DRIVER DISTRACTION DETECTION AND EVALUATION METHOD WITH COMPUTATIONAL INTELLIGENCE ALGORITHMS

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InTErdisciplinary trAining network in Multi-actuated ground vehicles (ITEAM): Consortium

9 European countries

11 Beneficiaries

8 Partner organizations

7 Nonacademic organizations

10 Universities

2 Research centers

https://iteam-project.net/
Motivation: Traffic accident fatalities

Sources:
- NHTSA Foundation
- European Commission, Directorate General for Mobility and Transportation
Motivation: Driver distraction (DD)

18% (4 698 deaths)
of all road accidents with fatal outcomes are due to
driver distraction in EU alone

The aim of current research is traffic safety improvement via
detection and further minimization of driver distraction
induced by in-vehicle information system applying computational
intelligence methods;
Motivation: DD definition

“Driver distraction occurs when a driver is delayed in the recognition of information needed to safety accomplish the driving task because some event, activity, object or person within or outside the vehicle compelled or tended to induce the driver’s shifting attention away from the driving task” – J.R. Treat.[1]

“Driver distraction is the diversion of attention away from activities critical for safe driving towards a competing activity” – M.A. Regan.[2]


Motivation: Sources of DD

External
- Accidents
- Wildlife
- Pedestrians
- Bicyclists

Internal
- Cell phone
- Eating and drinking
- Reading and writing
- Media and navigation

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**Motivation:** Forms of DD

- **Visual**
  - “Taking eyes off the road”

- **Auditory**
  - “Taking ears off the road”

- **Biomechanical**
  - “Taking hands off the road”

- **Cognitive**
  - “Taking mind off the road”
Motivation: Evaluation methods

Performance-based

Behavioral

Psychological

Subjective
DD Detection and Evaluation Method: Performance-based measures
**Current Method:** Higher sensitivity to low distractions
DD Detection and Evaluation Method

Preprocessed training data

Non-distracted driving

Vehicle speed deviation ($\Delta v$)
Lane keeping offset ($\Delta x$)

Distracted driving

Speed limit ($v_l$)
Curve radius ($c_r$)
Curve direction ($c_d$)

Information about the environment

Machine learning driver model (Predictor)

Machine learning driver model (Predictor)

Error calculation

Level of distraction (DD)

Fuzzy logic reasoning (Evaluator)

Performance prediction

Performance error

$e_{\Delta v}$
$e_{\Delta x}$

$\Delta v_p$
$\Delta x_p$

$\Delta v_t$
$\Delta x_t$

$\Delta v$; $\Delta x$

$\Delta v_t$; $\Delta x_t$

$e_{\Delta v}$
$e_{\Delta x}$
Driver-in-the-loop experiment
Data Collection: Participants

- **18 participants**
  - **27.8%** female
  - **72.2%** male

**Age ∈ [24 39]**
- **Mean 30**
- **38.9% ≥ 30**
- **61.1% < 30**

**Experience ∈ [1 21]**
- **Mean 11**
- **50.0% ≥ 11**
- **50.0% < 11**

Special thanks to the volunteers from IPG Automotive GmbH (Karlsruhe, Germany) for participating in the driver-in-the-loop experiments.
Data Collection: Apparatus

- Gas pedal
- Break pedal
- Steering wheel
- 2 LCDs

- Real-time driver-in-the-loop simulation
- Head-up display
- MATLAB®/Simulink® integration with IPG CarMaker®
**Data Collection: Procedure**

- Length 10626 m
- 2 lines
- Line width 3.5 m

- Free run trial
- 2 laps free run
- 1 lap driver distraction with smartphone chat

- Sample frequency 50Hz (0.02 s sample period)
**Case Study Results:** Driver performance prediction by machine learning

![Graph showing driver performance prediction](image)

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Case Study Results: Driver performance prediction vs real driving performance

\[ \Delta v_p \]

\[ \Delta x_p \]

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Case Study Results: Resultative drive performance

\[ \Delta v_r \]

\[ \Delta x_r \]
Case Study Results: DD evaluation

Conclusion

A novel DD detection and evaluation methodology based on computational intelligence algorithms (i.e. machine learning and fuzzy logic combination) is developed, which includes:

- a model of normal driving (machine learning);
- a subsystem for measuring the errors from the secondary tasks;
- a module for total distraction evaluation (fuzzy logic).

An appropriate software (i.e. MATLAB) and hardware (i.e. IPG System Experience Platform driving simulator) set ups are proposed.

The method is verified in the driver-in-the-loop test with 18 participants with an interaction with cellular phone as a secondary activity.
Questions
THANK YOU FOR YOUR ATTENTION

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