Data Collection Technology at ARRB Transport Research

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Biography
Philip Roper joined ARRB Transport Research in May 2002. He holds a Bachelor of Engineering with Honours, in Civil Engineering from Monash University. Since joining ARRB Philip has participated in a number of road safety projects. The main focus of these projects has been on improving the safety of the road environment. Most recently, Philip has participated in an evaluation of the effectiveness of fixed, digital speed cameras in New South Wales. He has also conducted assessments of the dynamic safety and traffic impact of new tram stop designs, using some of the methods described in this paper.

Abstract
ARRB Transport Research has developed a range of data collection systems for use in road network surveys and behavioural studies.

One such technology is the ARRB TR video trailer. The trailer can be set up on roadways or in carparks and enables un-supervised video capture of vehicle or pedestrian movements for later analysis. Recent research has used vision from the video trailer together with data from vehicle mounted accelerometers, in an analysis of the movement of vehicles over undulating road surfaces.

In another application of innovative technology, ARRB TR was recently involved in the development and installation of systems designed to detect the in-vehicle use of occupant safety measures.

This paper details the use of some of ARRB TR's advanced data collection tools, including the video trailer, in recent research projects.

1. INTRODUCTION

The causes of all road crashes fall into three broad categories: human, vehicle and road environment. All three factors often contribute to varying degrees, while sometimes only one or two of them are involved.

Although ARRB TR carries out road safety research pertaining to any one or a combination of all three of these categories and their interactions, much of the road safety research conducted at ARRB TR focuses on road user behaviour (human) and engineering treatments (road environment). In the course of this research it is often necessary to collect various data on the operation of the road network. To aid in this data collection, ARRB TR staff make use of a range of technological aids, many of which have been developed within ARRB TR.

This paper concentrates on a selection of data collection systems that have been used recently, or are in use on a continuing basis, in road safety and road maintenance research at ARRB TR.

2. GIPSI-TRAC

The Gipsi-Trac road geometry data acquisition system was developed by ARRB TR in 1992 and continuing refinement has improved the system's data collection ability and ease of use. As Gipsi-Trac forms the basis of much of ARRB TR's network survey ability, a basic description of its operation is warranted.

Gipsi-Trac is an acronym for *Global and Inertial Positioning System Integration for Tracking Route Alignment and Crossfall*. The equipment is mounted in a survey vehicle and consists of inertial sensors (Inertial Guidance System) which work with an electronic odometer and GPS navigation unit to produce a three-dimensional road map as the survey vehicle travels. The Inertial Guidance System component makes use of gyroscopes and accelerometers to determine its position and orientation. Output is recorded every 10 metres at road speeds up to 100 km/h.

Gipsi-Trac's ability to generate an electronic map of the road geometry can be utilised when determining an appropriate speed at which bends in a road can be traversed. The curve radii and crossfall of the road (superelevation) are measured and fed through algorithms from the Austroads Rural Road Design guide to generate a suggested advisory speed for all points along the road.

The Gipsi-Trac analysis is not a 'black box', and requires the application of sound engineering judgment to turn the system's recommended speed into an appropriate advisory speed for the bend in question. Factors such as surface friction, roadside environment and abutting land use must be considered before a final judgement can be made. As the advisory speed generated by Gipsi-Trac makes no allowance for these other factors, especially surface condition, its output should not be applied as an advisory speed without careful consideration of the conditions.

Notwithstanding these limits on the use of its output, Gipsi-Trac provides an accurate and comprehensive record of the geometry of a road. This provides a consistent starting point for subsequent calculations and removes the need for manual methods of road geometry measurement. The system's measurement of crossfall and grade provides a record of a road's geometry that can be used to decide if and where future realignment works should be undertaken.

3. NETWORK SURVEY VEHICLES – GIPSI-TRAC, LASER ROAD PROFILING AND VIDEO IMAGING

ARRB TR's Network Survey Vehicles are custom-built for each customer and can include a combination of Gipsi-Trac, multi-laser profilers and digital cameras to enable the simultaneous collection of various types of road environment data. Vehicles currently in use by ARRB TR for collection of road network data make use of Gipsi-Trac and link its output to laser profilers across the front of the vehicle and four digital video cameras on the roof.

The cameras can be aimed at any four points on the road around the vehicle and will take images at intervals as short as 3.3 metres. The combined data from all of the systems on the vehicle serve as a record of the condition of the road at the survey date. Any section of the road can then be examined at a later date without visiting the site again.

Information that can be extracted from video images collected during a survey includes lane and shoulder width data, the presence and location of roadside furniture, the condition of signs and linemarking, pavement cracking and general road condition.

Lasers are used to examine the roughness and rutting of the road surface. The laser units are mounted on a special assembly across the front of the vehicle and monitor several points across the width of the lane. Other lasers point out to the edges of the traffic lane, enabling data to be captured across a wide path. Thirteen lasers are usually fitted to a multi-laser profiler and these provide a number of data collection points across the road surface.

The roughness measuring ability of the system allows for examination of macro texture and roughness at highway speeds. Rutting is also measured and all data is applied to maps generated during the survey for browsing at a later date in any order.

All of the information gathered by a Network Survey Vehicle can be analysed at any time after collection. The system provides a safe method of collecting a large range of information about the road environment. The information enables road maintenance staff to best allocate rehabilitation resources and also aids in research projects requiring road environment data.

ARRB TR's Safety and Traffic Group intends to make use of a Network Survey Vehicle in the near future to measure roadside shoulder widths on rural roads for a project assessing the relative benefits of various shoulder widths. This would be achieved using the combined outputs of Gipsi-Trac and the video imaging equipment.

4. VIDEO TRAILER

ARRB TR's Video Trailer has been in use for many years and is still in demand as a survey tool in traffic studies conducted for road authorities and private consultants.

The trailer consists of a video camera on a mast of variable height, video recording equipment and battery power supply. The trailer is a standard size and can be towed by a normal passenger car. The portability and self-contained power supply of the unit make it a useful tool for conducting traffic observations across an entire day without the need for multiple staff to monitor the site.

Two cameras can be used with the video trailer. The main camera is mounted on the telescopic mast at the front of the trailer. A compressed gas system allows the mast to be extended to a maximum height of 10 metres above ground level, providing a clear, wide view of a traffic scene. The camera can be panned, tilted, zoomed and focused using controls at the base of the trailer.

The second camera attaches to a mounting approximately 1.6 metres above ground level. This camera can be manually fixed in position to record a scene from a secondary viewpoint. An arrangement using both the main and second cameras allows the system to capture the same traffic scene from different viewpoints, or to capture images of approaching and departing traffic. The images from both cameras can be arranged on one frame of video for simultaneous viewing.

Potential applications of the video trailer include:
- Traffic volume counts
- Pedestrian counts
- Turning movement counts
- Gap acceptance studies
- Queuing measurements
- Traffic and pedestrian behavioural studies.

The operation of the video trailer can be combined with manual survey techniques if desired. In that case, the video images serve as a useful record of the general traffic scene for confirmation and synchronisation of manually generated data.

A recent research project required the evaluation of the geometric design of two prototype tram stop platforms. The tram stops were built as large raised pavements in the running lanes, with the intention that traffic drive over them at normal speed. The height of the platforms matched the floor level of trams and the arrangement was intended to provide tram passengers with a level surface from the footpath to the tram floor.

To assess the dynamic safety of these platforms for use by general traffic, ARRB TR used instrumented vehicles to measure the changing accelerations experienced by vehicles and their occupants while travelling over the platforms.

Horizontal and/or vertical accelerations at various positions in the passenger compartment were measured along with lateral accelerations at the rear of the vehicles. Accelerations were measured using accelerometers mounted rigidly to the vehicle and connected to a data logger. The data logger recorded accelerations at 50 millisecond intervals, enabling detailed analysis of the movement of the vehicles.

The video trailer captured images of the vehicles from behind to enable monitoring of any lateral movement as the vehicles travelled over the platforms. In addition to the footage from the video trailer, a high speed video camera was used to monitor the response of individual axles as they traversed the platforms.

The combination of information from all of these sources facilitated a comprehensive evaluation of the level of force experienced by different vehicles and their occupants as they traversed the tram stop platforms. Results were evaluated against existing criteria for acceptable levels of acceleration in the design of raised pavements.

The video trailer has also been used recently in an evaluation of the relative safety of various on-road bicycle facilities. Using video footage shot parallel to the movement of traffic, measurements could be made of the lateral position of vehicles in their lanes. By calibrating points in the video screen with known measurements on the ground, vehicle positions could be judged with enough accuracy to establish patterns of driver and cyclist behaviour in various traffic situations. The use of video for this project enabled researchers to view the traffic scene multiple times and extract different information as the project progressed, without having to return to the site.

Another recent project involving the video trailer was an evaluation of the Walk Safe program in the inner-metropolitan Victorian Councils of Stonnington and Port Phillip. Traffic speed, vehicle paths and pedestrian behaviour were all analysed using video footage to decide whether pedestrian accident countermeasures were having an effect on behaviour.

Future development of video-related survey techniques will make use of machine vision technology, enabling computerised analysis of video images captured by the video trailer. The combination of the trailer's portability, with the automatic analyses possible using machine vision, will improve the ease of conducting turning movement and traffic volume surveys in locations where conventional traffic counters would be difficult to use. The added advantage of being able to re-visit any time period during the survey and qualitatively assess, for example, the formation of a queue, makes the video trailer a most worthwhile component of any survey.

5. AUTOMATIC SEAT BELT MONITORING SYSTEM

ARRB TR's Safety and Traffic Group, together with the Technology Group, has developed a device to monitor seat belt use in vehicles of various sizes.

The monitoring device uses seat belt buckles with built-in sensors that detect when the seat belt is clasped. The status of these sensors is monitored by a counter that feeds information to a data logger. The data logger then stores the information from the counter and the result is a record of seat belt use over extended periods of time. The logger can be programmed to record at intervals as short as one second or up to several hours, with all results stored in memory for later analysis.

The system can currently record seat belt activity for between one and 64 seat belts in up to eight groups. This variable capacity makes the system appropriate for use in cars, trucks and buses in any projects that require information on the use of seat belts by vehicle passengers.

The seat belt monitoring system currently provides total numbers of seat belts buckled but can be modified to show exactly which seat belts are buckled. This extra detail could be utilised for research into, for example, which passengers on buses are more likely to wear their seat belts.

In its current form the seat belt monitoring system is customised for use in buses seating up to 64 seat belted passengers, but it would also function in smaller vehicles.

As the system takes information from switches built into the seat belt buckles, passengers of the vehicle need not know that the system is present. The logging equipment can be hidden out of view of occupants and cabling can be concealed in most vehicles. This discreet operation minimises any chance of passengers noticing the monitoring system and modifying their behaviour as a result.

6. CONCLUSION

The video trailer, Gipsi-Trac, Network Survey Vehicles and specialised data collection systems such as the seat belt monitors are examples of the range of advanced technology available to researchers at ARRB Transport Research. Continuing development of equipment and techniques is aimed at increasing the road safety and traffic research potential of the organisation and maximising the resultant benefit to the community.

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Survey, Gipsi, video, data collection