Perception platform and fusion modules results

Angelos Amditis - ICCS and Lali Ghosh - DEL

interactIVe final event

20th-21st November 2013

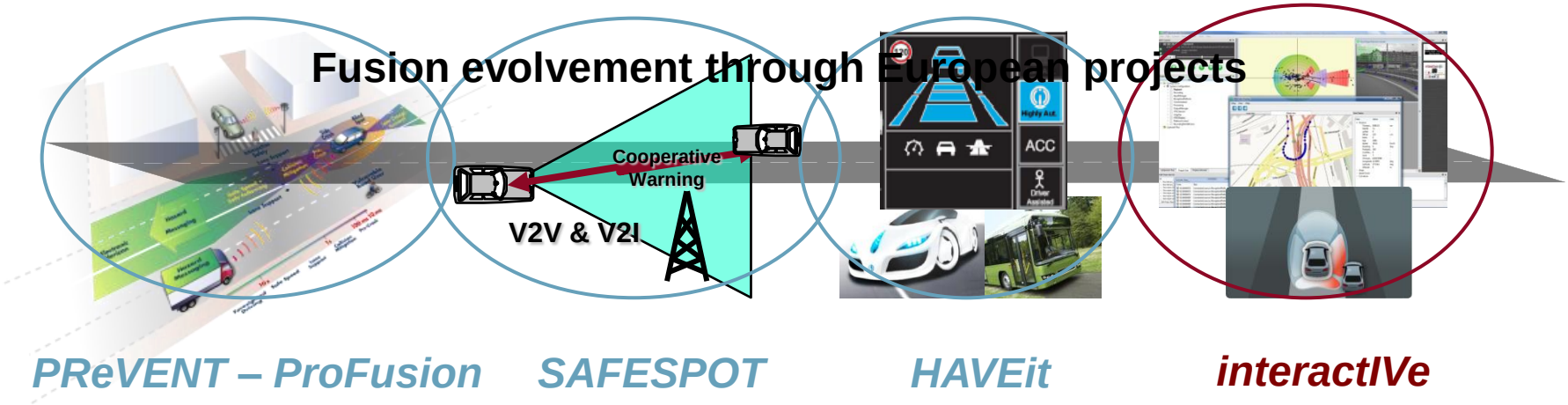
Agenda

- Introduction
  - Environment Perception in Intelligent Transport Systems
  - Environment Perception in interactIVe
- Perception Platform development
  - The concept
  - The modules
  - Results
- Future work
- Conclusions

Introduction (1/2)

- Stand alone sensors not sufficient (physical limitations)
- Multiple ADAS function in modern vehicles

- Fusion of information from heterogeneous sources **to provide a holistic environment perception** in an **integrated, adjustable** platform
  - Perception sensors: radars, cameras, laser scanners etc.
  - Digital maps
  - Wireless communication (V2X)

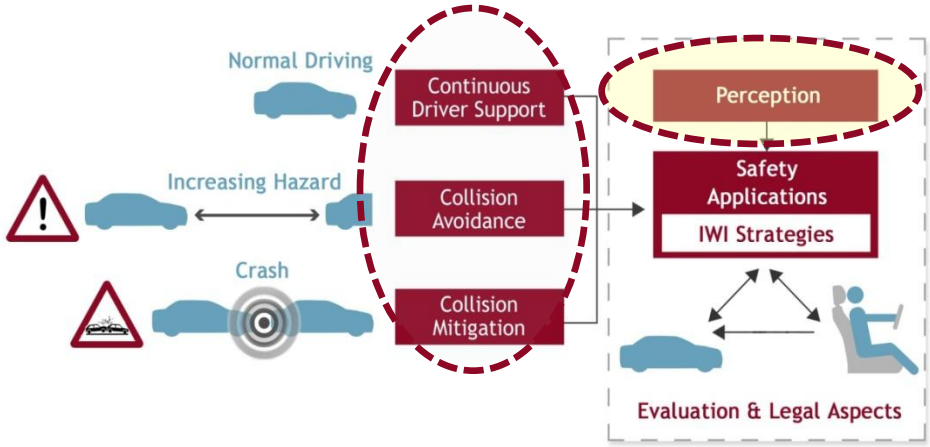


Introduction (2/2)

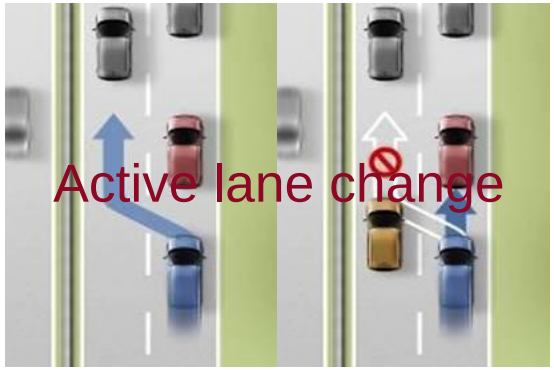
Current systems …

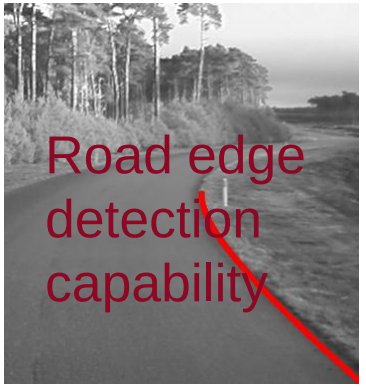
- independent functions
- multiple expensive sensors

→ unnecessary redundancy



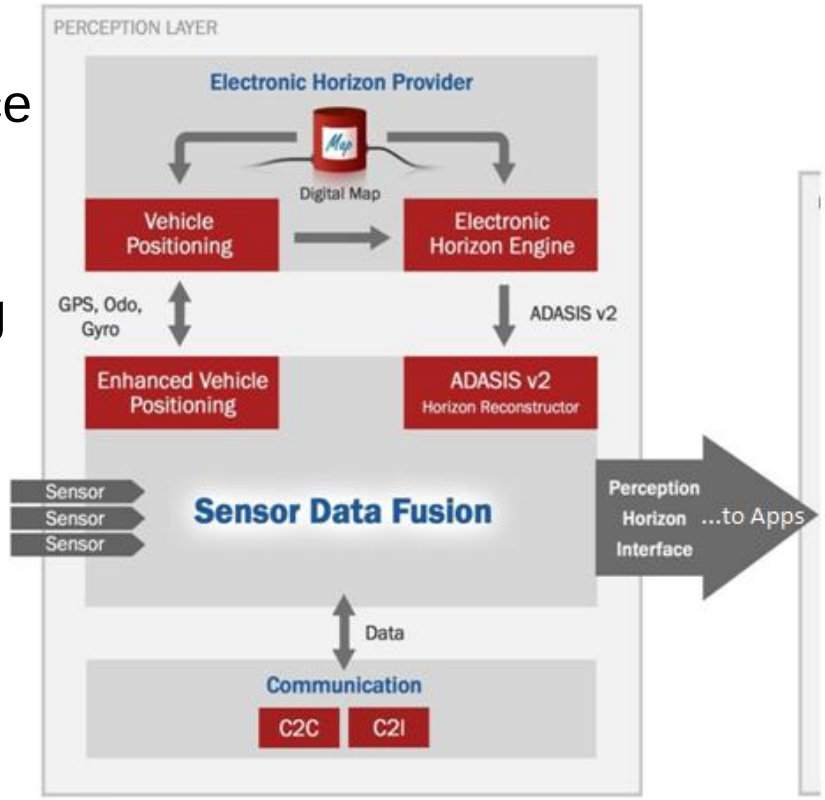
interactIVe challenges



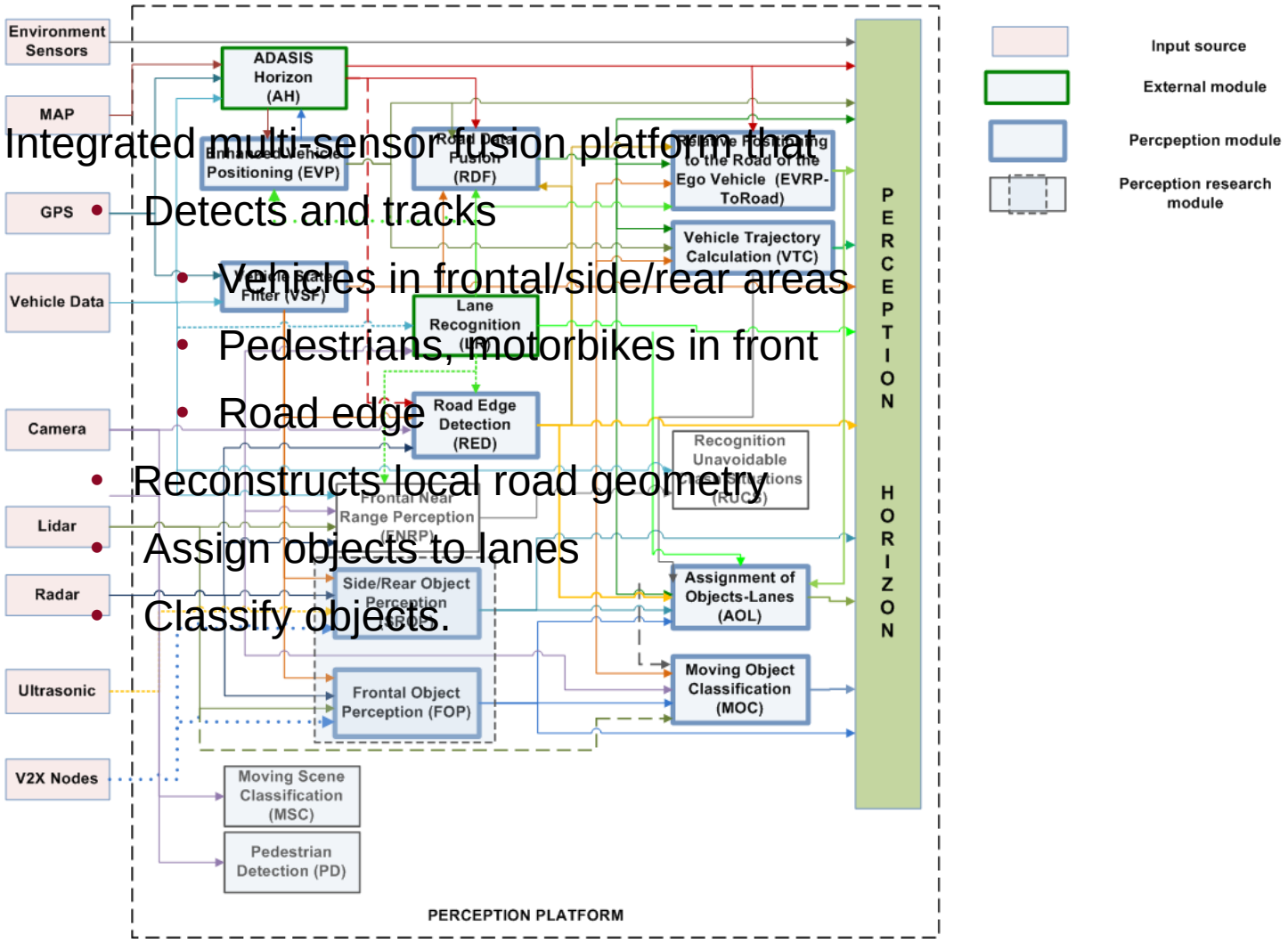


Perception platform | the concept

- One interface structure for each sensor type or information source *(plug-in concept)*
- Reference implementation using ADTF (Automotive Data and Time-Triggered *Framework*)
- Multiple perception modules
- Unified Output: Perception Horizon



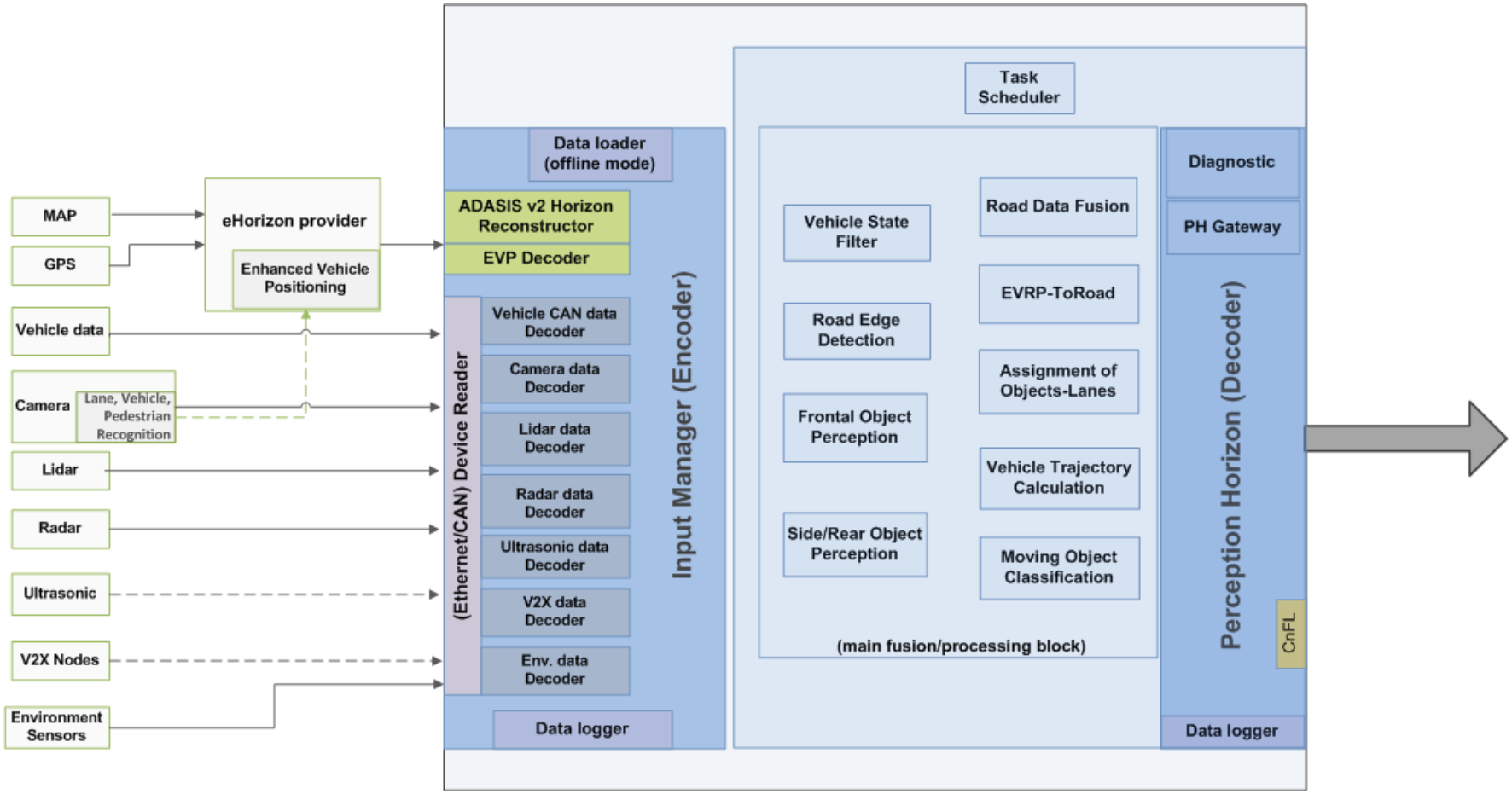
Perception platform | the functional architecture



Integrated multi-sensor fusion platform that:

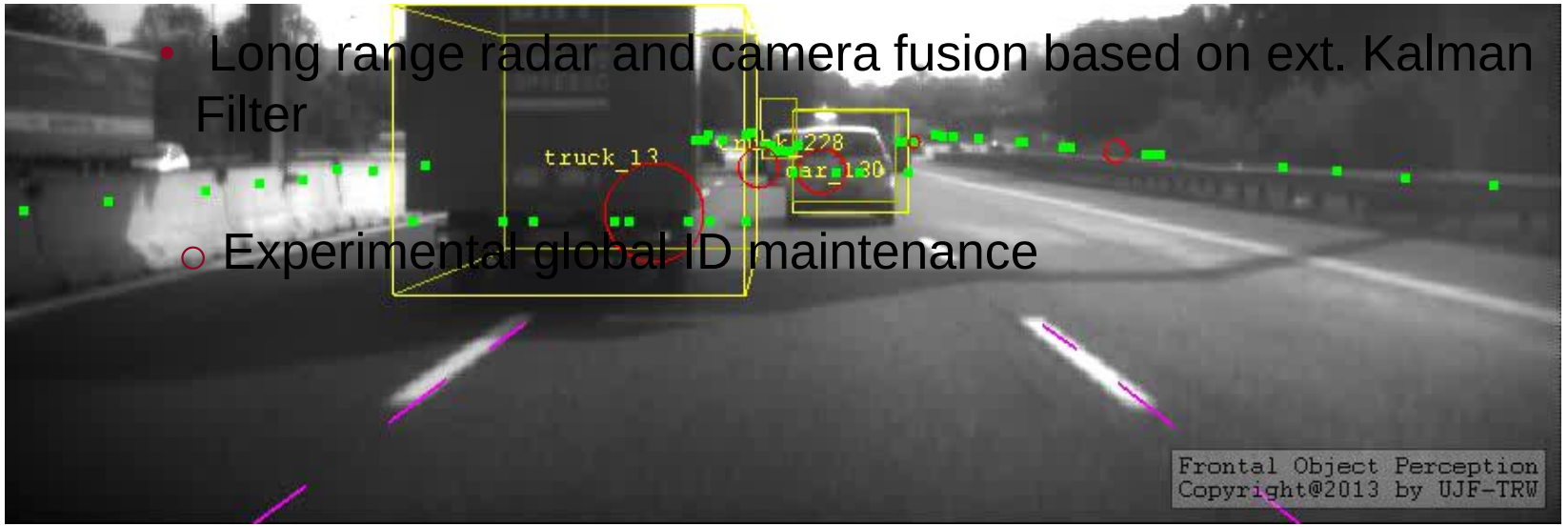
- Detects and tracks
  - Vehicles in frontal/side/rear areas
  - Pedestrians, motorbikes in front
  - Road edge
- Reconstructs local road geometry
- Assign objects to lanes
- Classify objects.

Perception platform | Physical architecture



Perception Platform | the modules results' highlights (1/4)

- Object detection, tracking and classification
  - Lidar, camera, radar fusion based on object-level belief network (incl. moving object classification)



- Long range radar and camera fusion based on ext. Kalman Filter
  - Experimental global ID maintenance

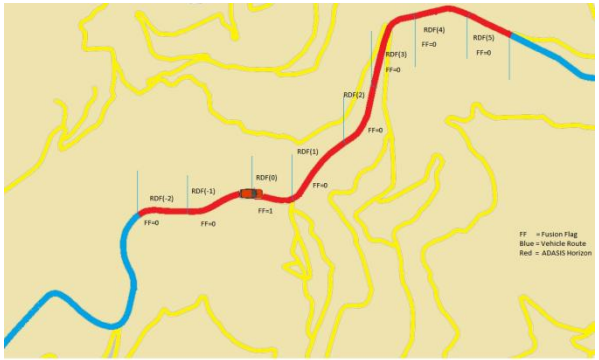
Perception Platform | the modules results' highlights (2/4)

- Road edge detection (RED)

(rural road example)

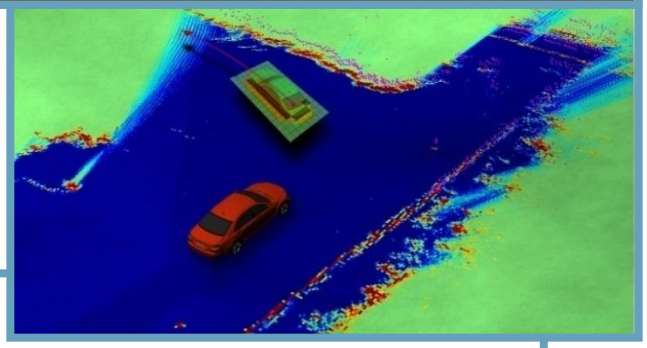
(no lane markings)

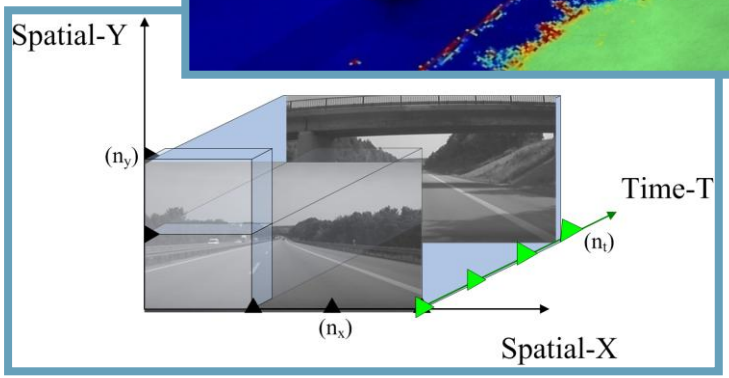
- Road geometry reconstruction
  - Fusion of LR camera, RED and dig. maps
  - Adaptive fuzzy system



Perception Platform | the modules results' highlights (3/4)

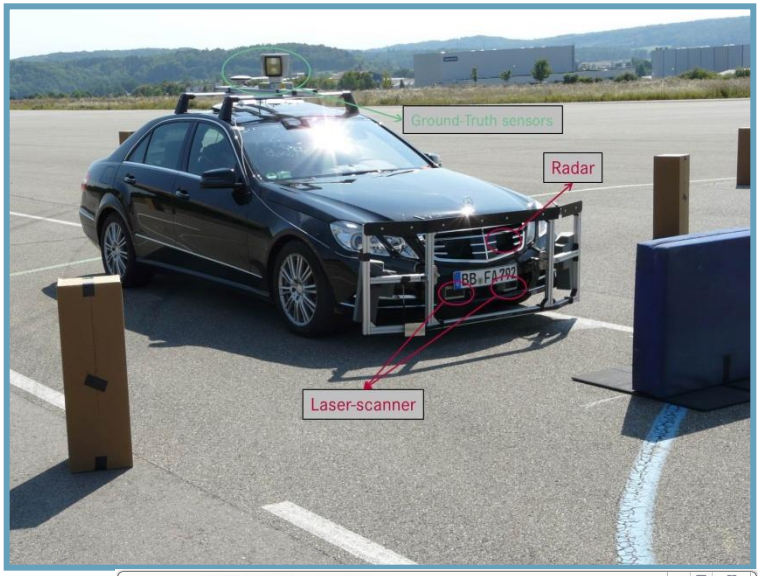
- Scene recognition/situation assessment
  - Vision based pedestrian detection (based on interest point detection)
  - Recognition of unavoidable crash situation and frontal near range perception
  - Video scene classification based on combined motion/visual vocabulary

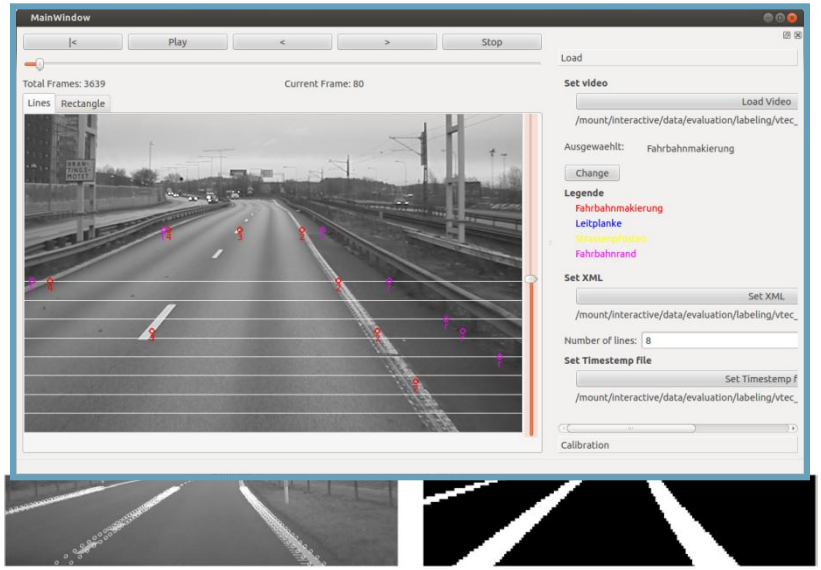


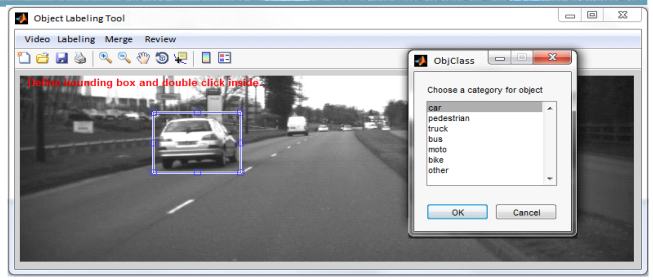


Perception Platform | the evaluation tools

- Tools developed specifically for evaluating Perception modules







- creation of reference data
- semi-automatic annotation tools

Future work

Multi-sensor platform

- Reduce object detection false alarms by filtering of non-moving targets
- Compare surrounding track id maintenance by using different sensor sets
- Exploit machine learning algorithms for real-time scene recognition
- Improve models for road boundary tracking
- V2X integration for collaborative perception

Accurate road geometry estimation

- **Arc spline-based** digital maps for vehicle self-localisation using landmarks

Evaluation of Perception system on the field

- While very good performance in dedicated test tracks, more false detections on real roads (complex scenarios)

Conclusions – Lessons learned (1/2)

(technical observations)

- Vision based object/scene recognition is very promising and has the advantage of low-cost sensor set-up

- Need for high precision road structure ground-truth data (incl. road boundary)

- Linux based OS are recommended for real-time integrated Perception systems
  (flexible multi threads handling/ 10-15 ms triggering delay)

→More information in the demo sessions in the exibition area and in the technical presentations

(…general observations → next slide)

Conclusions – Lessons learned (2/2)

- Generic sensor interfaces pave the way for a **plug & play concept** in sensor data fusion platforms.
- Need for dedicated **tools for** sensor and platform **data collection and synchronization, analysis** (e.g. using data mining tools) **and processing**
- Multi sensor fusion adds reliability in object tracking especially in urban complex scenarios
- High level object based fusion should be preferred over low-level fusion for time- critical applications

Acknowledgments

Perception team

Special Acknowledgments to interactIVe demonstrator teams for logging the vehicle/sensor data.

interactIVe

Accident avoidance by active intervention for Intelligent Vehicles

Thank you.

Co-funded and supported by the European Commission

SEVENTH FRAMEWORK PROGRAMME

Angelos Amditis
Research Director, ICCS
a.amditis@iccsgr
http://i-sense.iccs.ntua.gr/

Lali Ghosh
Advanced engineer manager,
Delphi Automotive systems
lali.ghosh@delphi.com

ICCS

DELPHI