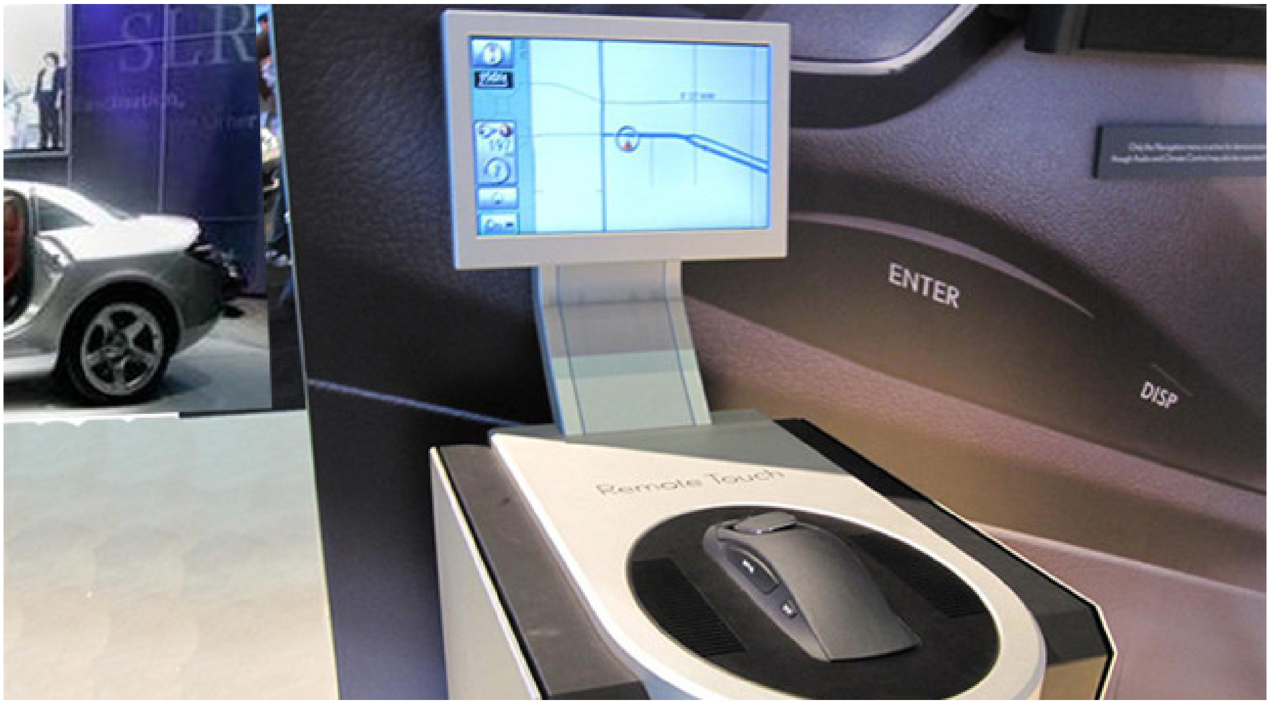


Are we safe with integrated vehicle driver assistant system?

3 SEP 2014 BY OUSSAMA DERBEL 0

Is the displayed safety accurate in the current smart vehicle?

Car manufacturers are enhancing driver safety by mean of passive and active safety systems. Passive safety includes seat belts, strong body structures or airbags. Active safety refers to the systems that help the driver to prevent, avoid or minimize the effects of an accident. These systems are based on the integrated vehicle sensors (accelerometer, gyroscope …) and algorithms used to determine the driver safety level based on the vehicle parameters (e.g. velocity, acceleration…). They are called also Advanced Driver Assistance System (ADAS). An example of these systems is shown in the video below.

These systems are designed to increase safety not only of the passengers of the car but also of the others cars drivers making the traffic. Traffic safety studies can be classified into two categories.

The first one is based on collision scenarios such as the emergency braking scenario. Here, the number of collision and the Energy Equivalent Speed (for severity) are used to evaluate traffic safety [1]. Based on a statistical approach, a safety level is computed for mixed road traffic.

The second category focuses on collision free scenarios. In this case, the evaluation of traffic safety needs relevant indicators such as the Time To Collision (TTC) [2]. The TTC criterion is the time at which a collision will occur when neither steering nor braking would avoid the impact. It takes account of the relative velocity and headway and is implemented as an option in most vehicle's warning systems. The Potential Index for Collision with Urgent Deceleration (PICUD) [3] is a safety indicator based on reaction time, velocity, inter-distance, relative velocity, deceleration capability as shown by the figure 1. These parameters are the most important ones for driver safety assessment.

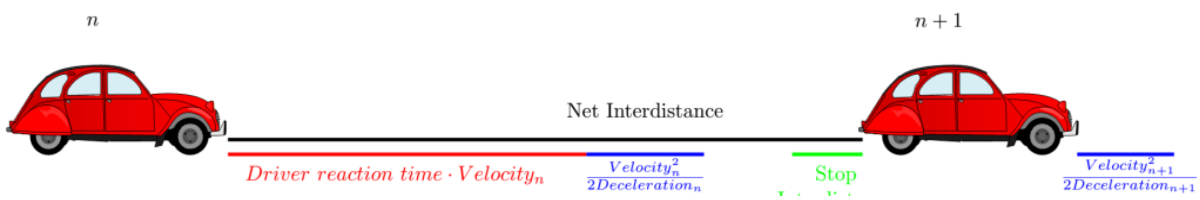


Figure 1. Important parameters related to driver safety evaluation in case of car following driving

The PICUD indicator is computed by the difference between the two vehicles stopping distances when the leader vehicle brakes with its maximum deceleration and the follower brakes with its maximum deceleration capability after the reaction time of the driver. So, the collision between two vehicles occurs if the stopping distance of the follower is greater than the leader's stopping distance in the emergency braking scenario. When implemented in ADAS, this indicator receives, as inputs, data from the Global Positioning System (GPS) and the accelerometer and return, as output, the safety level through a collision warning algorithm.

Generally, the GPS and the accelerometer are Micro-ElectroMechanical (MEMS) type. The advantages of MEMS devices are their low power consumption, the low cost and the small size. However, the accuracy of these sensors is relatively low. Calibration, temperature and linearity are the main errors sources of MEMS sensors [4]. Then, these sensors errors may have an influence on the determination and the driver safety level accuracy. The analysis of the impact of parameter errors on driver safety level is very important. In our research paper, the PICUD based collision warning algorithm is tested with the emergency braking scenario where the follower driver is unaware of the critical situation. Moreover, the noise has to be taken in account when computing the safety level indicator. Thus, the drivers, as well as the automotive manufacturers, have to consider that the displayed safety level has an error.

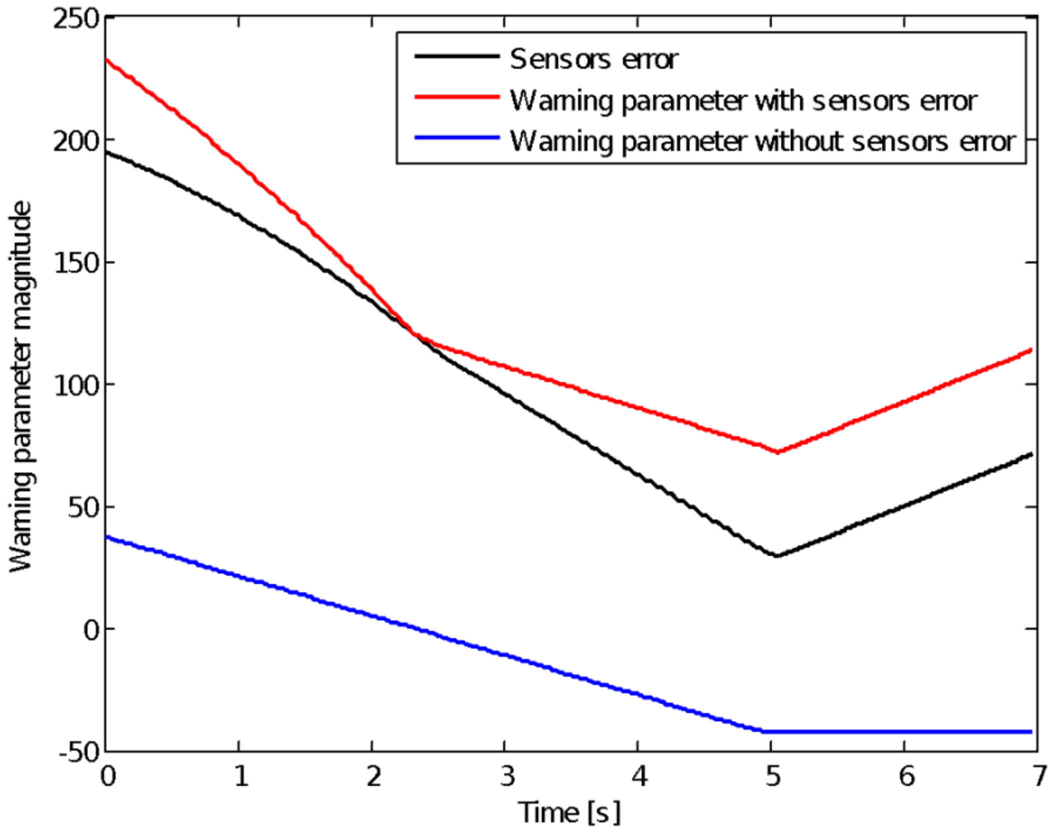


Figure 2. Impact of sensor errors on driver safety level using the PICUD indicator

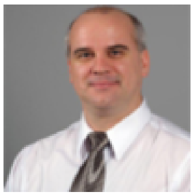
Figure 2 presents the individual parameter (PICUD) error contributions over the emergency braking test. This PICUD indicator takes in account all the parameters that must be included for the driver safety evaluation.

Results show that the warning parameter errors have an important influence on the driver safety level. For example, the warning parameter has an offset at the collision time (t=5 seconds). The noised collision parameter with the red is positive, which means that the driver is in safe driving situation, whereas the non-noised warning collision parameter, with the blue color, is negative and this means that the driving situation is dangerous. Then, the driver will be informed by a fake safe driving situation due to the sensors noise. As the figure 2 shows, the offset between the noised and non-noised safety indicator remains high. Here, wrong information will be transmitted to the driver (safe situation). Thus, the eventual crash will be the most severe since the driver is unware with the dangerousness of his situation.

Here, a high-performance filter has to be designed to estimate the non-noised information and discard the noise. But the high performance filter will be costly in terms of power consumption and price. Then, a balance has to be made between the advantages of the MEMS devices and the driver safety level accuracy in an ADAS.

It is obvious that automotive manufacturers take into account the effect of the noised parameters using some filtering algorithms. But is this sufficient when the subject concerns the human safety?

Oussama Derbel is an electric engineer in the department of electrical engineering at the École de Technologie Supérieure (ÉTS) at the LASSENA Laboratory. He works on the Vehicle Tracking and Accidents Diagnostic System (VTADS). His expertise is in the automotive field and especially in the traffic modeling and control and driver safety.



René Jr Landry is a professor at the department of electrical engineering at École de Technologie Supérieure (ÉTS) and the Director of LASSENA Laboratory. His expertise in the embedded systems, navigation and avionic is notably in the field of transport, aeronautic and space technologies.

To inquire on future projects of the LASSENA team, please consult the following link.

REFERENCES

[1] O. Derbel, B. Mourllion, and M. Basset, “Extended safety descriptor measurements for relative safety assessment in mixed road traffic,” in 15th International IEEE Annual Conference on Intelligent Transportation Systems, 2012, pp. 752–757.

[2] J. Hayward (1972). Near miss determination through use of a scale of danger.

Highway Research Board, 6(384):24–34.

[3] Minderhoud, M.M., Bovy, P., 2001. Extended time-to-collision measures for road traffic safety assessment. Accident Analysis and Prevention 8, 89.

[4] O. J. Woodman, “An introduction to inertial navigation,” University of Cambridge, Tech. Rep., 2007.

PICTURE REFERENCES

[1]http://commons.wikimedia.org/wiki/File:Remote_Touch_by_Lexus_kiosk.jpg