CONCEPT OF INDIVIDUAL DRIVER ASSISTANCE SYSTEMS WITH INCLUSION OF DRIVERS PERFORMANCE

Toralf Trautmann [1], Patrick Rogge [1]

[1] University of Applied Sciences Dresden, Dresden, Germany

Abstract
The number of elderly drivers is continuously increasing. These drivers often have problems to handle or even be aware of critical situations. Therefore, the amount of accident perpetrators in this age group is higher compared to other drivers. New advanced driver assistance systems (ADAS) designed especially for elderly drivers are necessary in order to reduce the number of accidents. The detection of the individual performance of each driver is an important piece of information to produce a purposeful intervention of the system. This paper describes results of an ongoing naturalistic driving study and first measurements to detect drivers performance during an exemplary drive in rush-hour traffic.

Keywords
advanced driver assistance systems, naturalistic driving study, individual performance of drivers

Introduction

In Germany, a periodical medical examination of elderly drivers to assess their fitness to drive is not regulated by law. This might be one reason for the increase in accidents caused by the disregard of the right of way in the age class above 65 years (see Fig. 1).

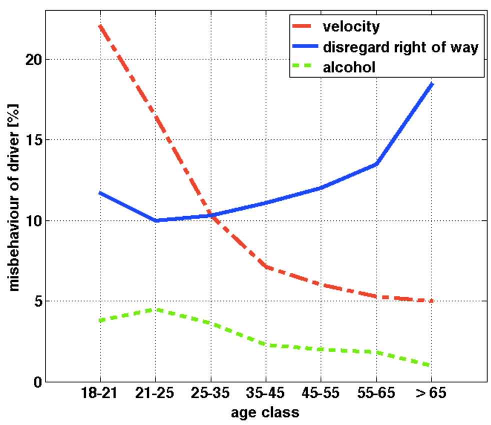

Fig. 1: Age dependency of accident reasons for the year 2011 [1].

Therefore it is necessary to assist those drivers even in well known critical situations with new systems. The control of such situations strongly depends on the actual performance of the driver. For an acceptance of such new systems it is necessary to adjust the warning or driving intervention on drivers performance.

Classification of drivers

The handling of a car depends on the driver. The quality of driving is situated between defensively-minded or road rage.

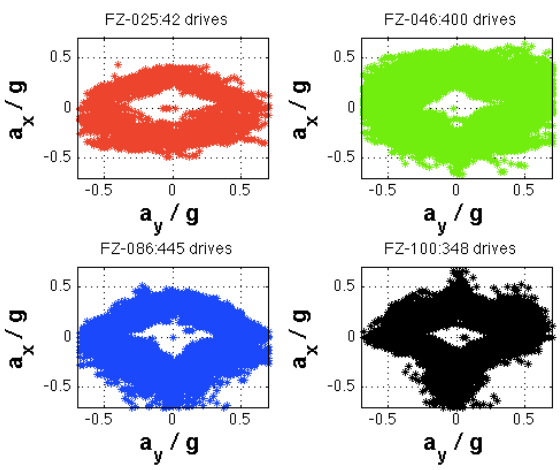

Fig. 2: Maximum values of longitudinal acceleration vs. lateral acceleration for trips with more than 1 hour of driving time [2].

An estimation of the driving quality can be made using the measurements of vehicle dynamics. Some examples are shown in Fig. 2. The black diagram on the bottom right of Fig. 2 shows for example a driving school vehicle with a defensive manner of driving. The green diagram on the top right shows a driver with a more dynamic driving behavior.

A second example with more detailed analysis of selected values is shown in Fig. 3 and Fig. 4. Here the velocity and the steering wheel angle at the same bend are compared between different drivers. Due to uncertainties of the GPS localization the graphs are shifted.

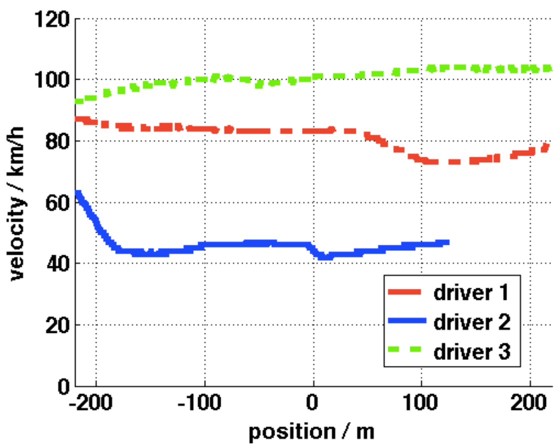

Fig. 3: Differences in velocity between different drivers at the same position [3].

It can be seen that driver 2 has the lowest velocity and he is also braking prior to the bend. This can be interpreted as a tentative style of driving. But the large deviations in steering wheel angle in Fig. 4 shows that this driver has problems with the control of the car. Therefore he might be insecure and this leads to a tentative driving style.

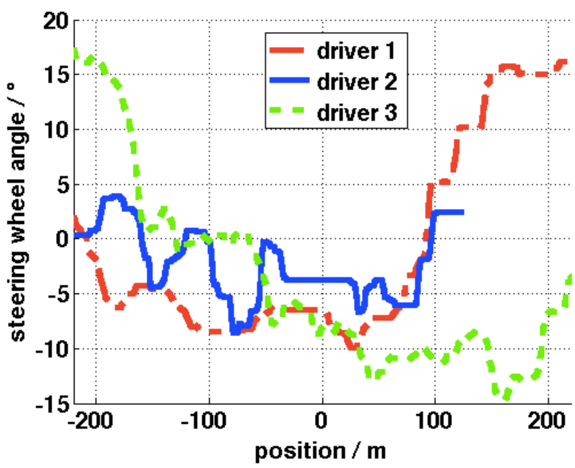

Fig. 4: Differences in steering wheel angle between different drivers at the same position [3].

Detection of drivers' performance

Based on the results of the classification a more detailed study was performed using clinical equipment. Additionally, a laser scanning device has been used to automatically detect the situation itself, e.g. distance to preceding vehicles or pedestrians.

During the one hour trip in rush-hour traffic some tasks should be conducted. The most difficult task was to back into a parking space.

The pulse rate and additional parameters like pCO_2 were measured using the digital monitoring system SDMS of the SenTec company. Whereas the pulse information seems to be connected with the difficulty of the driving task this was not the case for the pCO_2. Here long adaption periods without selective reaction were observed. The measurement of skin conductivity was not successful due to displacement of electrodes during steering.

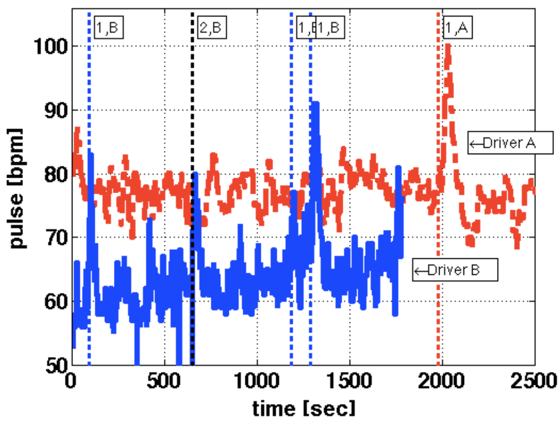

Fig. 5: Pulse rate measurements of two drivers. The task 1 is the parking manoeuvre, task 2 marks an unscheduled turning manoeuvre of driver B [4].

Concept of a new system

The results presented show that a personalized assistance is possible in principle. But for an easy-to-use and secure system some questions should be answered.

At first the method for the detection of a driver's fitness is the main task. The heart rate itself is non-specific except in very critical situations and therefore unsuitable. A more specific value is its variability. But the absolute value depends strongly on the person and different other parameters like breathing rate, too. Nevertheless, it seems to be possible to use this easy-to-measure value in connection with other driver selective parameters and after a long-time learning period.

The learning task is a requirement which answers the question about the sort of integration of the system into the car architecture. Normally, car manufacturers prefer integrated systems. But in this case the use is reduced to the driving time with restricted learning period. However, if the system is already usable outside the car the user gets more benefit. At first, the learning period can be extended to other surroundings like the home environment. Secondly, the detection of critical situations is possible anywhere. In addition to the use during driving a connection to a family doctor allows more detailed analysis and preliminaries.

As a result of this analysis a mobile phone or tablet PC seems to be the best choice as a basic part of the new system. External devices are easily connected using the wireless interfaces like Bluetooth or WiFi. Environmental data are available due to GPS and a digital map. For warning tasks the display of the device can be used directly. An example system is shown in Fig. 6.

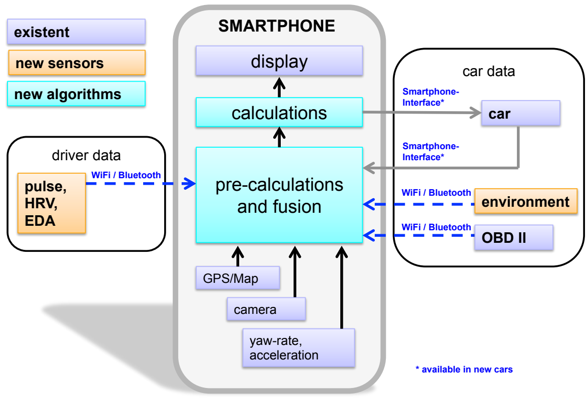

Fig. 6: Proof of the system.

The detection of car dynamics is more difficult. Some data like acceleration and yaw-rate (rotation about the vertical axis of the car) are measured by the device itself, but with low resolution. The most important parameter is the steering wheel angle and its variations. But these values are available due to the standard diagnostic interface (OBD II) only for a small amount of cars. As a consequence, an estimation of this value with loss of precision is possible at the moment.

For the future a special mobile phone interface will be introduced by car manufacturers. Then an integration of this and other parameters might be possible. Additionally, such interface allows active intervention into driving dynamics, too.

Conclusion

Our preliminary studies show the potential of the combination of driving and performance information. The main problem is the small database of measurements in real environment with critical situations. The concept presented allows us to realise a naturalistic driving study with a large number of drivers to develop and test both, new sensor concepts and new algorithms. The increasing number of easy-to-use and secure medical equipment will improve the acceptance of those new systems.

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Prof. Dr. rer. nat. Toralf Trautmann
Dipl.-Inf. (FH) Patrick Rogge
Faculty of Mechanical Engineering / Process Engineering
University of Applied Sciences Dresden
Friedrich-List-Platz 1, D-01069 Dresden

E-mail: trautmann@htw-dresden.de
rogge@htw-dresden.de
Phone: +0049 351 462 2854