Customized warning system for the lowering of driving performances in older drivers

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0. CONTENT

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4. Solution Implementation: a simplified approach respect to the current research on driver workload
5. The importance of a multi disciplinary approach
6. Safe Driving Behaviour: geriatric assessment
1. BACKGROUND AND INTRODUCTION

The fatality rate for car drivers for those aged 75 is becoming a serious problem in Europe and worldwide.

The number of elderly fatalities in European Countries has decreased less rapidly respect to the total fatalities, meaning that their share of the fatalities is increasing. (Source: Yannis, 2013)
The main factors affecting older drivers

The road safety of older drivers is to a large extent determined by two factors: functional limitations and physical vulnerability. Both factors contribute to the relatively high fatality rate among older drivers as a result of crashes. However, older drivers also adapt their behaviour to their limitations.

- Fitness to drive: functional limitations, diseases and medication
- Behavioural adaption
- Physical vulnerability

Quality of life: an important issue

Safety versus mobility and quality of life

- The importance of the private car
- The effects of driving cessation
- Alternative means of transport

THE EFFECTS OF AN ABRUPT INTERRUPTION OF DRIVING
(failing a periodic standard driving test procedure)

Lowering of self-esteem and dignity

Immediate difficulties for daily activities

Psychological and health consequences

Lowering of social activities, increasing of dependence

Quality of life degradation, higher costs for the community

....leaving their car often means leaving part of their social lives...
2. OBJECTIVES

1) Accompanying aged people during their day by day driving, in order to make them aware, slowly but continuously, about their decreasing driving performance, if any.

2) Providing a monitoring system to fit and healthy aged drivers concerned about a possible decreasing of their performance in the next future

In both cases the self-adaptive behavior (main characteristic of aged drivers) will be stimulated
3. PROPOSED SOLUTIONS

• Defining a personal driving profile during some months of “ordinary” driving

• Giving a simple, friendly feedback only at the end of the day, avoiding any information overload during the driving tasks

• More detailed feedback only in case of anomalous values
4. SOLUTION IMPLEMENTATION

The study is developing a framework consisting of a complete and integrated tool chain which includes several building blocks.
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This concept car contains high quality measurement equipment, which serves as excellent tools for the optimization of the technical driven performance indicators.
Access to in-vehicle systems

- Besides the high performance instruments, the concept car offers also full access to the in-vehicle systems through the high-speed CAN-interface.

- Thus the following driving parameters may be evaluated for the use driver performance estimation:
  Pedal position of gas pedal / Steering wheel angle / Status of brake pedal (on/off) / Fuel consumption / Tachometer speed of the car / Acceleration and Turn rate (in all three axis) / Velocity

- Using in-vehicle measurements means
  ➔ provision of information at no additional cost for the APP.
Graphic Feedback given at the end of each day, based of few parameters

First ongoing studies are based on 5 parameters (functions of speed, acceleration, brakes, road stretch moved and variations in steering)
Specific feedback given only in case of anomalous parameters

Anomalous parameter detected!

The number of brakings compared to the distance moved is much higher than your average: other measured parameters show normal traffic conditions as well as normal external environment. (If you believe that the real traffic conditions were rather exceptional, press the green button)

This may depend on physical problems of leg muscles or wrong perceptual distance of other vehicles. Should the next feedback still show this anomaly, you are strongly suggested to contact your doctor.
The general problem is complex

All the known projects are looking for a unique function, generally based on the Driver Workload concept, valid for all drivers in all possible situations: this implies a huge number of parameters.

Use of biometric sensors (e.g. camera recording the eye movements), generally not well applicable in the real life

The confidence of the driver in the feedback given has not yet proven
Some variables and parameters used in the ITERATE project - [www.iterate-project.eu](http://www.iterate-project.eu)

**Table I: Driver functions, parameters and coefficients**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATT</td>
<td>Parameter describing the driver Attitude</td>
</tr>
<tr>
<td>FXP</td>
<td>Parameter describing the driver Experience</td>
</tr>
<tr>
<td>DS</td>
<td>Parameter describing the Driver State</td>
</tr>
<tr>
<td>TD</td>
<td>Parameter describing the Task Demand</td>
</tr>
<tr>
<td>CULT</td>
<td>Parameter describing the driver culture</td>
</tr>
<tr>
<td>$F_i$</td>
<td>Generic function computing the driver performances when performing the $i^{th}$ operation</td>
</tr>
<tr>
<td>$f$</td>
<td>Function computing the contribution of ATT and EXP for $F_i$</td>
</tr>
<tr>
<td>$g$</td>
<td>Function computing the contribution of DS for $F_i$</td>
</tr>
<tr>
<td>$h$</td>
<td>Function computing the contribution of TD for $F_i$</td>
</tr>
<tr>
<td>$K_i$</td>
<td>CULT dependent constant contribution of $F_i$</td>
</tr>
<tr>
<td>$\alpha_i$</td>
<td>CULT dependent coefficient of function $f$</td>
</tr>
<tr>
<td>$\beta_i$</td>
<td>CULT dependent coefficient of function $h$</td>
</tr>
<tr>
<td>$\gamma_i$</td>
<td>CULT dependent coefficient of function $g$</td>
</tr>
<tr>
<td>$\Delta t$</td>
<td>Time step of the simulation</td>
</tr>
<tr>
<td>$v_{int}$</td>
<td>Intended speed</td>
</tr>
<tr>
<td>$v_{max}$</td>
<td>Maximum speed</td>
</tr>
<tr>
<td>$v_{leading vehicle}$</td>
<td>Speed of the leading vehicle</td>
</tr>
<tr>
<td>$p_{curve}$</td>
<td>Intended speed coefficient</td>
</tr>
<tr>
<td>$s_{int}$</td>
<td>Intended distance from leading vehicle</td>
</tr>
<tr>
<td>gas</td>
<td>Position of gas pedal</td>
</tr>
<tr>
<td>$g_p$</td>
<td>Gas pedal pressing ratio</td>
</tr>
<tr>
<td>brake</td>
<td>Position of brake pedal</td>
</tr>
<tr>
<td>$b_p$</td>
<td>Brake pedal pressing ratio</td>
</tr>
<tr>
<td>$X_{av}$</td>
<td>Distance from train to warning signal</td>
</tr>
<tr>
<td>$X_{av}$</td>
<td>Distance from warning signal to speed limit signal</td>
</tr>
<tr>
<td>$X$</td>
<td>Distance from train to speed limit signal</td>
</tr>
<tr>
<td>$X_{react}$</td>
<td>Distance from signal at which the driver starts to react</td>
</tr>
<tr>
<td>Visibility</td>
<td>Distance at which a signal is seen by the driver</td>
</tr>
<tr>
<td>$t_{ext}$</td>
<td>Time spent by train to reach the speed limit signal if speed remains constant</td>
</tr>
<tr>
<td>$t_{int}$</td>
<td>Time spent by train to reach the speed limit signal if speed properly decreases</td>
</tr>
</tbody>
</table>

Holistic "top down" approach, with many variables
The Challenge

Decreasing the complexity of the function:
- Simplified algorithm based on previous studies and empirical method
- No holistic approach but just one, well specified, and simpler objective: profiling the driving performances of older people

Improving the confidence of the driver:
- No interaction while driving, unless serious problems are detected
- The feedback is given only at the end of the trip
- The last feedback is shown before the trip
Envisaged outcome

• Cheap system, once on the market
• Can be implemented on used car
• Allows different drivers using the same vehicle, or the same driver using different vehicles
• No overlapping, neither competition with the automotive producers’ research related to the Driver Workload (this solution is only targeted to aged drivers)
5. THE IMPORTANCE OF A MULTI DISCIPLINARY APPROACH

This study is being carried out by an international group

- **Advantic Systemas y Servicios, Madrid, Spain** – *ICT and wireless networks*
- **Atilim University, Ankara, Turkey** – *Design and modelling – Road safety research*
- **Catholic University of Sacred Hearth, Rome, Italy** – *Research on health issues in aged people*
- **C&S Europe Consulting, Tervuren, Belgium** – *Road safety research*
- **Pwp-systems GmbH, Bad Camberg, Germany** – *Multimodal and cooperative traffic solutions*
- **Spring Techno GmbH & Co, Bremen, Germany** - *Intelligent algorithms for modelling and prediction*
- **Tallin University of Technology, Tallin, Estonia** – *Road safety research*
6. GERIATRIC ASSESSMENT

Safe driving behaviour in aged drivers is related to:

- Performance status (that may be modified by physical impairments)
- Cognition

Geriatric Assessment is able to detect by performance status and cognition three aged drivers subtypes:

- Fit - able to drive
- Prefrail - behavioural or physical changes may compromise ability to drive
- Frail - the ability to drive may be lost in a short time
**Medical Outcomes**

Short term perspective:

Identify pre frail drivers; good drivers that can lose some of their skills without realizing it

Long term perspective:

Find possible highlighting the evolution from a normal pattern to a deterioration.
Thank you for your attention!

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