NTSB: Overview on Drowsy Driver Detection

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NTSB: Overview on Drowsy Driver Detection

Agenda

➤ Motivation

➤ Market trends on driver monitoring

➤ Scope of Bosch activities

➤ Principles of steering-angle based drowsiness detection

➤ Summary
**Motivation**

- **34%** of all drivers experience highly drowsy driving  
  - DVR 2012 (German Road Safety Council)

- **41.0%** of drivers admit to having “fallen asleep or nodded off” while driving  
  - AAA 2010

- **24%** of drivers experienced drowsiness  
  - GDV, 2008 (Institute for traffic engineering of German Insurances)

- **20%** of all crashes were influenced by drowsiness  
  - NHTSA/VTTI 100 car study 2006

- **90%** of drowsiness-related accidents occur on non-urban roads  
  - VW 2005

> There are several studies documenting drowsiness in road traffic safety
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Interior / driver monitoring: Bosch history

Research and Pre-Development

- Inattention Detection
  - Research project (2001-2006):
    - Video-based eye-lid closure measurement.
  - AKTIV (2006-2010):
    - Algorithm development for inattention.

- Occupant Protection
  - Pre-development project (2001-2006):
    - Video-based occupant classification for passive safety (FMVSS 208 requirement)

- Drowsiness Detection
  - Production project (2006-2010):
    - Function development using driver steering behavior, market introduction in 2010.

Current approach is to utilize existing sensors for drowsiness detection

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Driver Drowsiness – Detection Variants

<table>
<thead>
<tr>
<th>Solution</th>
<th>Basics</th>
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<tbody>
<tr>
<td><strong>Steering pattern monitoring</strong></td>
<td>➔ Steering angle sensor signal or electrical power steering</td>
</tr>
<tr>
<td>➔ Detection of characteristic steering behavior</td>
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<tr>
<td><strong>Lane monitoring</strong></td>
<td>➔ Multi Purpose Camera</td>
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<tr>
<td>➔ Monitoring of lane-keeping behavior</td>
<td></td>
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<tr>
<td><strong>Driver eye/face monitoring</strong></td>
<td>➔ Interior Camera</td>
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<tr>
<td>➔ Analysis of eyelid closure behavior</td>
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<tr>
<td>➔ Yawning detection</td>
<td></td>
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<tr>
<td><strong>Physiological measurements</strong></td>
<td>➔ Electroencephalography (EEG)</td>
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<tr>
<td>➔ Brain activity</td>
<td>➔ Electrodermal activity (EDA)</td>
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<tr>
<td>➔ Heart rate</td>
<td>➔ Electromyogram (EMG)</td>
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<tr>
<td>➔ Skin conductance</td>
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<tr>
<td>➔ Electrical activity by skeletal muscles</td>
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#### Detection Principles - Comparison

<table>
<thead>
<tr>
<th>Steering based - Measuring driver’s movements</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High sensor availability in vehicles</td>
<td>Dependency on vehicle parameters</td>
</tr>
<tr>
<td></td>
<td>Small motions can be detected</td>
<td>Influence of driving style</td>
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<table>
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<tr>
<th>Lane based - Measuring driver’s lane guidance</th>
<th>Pros</th>
<th>Cons</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Simple vision based sensor</td>
<td>Dependent on environmental conditions</td>
</tr>
<tr>
<td></td>
<td>Minimal influence of driving style</td>
<td>Constraints for signal availability</td>
</tr>
</tbody>
</table>

→ Detection principles can be combined to improve performance

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Driver monitoring – Future state

Driver safety awareness

Interior Monitoring

CE trends

New market for health services
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Steering angle signal Inputs

Electric Power Steering (EPS)

Steering Angle Sensor

- System offers flexibility in using inputs from two products available in the market
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Operating principle

Detection of driver’s reduced guidance ability

via

Situational Context (Duration, Monotony)

Additional bus data:
- Time, vehicle speed, turn indicator, …

High precision steering angle sensor

Electric Power Steering

Camera w/ Lane Data

Driver Drowsiness Detection algorithm

Drowsiness value

Warning (Audible and/or visual)

Adaption of driver assistance systems

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Detection of driver drowsiness

Bosch’s system evaluates driver micro sleep events to determine level of drowsiness.
Summary

➢ Drowsiness is one major reason for serious accidents

➢ The Bosch system operates by analyzing the driver’s steering behavior

➢ Identifies steering patterns where the driver does not steer for a brief period and then makes an abrupt steering correction

➢ System combines the frequency and strength of these reactions with other data, such as vehicle speed and duration of travel, to calculate a drowsiness index

➢ Driver Drowsiness Detection identifies when a driver is at risk of falling asleep and sends a warning
Thank you.