WORCS 2013
Toward vehicle automation
ADAS, the new challenges

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Innovative solutions must be provided to optimize the use of individual vehicles considering three criteria:
Safety (zero accident), Mobility (zero congestion), Weak environmental impact
Vehicle automation proposes a global answer to these challenges.

The Vehicle automation should result from a progressive evolution.

- Vehicle automation includes different steps which higher level is the Automated Road.

Control of the vehicle autonomously by ADAS; Driver can overrule Partly autonomous assistance in complex situations (ABV…)

Control of the vehicle by driver, manually & ADAS Intervening assistance in critical situations
  Driver can overrule (emergency break)

Control of the vehicle by driver, manually & ADAS information . Indicating assistance
  (Lane departure warning)

Control of the vehicle by driver, manually, No technical assistance

The Automotive Industry challenges
The Vehicle Automation

Vehicle automation should result from a progressive evolution.
The 4 Megatrends in the Automotive Industry
“Safe Mobility” and ADAS technologies

Doing more.
For safe mobility.

Doing more.
For clean power.

Doing more.
For intelligent driving.

Doing more.
For global mobility.
“Safe Mobility”: A global challenge...

>1,000,000 fatalities /

US Fatalities Per year <34,000

EU Fatalities Per year (000’s)

52 41 26 2010

Asia Fatalities: Increase of >20%
(source: WHO, 2009)
“Safe Mobility”: State of the art and the ambitions…

In OCDE countries, the road fatalities have been drastically reduced these last 10 years thanks to Education and Training, Awareness campaigns, repression and regulation, improved road infrastructure, technological solutions have contributed to this improvement.

Europe has the ambitious objective to continue these efforts dividing by two the number of fatalities on its roads within the next 10 years (from 34 000 to 17 000) focusing on inter vehicle accidents, accidents between vehicles and other road users (e.g. VRUs).

Focus will be on the integrated safety associating active, passive, post crash safety and interactivity between the vehicles, the infrastructure and the other road users.

Statistics demonstrate that driver's behaviors are the direct or indirect causes for nearly 90% of accidents.
Drivers’ behaviors are the major causes of road accidents

- Bad perception and/or bad knowledge of the driving environment
- Low training ("Sunday" drivers, young drivers, etc)
- Over/under working load
- Socio-economic pressure
- Reduced physiological state (drowsiness...)
- Reduced physical or psychological state (elderly, look but not see...), Driving errors due to distraction
- ...

Most of the experts agree that the progressive deployment of passive safety and now active safety systems and in particular ADAS, will efficiently help the driver and contribute to road accident reduction
"Safe Mobility"
From Passive and Active Safety Systems

ADAS Applications

- Information
- Pre-Crash Action
- Accident Prevention
- In-Crash Action
- Post Crash Action

ContiGuard® represents Continental’s Integrated Safety concept
The active safety systems

ADAS functions overview

Adaptive Cruise Control
Stop and go

Emergency Brake Assist
Autonomous emergency braking

Blind Spot Detection
Overtake checker

Lane Departure Warning
Lane keeping

Pedestrian & Crossing Traffic Detection

Emergency Brake Assist
Autonomous emergency braking

Blind Spot Detection
Overtake checker

Lane Departure Warning
Lane keeping

Pedestrian & Crossing Traffic Detection

Intelligent Headlamp Control

Traffic Sign Recognition

Long Range Radar
Environment Sensor 77GHz

Short Range Lidar Sensor

Short Range Radar Sensor 24GHz

Multi Functional Camera

Stereo Camera
The active safety systems

ADAS and vehicle automation challenges

Technical performances of ADAS technologies are very promising and are still improving

But

they are providing new challenges

Technical

Human factors

Legal issues

.....
ADAS and vehicle automation challenges

Technical and legal issues

**Technical issues**
- ✓ System and component reliability and integrity
- ✓ Inappropriate activation (false detection…)
- ✓ No activation (non detection…)
- ✓ Safe and low cost architecture
- ✓ ……

**Legal issues**
- ✓ Who is responsible in case of accident?

- ✓ Sensing performance improvement
- ✓ Multi source information – redundancy Camera+Lidar; Camera+ Radar, Stereo camera, for example obstacle detected by the radar and need confirmation from the camera before taking any action
- ✓ Parallel processing
- ✓ Detection of non operational situations, (camera blockage…)
- ✓ Internal diagnostic process
- ✓ Functional Safety (ASIL) Automotive Safety Integrity Level
- ✓ ……

- ✓ Vienna convention establishes that driver must always have the control of their vehicle
ADAS and vehicle automation challenges

Raising problems

Migration from a fully active driving to an assisted / autonomous driving rises new problems

- Trust
- Comprehension,
- Conscience of activated modes,
- Authority
- Situation awareness,
- Workload and capacity of attention especially during transition phases (Automatic to manual and vice versa),
- Acceptability and usability (older population, ...),

- Hand over command to driver if system can not deal with the situation
- Assist the driver or even take control if driver can not handle the situation
ADAS and vehicle automation challenges

The safety research trends and gaps

- Reliable and safe systems are mandatory

- Optimize interaction and task repartition between driver and ADAS as a "co-pilot" (Degrees of freedom…)

- Keep the driver appropriately in the loop (enhancing system acceptance)

- Integrate at the early stages of the system design safe and harmonized interactions with the driver:
  - Organization and prioritization of the information delivered to the drivers provided through unified human Machine Interface focusing on transparence and personalization.

- Continue the improvement of ADAS technologies

- New Human Machine Interaction concepts

- Achieve reliable and robust models and monitoring of the driver

- Multi modal interfaces
ADAS and vehicle automation challenges
The safety research trends and gaps

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Adaptive Human Machine Interaction

Objectives

A first Human Machine interaction concept

From a simple design process: “one function = one interface”.

To a global approach that allows considering the human dimension, driver situation, capacity, needs and requirements

It assumes that a good knowledge about the driver is available
Adaptive Human Machine Interaction
Requirements

- Provide the best assistance, to all drivers, adapted to the situation (driver state, environment)
- Create an emphatic relation between the system and the driver to encourage ADAS usage in a permanent way acting on the long term behavior (prevention)
- Increase ADAS acceptability (adhesion of drivers)
- Improve driver situation awareness in case of fault or impairment
- Configure assistance in relation with driver’s understanding, capacity, availability
- Take into account the individual wishes of the driver
- Autonomously decide when and how the driver has to be informed about the current issues.
Adaptive Human Machine Interaction
Concept

Driving performance
- Tailgating
- Speeding
- Lateral positioning

Risk assessment

Driver state assessment
- Drowsiness diagnostic (eyelid)
- Visual Time Sharing diagnostic
- Visual Distraction diagnostic
- Cognitive diagnostic (Phone)

Diagnostics

Driver models
- Driver situation assessment
- Driving style assessment

Driving behaviors

Decision Rule
Use cases

Main trigger

Driver state assessment

Driver Wishes

Adaptive ADAS Warnings
Adaptive Human Machine Interaction

Principles

The driver is informed or warned if he doesn’t drive in a safe way (makes faults)

The alert level depends on:
- His wish for assistance
- His driving style
- His driving behavior
- His level of attention
Driver state assessment

Driver Monitoring & modeling

Brick building approach to improve knowledge about the driver

Identification and real time extraction of pertinent parameters

Physiological Behavior

Breath, Hearth frequency
EEG/EOG

Driver attitudes
Head pose, Eye gaze, attitudes and postures

Driver vigilance
Self centered movements

Driver monitoring

Driver attention
Driver peripheral activity

Indirect diagnostic
Direct diagnostic

Driver postures

Visual distraction

Driver behavior
Driving situation assessment

Driving style
Gesture recognition

Biometry
Driver's face recognition

Vehicle behavior
Lane position, Car to car distance, Vehicle speed

Intrusiveness
Some Challenges

- Non-intrusive measurement set up
- Deal with complex and disturbed environment
- Drivers diversity and variability
- Drivers acceptance
- Realistic and reliable evaluation methodologies
- Real time processing
- Automotive constraints, cost size, robustness condition of use
Driver models
Evaluation of the driving style and behavior

- Speed + limit
- Inter-distance
- Lateral position
- Gas pedal
- RPM
- Brake pedal
- Steering angle

**Risk analysis**

**Engine use**

3 levels:
- Smooth
- Normal
- Aggressive
Driving performance
Assessment of risk indicator

- **Car speeding**
  - Speeding risk

- **Lateral Control**
  - Lateral control usual limits (statistics)
  - Lane position risk

- **Headway**
  - Tailgating risk

### Charts
- **Speeding Risk (Aide D231)**
  - Speeding percentage vs. speeding risk

- **Lane position Risk (Aide D2.3.1)**
  - Lane position vs. lane position risk

- Graph showing factors index vs. dangerous headway
Driver wishes
Principles

Driver "WISH"

Volunteer personalization
Assistance level

No Assistance
Silent care
Act to avoid crash

Low Assistance
Inform only on problems
Only critical warnings

“Normal” Assistance
display only abnormal errors
Soft warnings

High Assistance
Care for safety
Tight settings official rules
Maximum support (intrusive)

High+
Give some guidance towards engine and gear usage
Maximum support (intrusive)

ECONOMY

Driver support

(idea: non assisted ➔ assisted)

Each warning / information can be deactivated
DrivEasy
Vehicle implementation

C4 Car

DM DDS

Conti LDW

Lidar

ARS350

DM camera

CAN

CAN GPS interface

Router Pro

C4 display

Driver1

Driver2

Quad

VIDEO

Recording Video & sound

sound

Trunk

Control button

Vibrations

HMI

DrivEasy seat and pedal

DrivEasy PC

DrivEasy CAN

s Candle

spare

USB

Video & sound

VGA

HMI

Rear seat

Rear seat

Trunk

Trunk

ARS350

USB

DrivEasy CAN

Router Pro

CAN GPS interface

DM DDS

Conti LDW

Lidar

ARS350

DM camera

CAN

C4 Car
DrivEasy

Description of acceptability study

- Open road ➔ city + normal road + Highway portions

- Former presentation to explain the options to the user

- Free usual driving is asked for first part of the test without DrivEasy; then way back with DrivEasy

- Small number of people ➔ 15 tests

- Questionnaire at the beginning before driving, then after driving; each warning is quoted

- Recording of all parameters + quad video recording (further processing)

- Statistics on the questionnaires is the result of the study
Great efficiency for:
- headway reduction
- Over Speed reduction

In spite of a willingness to “push”
DrivEasy
Risk analysis

Benefit between 18 et 50% for 75% of tests
**DrivEasy Benefits**

**Without DrivEasy:**
- Each sensor / system generate warnings according to its own criteria

**With DrivEasy:**
- Usage of all sensors to make a decision “do we alert or not”? (according to situation)
- Warning adaptation (up to inhibition) when “at risk” situation occur
- Each driver may decide the assistance level (from zero to maximum support)
- Driver is informed of the risk without action on the vehicle, in a progressive way
- DrivEasy is aimed for long term driving behavior improvement
- Parameter settings is a compromise (neither too severe, nor too tight)
- Are people ready to accept a system which help them to be careful, to respect the law… (a comprehensive assistant)
Perspectives
The Vehicle Automation Perspectives

Improving road safety could be partly achieved thanks to the maximization of ADAS use and more and more automatic driving operations.

The vehicle automation deployment assumes many technical or non-technical issues to be considered:

- Increase ADAS functionalities and performances (new technologies, car to X…)
- Increase system and component reliability and integrity
- Highly reliable, standardized platform and safe architecture, for compositional development, sharing sensors, actuators and HMI, enabling the low cost development of complex driver assistance systems and applications
- Certification
The Vehicle Automation Perspectives

- Individual, industrial, public responsibilities
- Road infrastructures improvement and adaptation
- Improve the knowledge about the driver: driver modelling and monitoring
- Consider human factors
- Define new Human Machine interaction concepts and relations between the driver and the vehicle /system to encourage the driver to use the assistances
Driver Assistance 2025
360° predictive safety in all vehicle segments

“Safe Mobility”:
- ADAS should
  - Improve the perception of the environment
  - Inform/warn the driver of critical situations
  - Help the driver to take decisions
  - Substitute the Driver
“Regulation” is Driving the ADAS Market

AEBS
Advanced Emergency Braking System

FCW
Forward Collision Warning

LDW
Lane Departure Warning

BUA
Back-up Aid

BSD
Blind Spot Detection

AEBS/LDW
Mandatory for new Trucks >3,5t.

AEBS/LDW
Part of the NCAP Star-Rating

FCW/AEBS/LDW/BSD
Part of the NCAP Star-Rating

FCW/LDW
Availability need to be listed in the showroom

FCW/AEBS/LDW/BSD
Bonus Rating (Beyond NCAP)

BUA
Mandatory for SUV's & Van's

AEBS/LDW
Mandatory for cars (new types)


decided
(‘) possible extension
Future Market Growth Projection

Market push - New consumer ratings and expected regulations!

Worldwide Market Growth (Mrd. €) of Advanced Driver Assistance Systems

CAGR ('10-'20): 33%

* Market estimation of Continental

Market Definition: All comfort & safety vehicle control, driver warning and information systems applying surrounding sensors except short range distance monitoring systems based on ultrasonic sensors
FULLY AUTOMATED
- Monitoring of the system not required
- Driver does not need to be able to take over the driving task
Example: Highway driving up to 130 km/h

HIGHLY AUTOMATED
- Monitoring of the system not required
- Driver needs to be able to take over the driving task with lead time
Example: Stop-and-go (highway)

PARTIALLY AUTOMATED
- Monitoring of the system required
- Driver needs to be able to take over the driving task at any moment
Example: Stop-and-go up to 30 km/h
Thank you for your attention!

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