NTSB: Overview on Drowsy Driver Detection

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Agenda

- Motivation
- Market trends on driver monitoring
- Scope of Bosch activities
- Principles of steering-angle based drowsiness detection
- Summary

Motivation

34% of all drivers experiences 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

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)

Production development

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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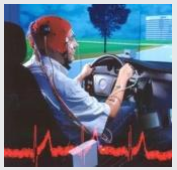
Driver Drowsiness – Detection Variants

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

Detection Principles - Comparison

Steering based- Measuring driver's movements	
Pros	**Cons**
➔ High sensor availability in vehicles	➔ Dependency on vehicle parameters
➔ Small motions can be detected	➔ Influence of driving style

Lane based- Measuring driver's lane guidance	
Pros	**Cons**
➔ Simple vision based sensor	➔ Dependent on environmental conditions
➔ Minimal influence of driving style	➔ Constraints for signal availability

➔ Detection principles can be combined to improve performance

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Driver monitoring – Future state

Driver safety awareness

CE trends

Interior Monitoring

New market for health services

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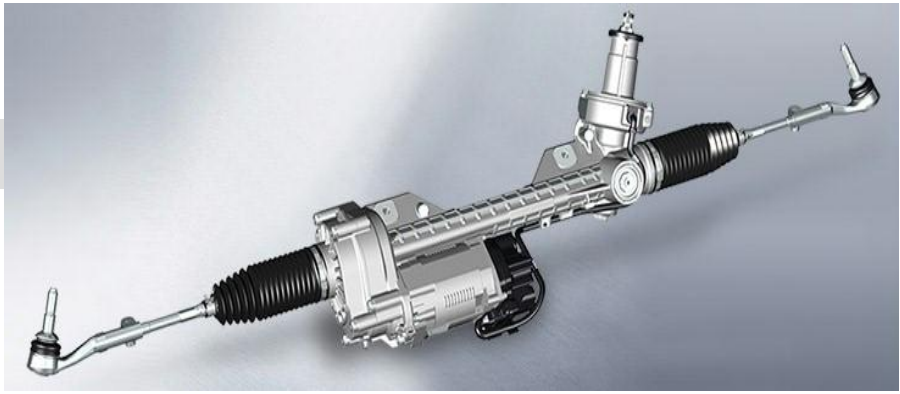
Steering angle signal Inputs

Electric Power Steering (EPS)



Steering Angle Sensor

➔ System offers flexibility in using inputs from two products available in the market

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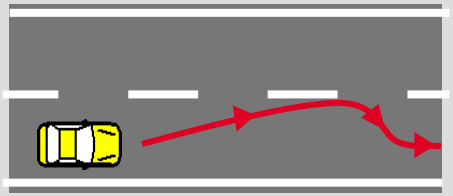
Operating principle

Detection of driver's reduced guidance ability



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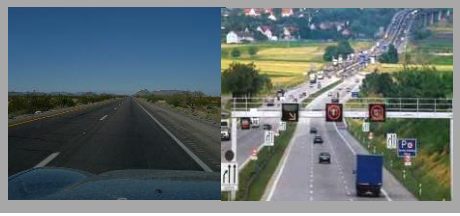
High precision steering angle sensor

Alternative

Electric Power Steering

Camera w/ Lane Data

Situational Context (Duration, Monotony)



Additional bus data:

Time, vehicle speed, turn indicator,…

Driver Drowsiness Detection algorithm

Drowsiness value

Warning (Audible and/or visual)

Adaption of driver assistance systems

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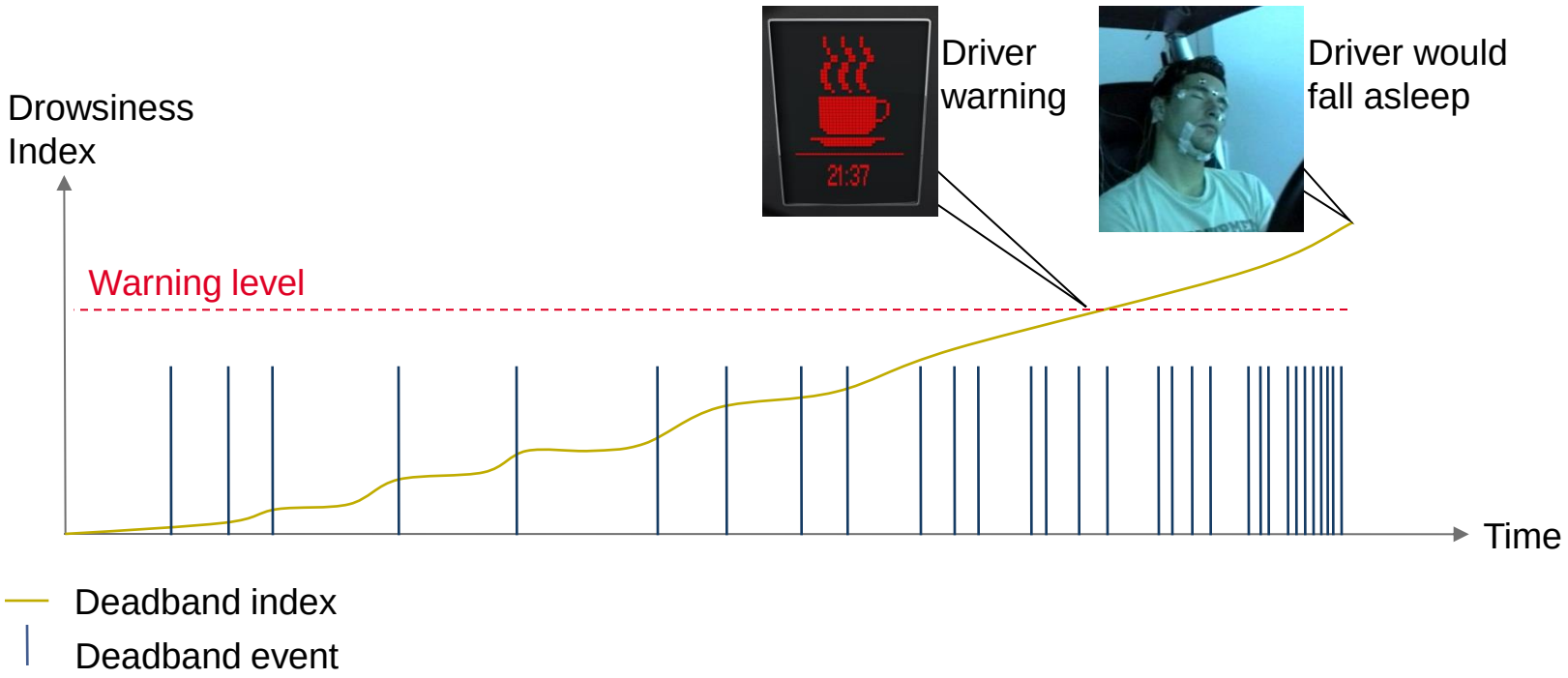
Detection of driver drowsiness



➔ 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