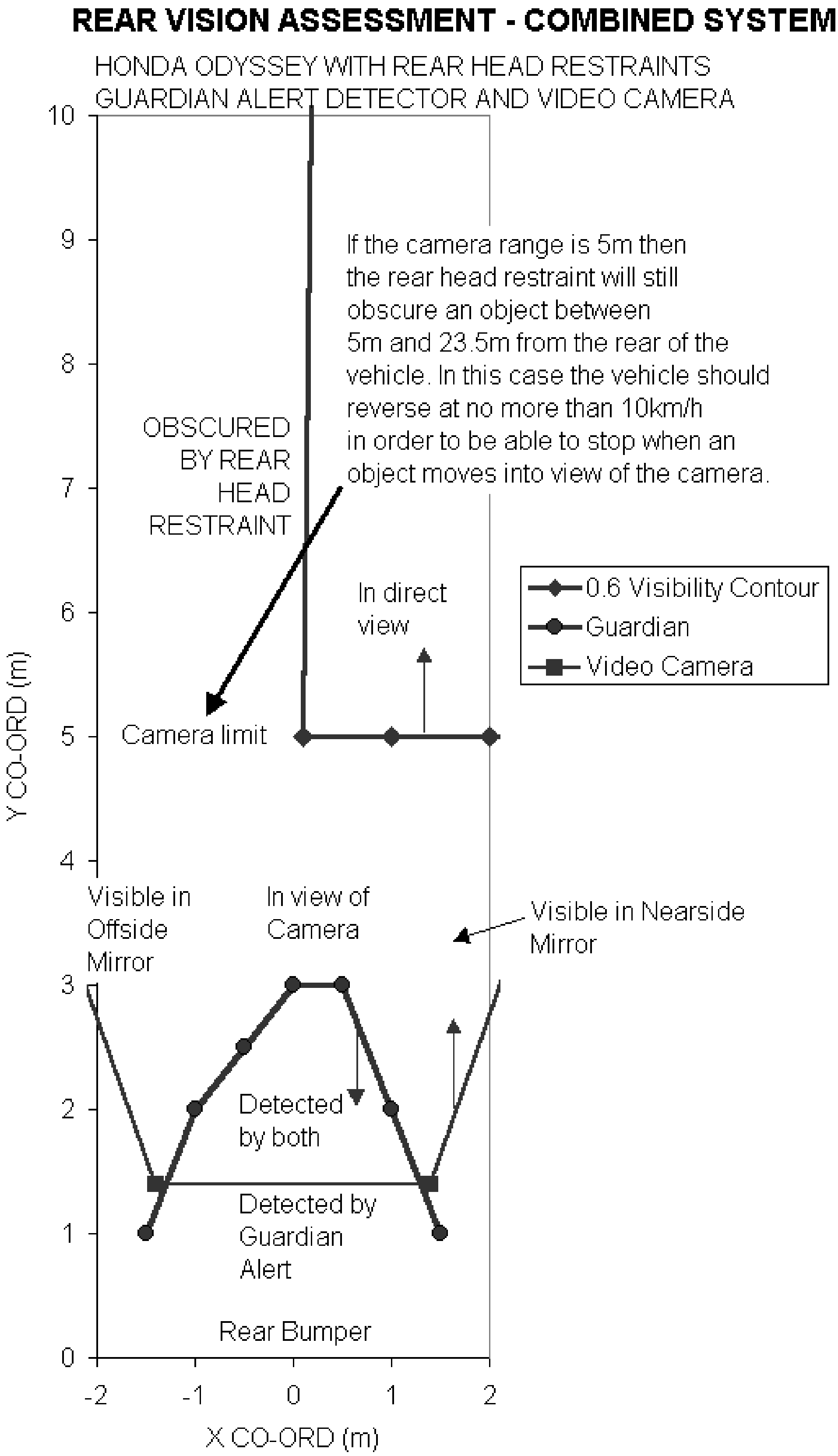

Figure 2. Performance of combined system - proximity sensor and video camera.