Establishing a testing capability for the assessment of Autonomous Emergency Braking (AEB) and Forward Collision Warning (FCW) in Australia

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Abstract

Advanced driver assistance systems (ADAS) such as autonomous emergency braking (AEB) and forward collision warning (FCW) systems are increasingly being developed and introduced into the Australian vehicle fleet. These active safety systems are designed to detect potential collisions and alert the driver and/or apply the brakes of the vehicle to minimize the severity of the collision or stop it from occurring at all. The potential for these technologies to reduce crash speeds or eliminate the crash altogether is substantial and they are predicted to result in a significant reduction in road trauma. However, not all AEB/FCW systems operate in the same way or provide the same level of benefit to the road user. Different systems utilise different types of sensors, operate at different speeds/ranges, and respond to critical situations in different ways. It is therefore important that AEB/FCW systems made available in Australia can be tested and rated for effectiveness. This paper summarises the development of an AEB/FCW evaluation capability by the Centre for Automotive Safety Research. Preliminary results obtained during the testing of an AEB system currently available in Australia are presented.

Introduction

In recent years a number of new vehicle technologies have been developed under the banner of advanced driver assistance systems (ADAS). These technologies make use of advanced sensors to assist with various components of the driving task. Some ADAS technologies are designed to identify when there is potential for a collision to occur and either warn the driver or take some kind of avoidance action automatically. Electronic stability control (ESC) is an example of an ADAS technology that has proven to be very successful. Other examples of ADAS technologies that are emerging or currently being developed include lane departure warning (LDW), lane keeping assist (LCA), blind spot detection (BSD), and vehicle to vehicle communication (V2V).

Some of the most promising of these emerging technologies, in terms of crash avoidance and impact severity mitigation, are autonomous emergency braking (AEB) and forward collision warning (FCW). Several research papers and expert opinions have agreed that AEB and FCW will contribute significantly to the reduction of road trauma into the future and have the potential to considerably reduce the human and financial costs of road crashes (Rosén, 2013; Kusano and Gabler, 2012; Doecke et al., 2012).

AEB and FCW systems both utilise forward facing sensors that are designed to identify objects in the vehicle’s travelling path. The distance and speed of any objects that are detected by the system can then be used to determine whether a crash may be about to occur. When this ‘crash potential’ reaches a certain critical level the AEB and FCW systems respond in different ways. A FCW system will alert the driver to the potential emergency situation through auditory, visual, or haptic warnings which can increase in intensity if the driver takes no action. An AEB system will often incorporate driver warnings (in a similar manner to a FCW system) but will additionally apply the vehicle’s brakes automatically if there is no driver response. Automatic braking is typically triggered at the last possible moment, with just enough time/space for the vehicle to avoid colliding with the object in front.

AEB and FCW systems are often divided into two categories depending on the driving conditions in which they are designed to operate. Some are designed to work at low speed (60 km/h and below) in stop-go, urban driving conditions. Other systems operate at higher speeds (between 60 and 100 km/h) and are targeted at highway type driving. Insurance companies have shown considerable interest in the evaluation of systems that are able to reduce low speed, rear end collisions because these types of crash comprise a large proportion of claims. However, the evaluation of systems designed to avoid, or mitigate, collisions at higher speeds or with vulnerable road users are more relevant to reducing fatal and serious injuries resulting from road trauma.

Evaluation of systems

There are several reasons why AEB and FCW systems require evaluation. Research indicates that there are major differences between various AEB/FCW systems such as the range of speeds at which they are operational, the types of sensors used, the amount of time taken to identify a hazardous object or situation, and whether they respond to vulnerable road users such as pedestrians or cyclists (ADAC, 2012; Hulshof et al., 2013). Additionally there are differences in the way that systems respond to an identified hazard. For example, some may present audible warnings to the driver up until the last moment and then brake strongly, while others may brake lightly when a danger is initially identified and then more strongly if there is no response from the driver.

Conducting evaluations of AEB and FCW systems in Australia is considered important. The Australian fleet composition and driving environment are different to those of other developed countries and thus manufacturers may be inclined to desensitise (or even remove altogether) AEB and FCW systems from their vehicles, rather than have their systems not work correctly. Some of the considerations for AEB and FCW within Australia are listed below:

- The Australian fleet comprises a high percentage of utility and work vehicles
- Delineation is not provided or is of low quality on many Australian rural roads
- A considerable number of Australian roads are unsealed and can produce dusty conditions in hotter months which may affect the performance of AEB/FCW systems
- Some areas of Australia experience extreme weather conditions
- Many Australian rural roads are unfenced, allowing wild and domestic animals to wander onto the roadway.

The evaluation of AEB and FCW systems in Australia would ensure that the most effective systems are fitted to vehicles entering Australia and support the development of systems that are suitable for Australian conditions and crash types. It would also provide evidence to encourage faster take up of AEB and FCW systems in Australia through consumer demand. Finally, a local Australian evaluation capability would provide further opportunities for research and development of other current and future ADAS technologies.

Any evaluation of AEB and FCW needs to account for the various ways in which these systems operate to prevent or reduce the speed of frontal collisions. An evaluation protocol developed by EuroNCAP (Schram et al., 2013) addressed this by considering a range of collision scenarios relevant to AEB/FCW and identifying those that were recorded as occurring most frequently in European crash databases. Using this method meant that the evaluation would focus on crash scenarios that make the greatest contribution to road trauma. Three test scenarios are included in the EuroNCAP protocol and each involves the test vehicle approaching another (target) vehicle from behind. The first test scenario simulates an approach towards a vehicle that is stationary. The second scenario simulates an approach towards a vehicle that is travelling slower than the subject vehicle. The third simulates a situation in which a vehicle ahead brakes suddenly.

Developing a testing capability

Major pieces of equipment that are required to conduct the EuroNCAP testing protocol, such as accelerator and brake pedal robots, were either procured or developed by the Centre for Automotive Safety Research (CASR). A mock evaluation test was performed in order to demonstrate that the equipment could be operated and utilised correctly.

A Subaru Forrester equipped with an EyeSight AEB system was borrowed from Subaru Australia and each of the three evaluation test scenarios were performed (CASR, 2014). A target vehicle (see Figure 1) was borrowed from Bosch Australia. Note that several types of target vehicle exist which endeavour to appear as a legitimate vehicle when detected by both vision and radar based AEB systems. The ability of such target vehicles to represent the diverse Australian fleet composition could be an additional opportunity of future research.

Figure 2 shows the results of a successful run through the third test scenario. Both the test vehicle and target vehicle were travelling at a speed of 50 km/h with the target vehicle leading by a distance of 12 metres. The test then began with the target vehicle braking at a constant deceleration of 2 m/s^2. A few seconds later the AEB system on the test vehicle can be seen braking heavily to avoid a collision with the target vehicle. The minimum distance between the test and target vehicles was approximately 1.5 metres.

The travelling speed, vehicle separation, and rate of deceleration are all parameters specified within the EuroNCAP protocol. Each of these parameters was met within tolerance (grey areas in Figure 2) and the test was determined to have been performed successfully.

Note that the results shown in Figure 2 should not be considered as an official assessment of the Subaru Eyesight system as the full protocol, including warm up of brakes and tyres, was not conducted. Rather, the results should be viewed as an example of the capability of CASR to successfully perform the EuroNCAP evaluation test protocols.

Further testing that focusses on the evaluation of AEB/FCW systems which respond to pedestrians and other vulnerable road users such as cyclists is also planned.

Figure 1. Evaluation testing being performed

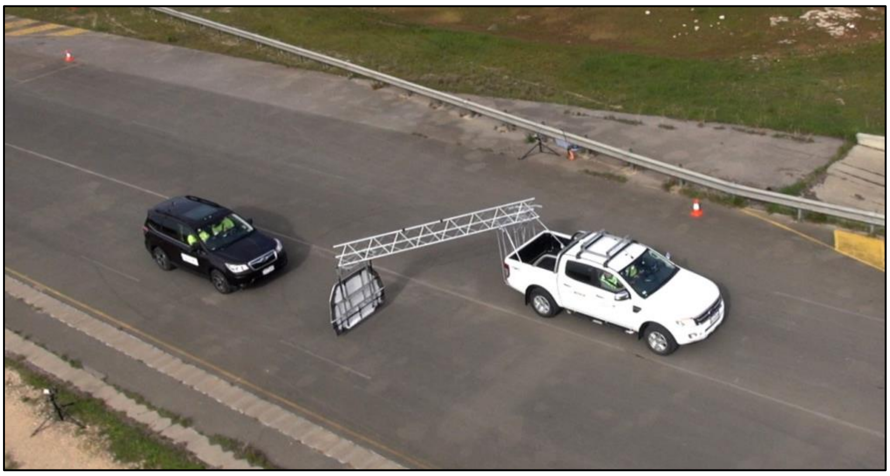
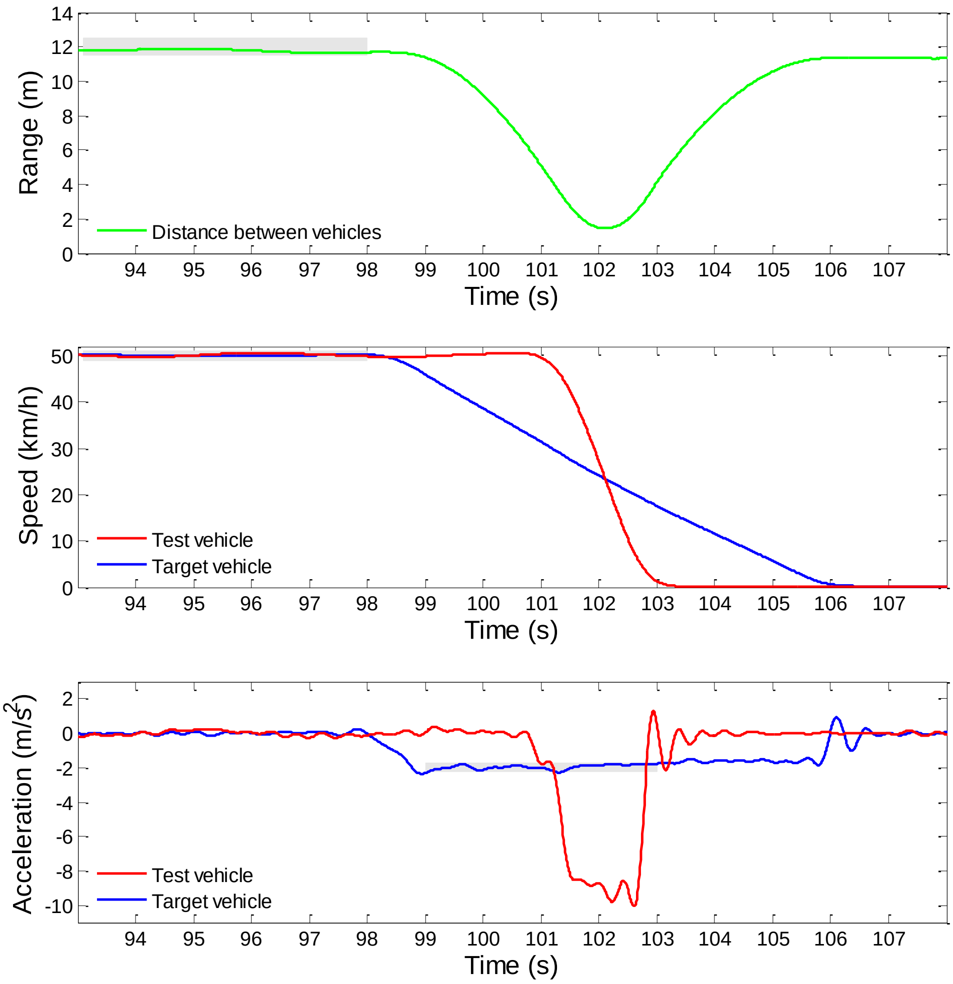


Figure 2. Performance of all equipment during an evaluation test



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