Test methods for active safety functions to avoid accidents between cars and bicycles

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ABSTRACT

Road fatalities are reduced, but the number of bicyclists and pedestrians killed or severely injured is at an unchanged level. The introduction of active safety functions is believed to further reduce fatalities among car occupants. There are presently no active safety functions for protecting bicyclists. Test methods will be a key enabler to show that novel safety functions for bicyclists have the possibility to reduce and mitigate accidents. The most relevant accident scenarios must be identified. Test procedures and bicycle test targets are needed.

Keywords: active safety, road vehicles, bicycle, vulnerable road user, test method.

1 INTRODUCTION

The safety of passenger cars has greatly improved during recent years. The development of protective measures to reduce the consequences of a crash ("passive safety") has made road vehicles safer. Systems of airbags, seat belts and protective structures have increased safety for the drivers, passengers and lately also pedestrians. Passive safety technology is well developed and has greatly contributed to reduction of fatalities and injuries. Testing programs for assessment of these passive safety measures have been established. But there is still an intolerable number of deaths and severe injuries. More than 30,000 people still die on European roads every year [1].

Functions to avoid and mitigate road accidents ("active safety") have been introduced in recent models of road vehicles in increasing numbers. The purpose is to try avoiding accidents through active support to the driver. Such systems are called active safety systems or driver assistance systems or ICT-based safety systems. The active safety functions are under rapid development and there is presently, and in contrast to passive safety, no generally accepted assessment programme in place. Electronic stability control (ESC), warning and autonomous emergency braking systems and lane keeping support are examples of such active safety functions which are seen as the main contributor to further reduction of deaths on our roads.

At the same time as fatalities for car drivers are reduced, the level of fatalities for pedestrians and bicyclists is more or less the same [2]. This means that the proportion of Vulnerable Road Users (VRUs) in road accidents is increasing. It will be increasingly important to work for improved pedestrian and bicycle safety.

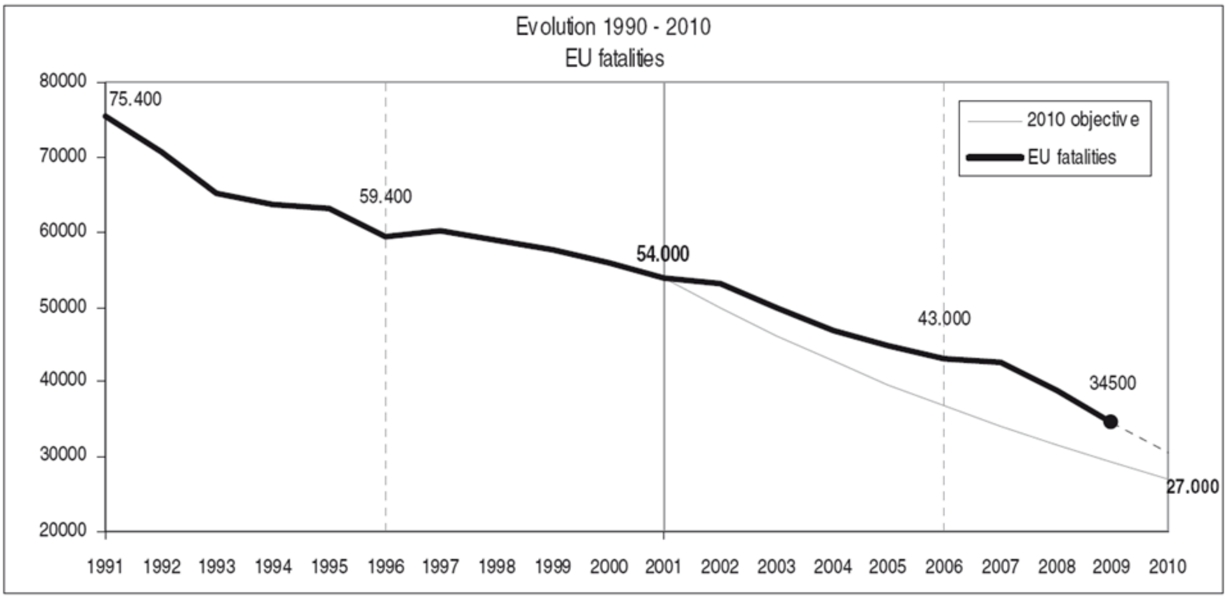
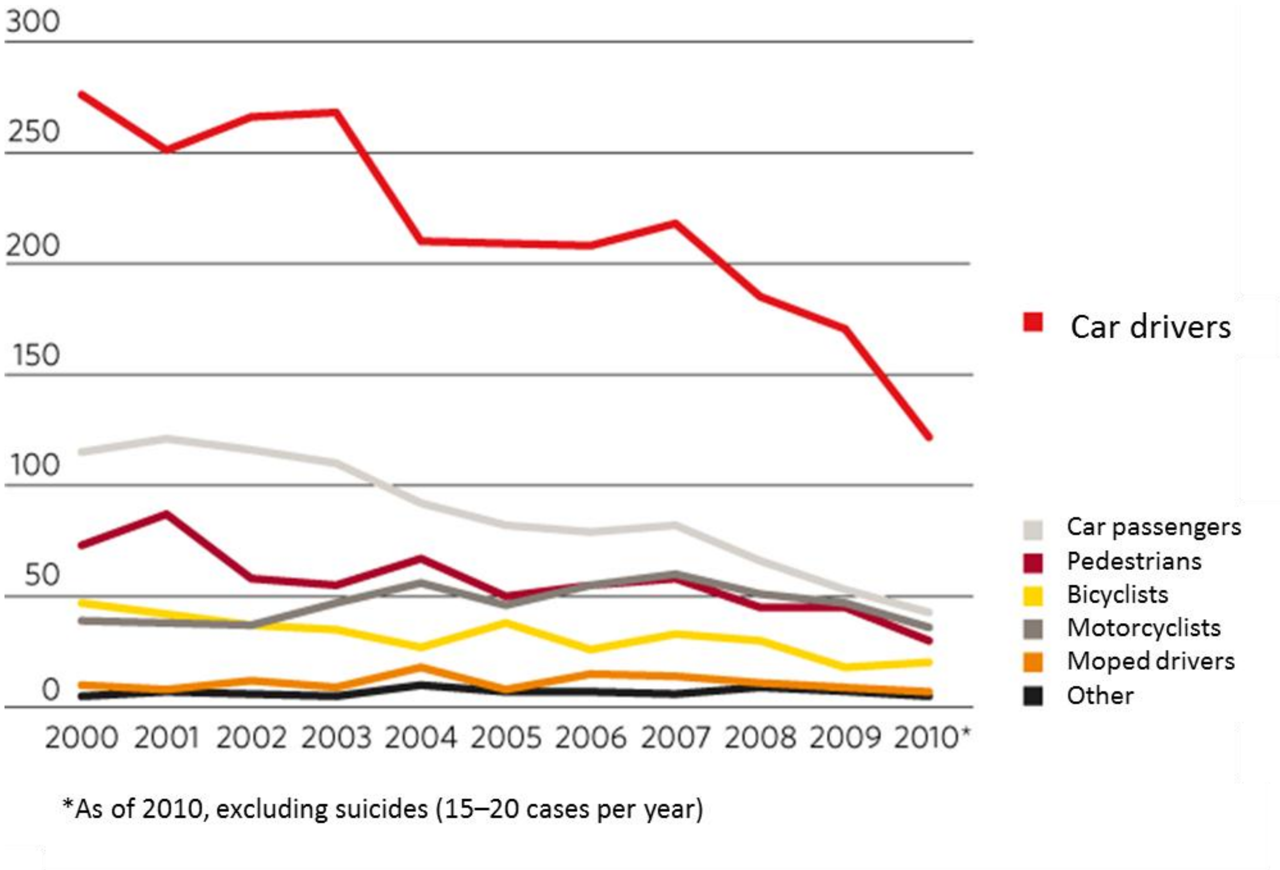


Figure 1. Road traffic fatalities in Europe [1].



Source: The Swedish Transport Administration Annual Report 2010

Figure 2. Number of fatalities per road user in Sweden [2].

2 ACTIVE SAFETY FUNCTIONS

Functions to avoid or mitigate bicycle crashes could be built into cars, buses and trucks. The new safety functions could also be built onto the bicycles.

Active safety functions with the potential to reduce accidents with VRUs are available in vehicles today. Autonomous emergency braking functions has the ability to detect a pedestrian (see figure 3). If the driver does not brake, the vehicle will trigger the braking action. Such functionality should be possible to adopt for bicycle safety. Cars and trucks might in the future be equipped to brake autonomously for cyclists.

Active safety functions for bicycles are still not available on the market. Researchers are discussing possibilities to develop bicycle-based functions to warn the cyclist in hazardous situations. An even further step could be to develop autonomous functions for propulsion and/or braking of bicycles.

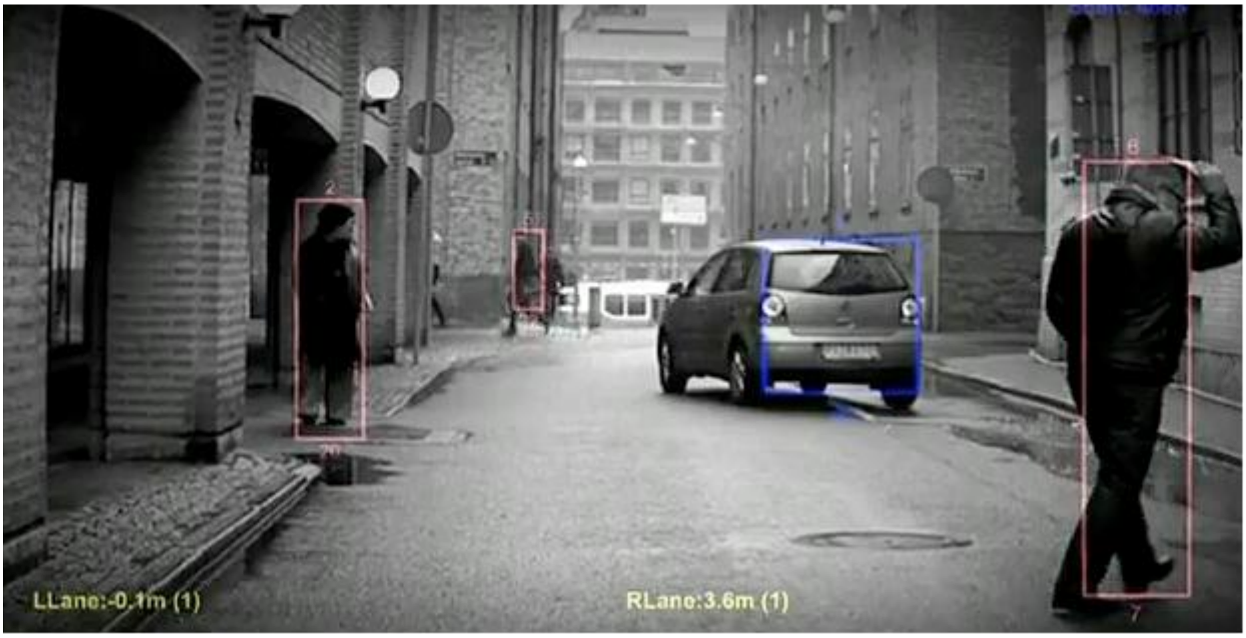


Figure 3. Detection of pedestrians on the road [www.volvocars.com]

Wireless communication between vehicles and between a vehicle and the infrastructure will soon be used for active safety functionality. A future scenario is when a car has detailed real-time information of the position and speed of other surrounding vehicles. The wireless connectivity will be used to implement novel active safety functions. A bicyclist can receive information from surrounding vehicles, and surrounding vehicles can be made aware of bicyclists.

3 TESTING OF ACTIVE SAFETY FUNCTIONS

The possibility to test new functions will be essential to succeed with the development of active safety. Bicycle manufacturers and independent testing laboratories can today manage conventional testing of bicycles in a precise and repeatable manner. (See figure 4.) There are test methods and test equipment well suited to test mechanical aspects of bicycles. Testing programmes are also in place to assess what will happen if a human body hits the hood or the windscreen of a car. The impact stress to the human body should be kept at a low level. It is in most cases fairly straight-forward to decide what performance metric should be used.

Testing of active bicycle safety can only be made if the most important accident scenarios are known. It can be expected that bicycle safety is tested in at least crossing scenarios, turning scenarios, straight road scenarios and bicycle lane scenarios. The objective would be to show that the implemented safety functions actually reduce the probability for fatalities and severe accidents. But it is not always easy to find a performance metric.

Figure 4. Brake testing for bicycles can be made precise and repeatable [www.smp.nu].

Test targets will also be needed. The tests cannot be considered safe enough to use real bicyclists as targets. Some of the tests are expected to fail. A car crashing into the target could seriously hurt a human bicyclist. A less important result is also that the car used in the test could be damaged with costly repairs required. Test targets have to fit several sensing principles; vision sensors, radar sensors and infrared sensors. It can also be expected that several bicycle targets of different size and shape will be required. The safety functions should work with both children and adults, and for different types of bicycles.

The testing must then be described in a test method to allow accurate and repeatable results. A performance metric will be needed to explain safety improvements. Examples of possible performance metrics could be collision speed (i.e. the relative speed at which the collision between the bicycle and the other object occurs), time to collision (i.e. the time remaining until the bicycle would crash into the other object), impact force (i.e. the maximum force at which the bicycle will hit the other object) and torque (i.e. the torque applied to a part of the body of the bicyclist, e.g. the neck).

4 THE ACTIVE TEST SUPPORT ACTION

Several initiatives have identified the need for standardised testing and assessment methods for active safety functions for road vehicles over the past years. While some of them are ongoing, similar, but different methods have been presented recently. It is now necessary to reach a harmonisation of the different initiatives in order to prevent different and incompatible test programs world-wide.

The support action ActiveTest has the goal to increase road safety by supporting the introduction of active safety functions, which allow mitigation or even avoidance of accidents. These functions are necessary to reduce fatalities on European roads significantly.

Several testing methods have been presented by standardisation, industry and research projects. Tools are being developed to support performance testing. ActiveTest provides a forum for exchange of experiences and comparison of principles from in-house testing at manufacturers with the results of research initiatives in Europe and overseas. This forum will be independent from industry, and thus neutral ground to allow for informal discussions.

Several organisations have compiled research agendas including testing "active safety", "integrated safety" or "ADAS". The European Technology Platform ERTRAC (European Road Transport Research Advisory Council) has developed a scenario for road transport in 2030 and the following years. The European Council for Automotive R&D (EUCAR) has published a paper summarizing R&D needs and trends with the title "Challenges and Priorities for Automotive R&D". The suppliers for car parts, systems and modules have through their organisation CLEPA published a Strategic Research Agenda addressing the future of automotive research. The European Automotive Research Partners Association (EARPA) has presented a safety position paper. EPoSS, the European Technology Platform on Smart Systems Integration, has a Strategic Research Agenda mentioning major research and development objectives for the next 15 years with respect to active safety.

An outlook for future research in active safety and performance testing is compiled by the ActiveTest support action within the European ICT research program. It was issued for commenting and addition during autumn 2012. The intention is to present research topics for active safety testing with background, objective and impact, which are shared and accepted by the research community.

5 CONCLUSIONS

There are active safety functions increasing the safety of pedestrians available on the market. Some car models have been equipped with sensor systems to detect pedestrians and trigger autonomous braking if the driver does not react. Such functions are not yet tuned for bicycles, but technological solutions exist to make it possible.

Development of active safety for bicycles will require proper testing to show that road safety will be increased. The most safety-relevant scenarios have to be identified, test targets looking like bicycles have to be developed and test methods must be established.

Active safety functions for bicycles are still in the research phase. There are discussions how to adopt information and communication technology to support bicyclists. Sensing systems may be employed to detect other road users and alert the bicyclists. A thrilling development would be if electric bicycles could provide instant extra power for emergency braking or emergency acceleration to act autonomously in a hazardous situation.

The technological development will certainly provide innovations we cannot see today. One example of improved passive safety is the bicycle helmet "Hövding". (See figure 5.) Hövding is a collar for bicyclists, worn around the neck. The collar contains a folded up airbag that you will only see if you happen to have an accident. The airbag is shaped like a hood, surrounding and protecting the bicyclist's head. The trigger mechanism is controlled by sensors which pick up the abnormal movements of a bicyclist in an accident.

Figure 5. Innovation in bicycle helmets [4].

But in the meantime, while waiting for the active safety for bicyclists, safety will be best increased by conventional measures. Studied in real traffic have shown that bicyclists sometimes turns or brakes in an unplanned way. A possible explanation is that riding a bicycle is perceived as less dangerous than driving a car. The risk perception of the bicyclists needs to be improved. Training of bicyclists can be important to make their journeys safer. Protective helmets for bicyclists have been proven to be effective when accidents occur. Also lights and reflective vests will increase the visibility and thereby make it easier for other road users to see bicycles.

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REFERENCES

[1] Towards a European road safety area: policy orientations on road safety 2011-2020, COM(2010) 389 final, 20.7.2010 (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0389:FIN:EN:PDF)

[2] The Swedish Transport Administration Annual Report, 2010

[3] The ActiveTest Research plan, draft September 2012, www.activetest.eu

[4] Bicycle helmet "Hövding", www.hovding.com