20th ITS WORLD CONGRESS TOKYO 2013

interactIVe

Accident avoidance by active intervention for Intelligent Vehicles

SIS63-Building the Future-Advanced Integrated Safety Applications: **interactIVe Perception platform and fusion modules results**

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Environment Perception in ITS

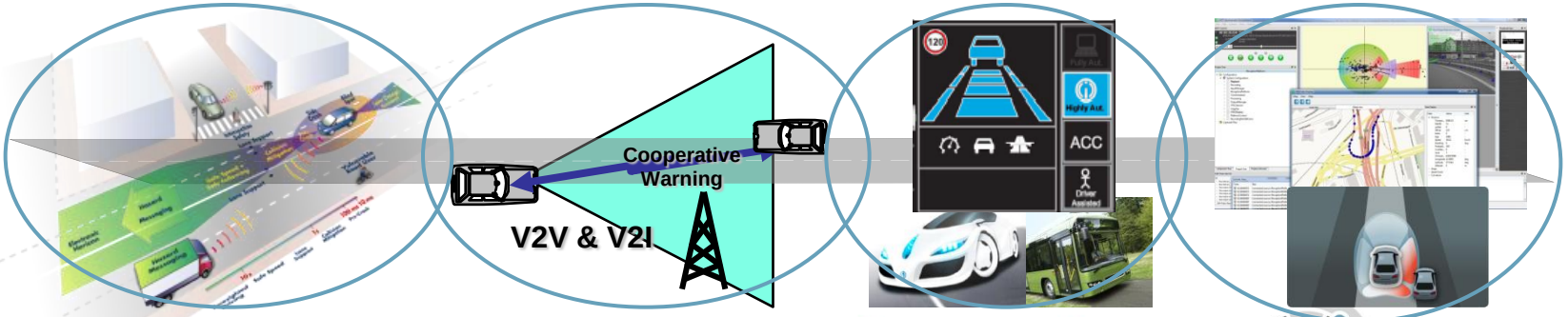
- Stand alone sensors not sufficient (physical limitations)
- Multiple ADAS function in modern cars

→Fusion of information from heterogeneous sources **to provide a holistic environment perception in an integrated adjustable platform**

  - Perception-related sensors: radars, cameras, laserscanners etc.
  - Digital maps
  - Wireless communication (V2X)

- Fusion evolvement through European projects

PReVENT (ProFusion) | **SAFESPOT** | **HAVEit** | **interactIVe**

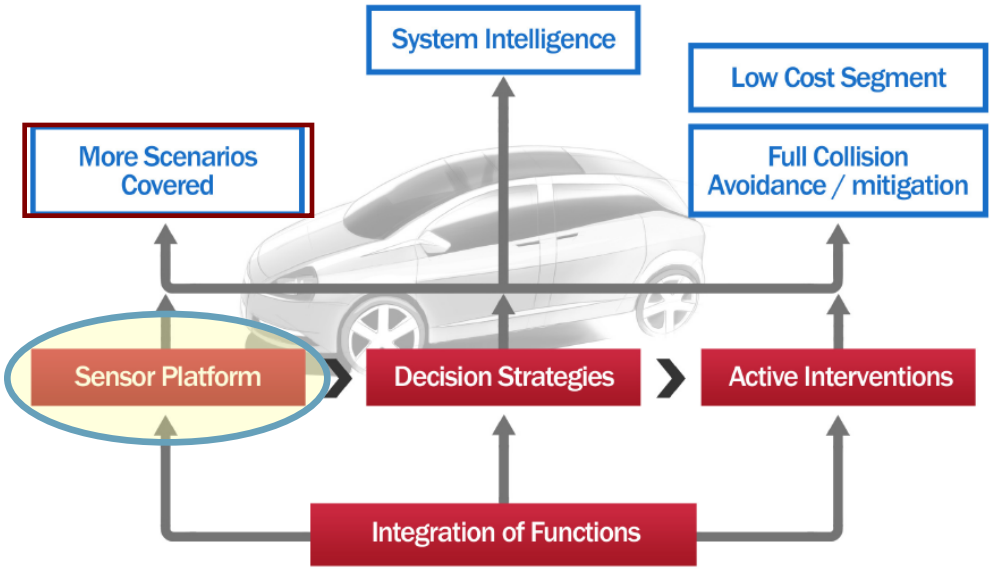


Environment Perception in interactIVe

Goal: *Development & evaluation of advanced Perception Modules (fusion and processing algorithms) that provide holistic driving environment perception for interactive continuous support and active intervention functions.*

Current systems:

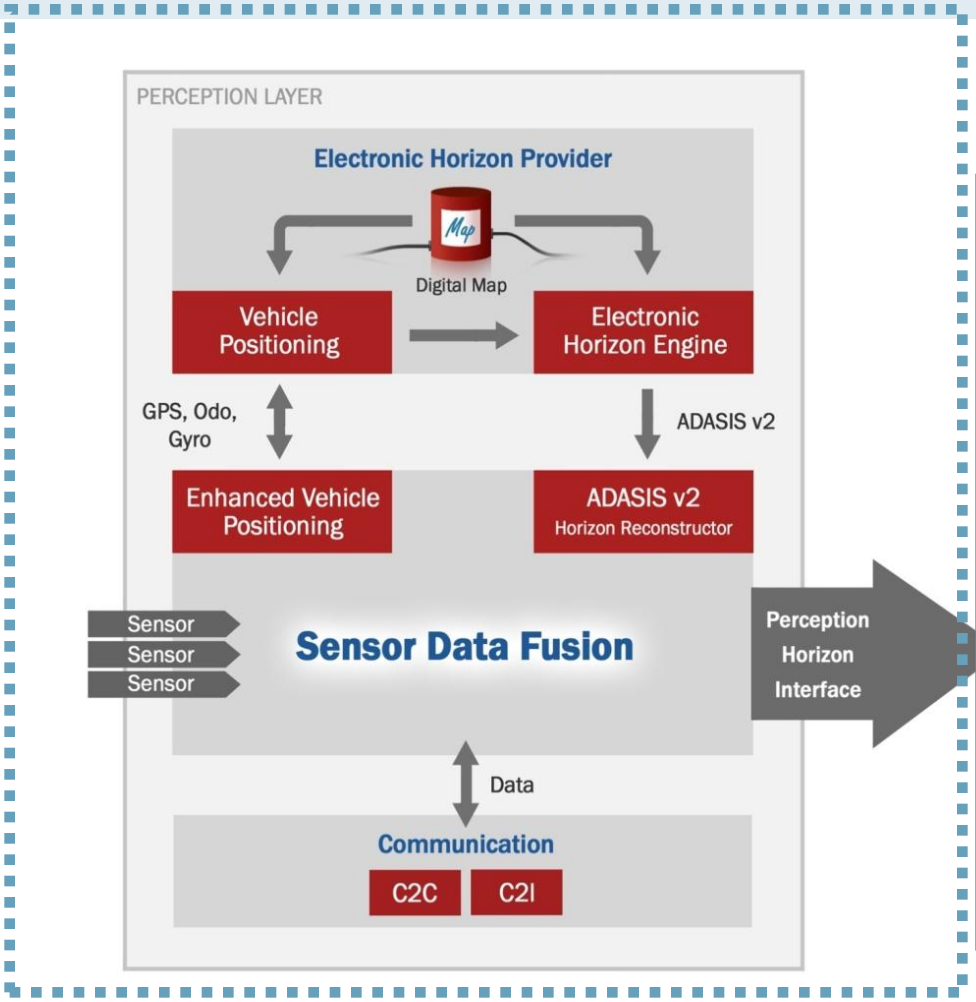
- independent functions
- multiple expensive sensors
- unnecessary redundancy



interactIVe Perception:

- vehicle components shared among various safety systems
- integrating applications upon a **common perception framework**
- discrete architectural layers common to all applications
- different fusion strategies based on various sensor sets in order to achieve close to real-time capability and also cover the low-cost segment scenario

Perception Layer in interactIVe

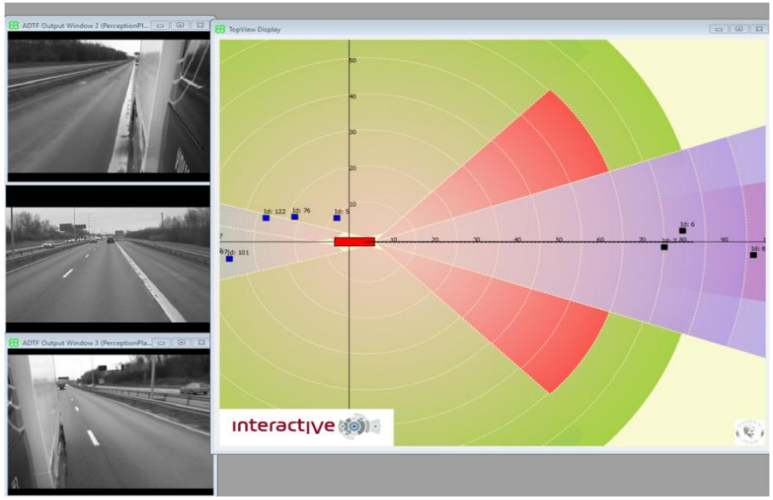


- Fusion of information from heterogeneous sources (sensors, maps, V2X)
- One Reference implementation for interactIVe demos
- Advanced research on enhancing the electronic safety zone surrounding the ego-vehicle

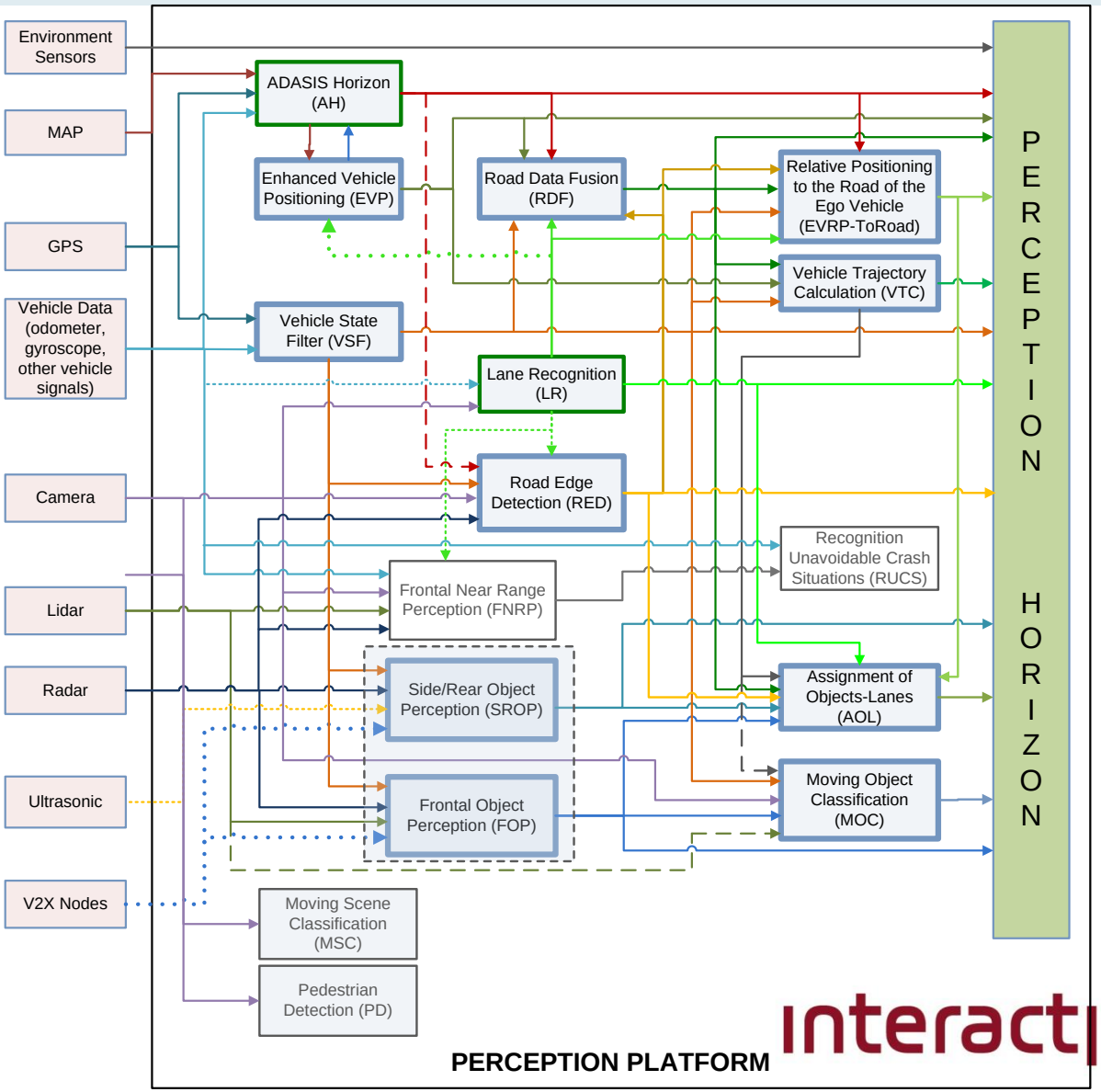
Perception Platform – Concept

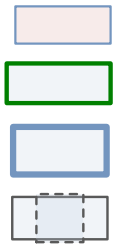
- Common *interface structure* for every sensor type or information source → Different sensor types and products attached based on the *plug-in concept*
- Reference implementation using ADTF (Automotive Data and Time-Triggered *Framework*)

- Development of a variety of *perception modules*, e.g.
  - object perception & classification
  - lane detection & road geometry extraction
- Unified Output: *Perception Horizon*



Perception Platform – Modules





Input source

External module

Percpeption module

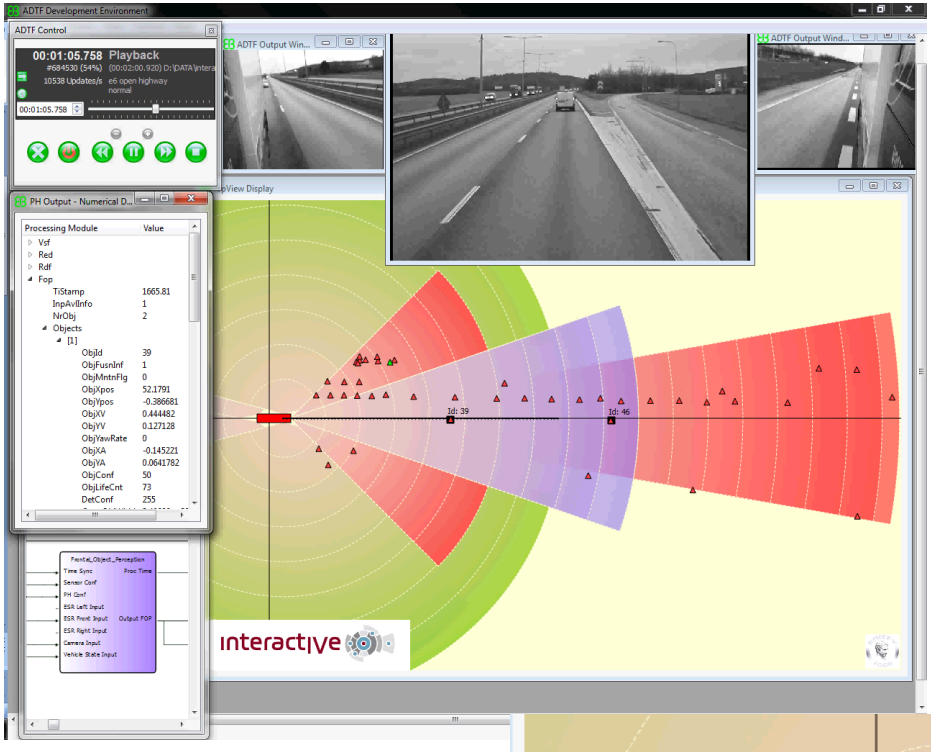
Perception research module

Perception Platform – Results (1/4)

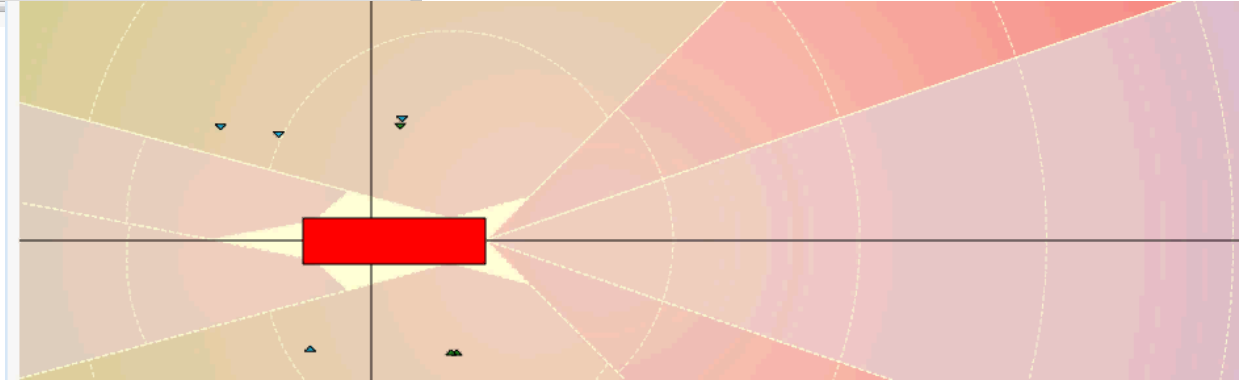
- Object detection, tracking and classification
  - Lidar, camera, radar fusion based on object-level belief network

…Object detection, tracking (continue)

- Long range radar and camera fusion based on ext. Kalman Filter
  - Frontal tracking



❍ Experimental global ID maintenance

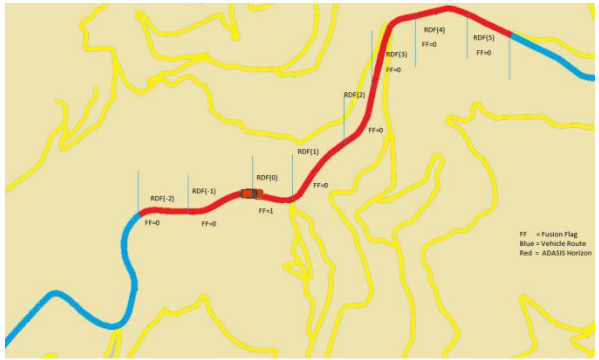


Perception Platform – Results (2/4)

- Road edge detection (RED)
  - rural road

  - no lane markings

- **Road geometry reconstruction** for several segments ahead and one segment behind based on lane rec camera, RED and dig maps. Based on adaptive fuzzy system (combined lateral + coeff domain)



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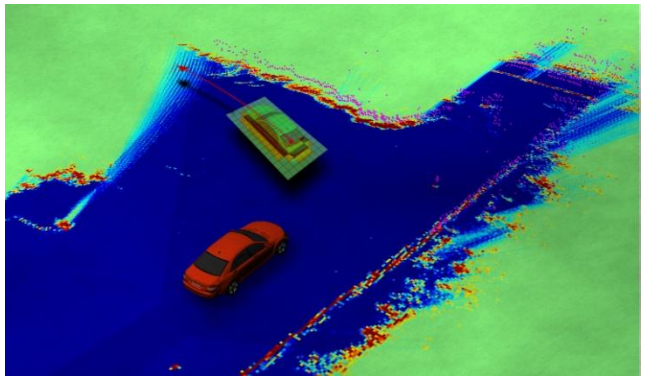
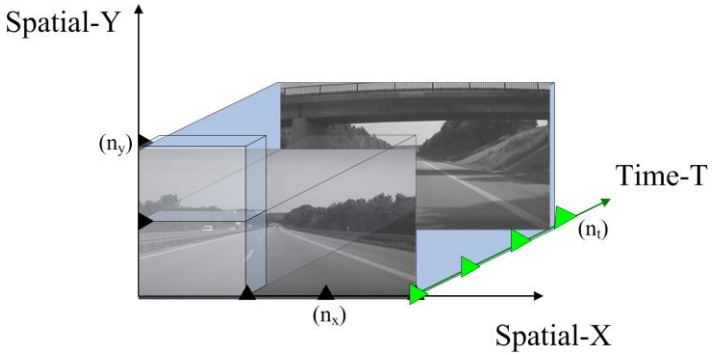
Perception Platform – Results (3/4)

- Scene recognition/situation assessment
  - Vision based pedestrian detection (based on interest point detection)



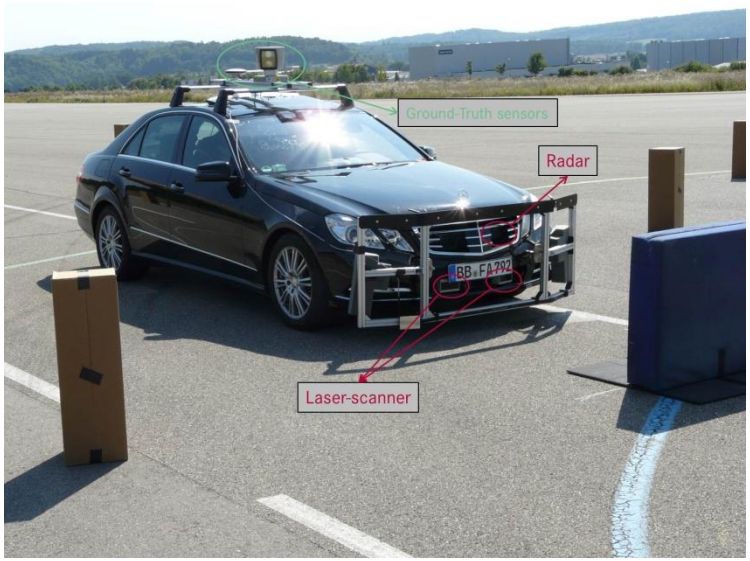
- Recognition of unavoidable crash situation and frontal near range perception

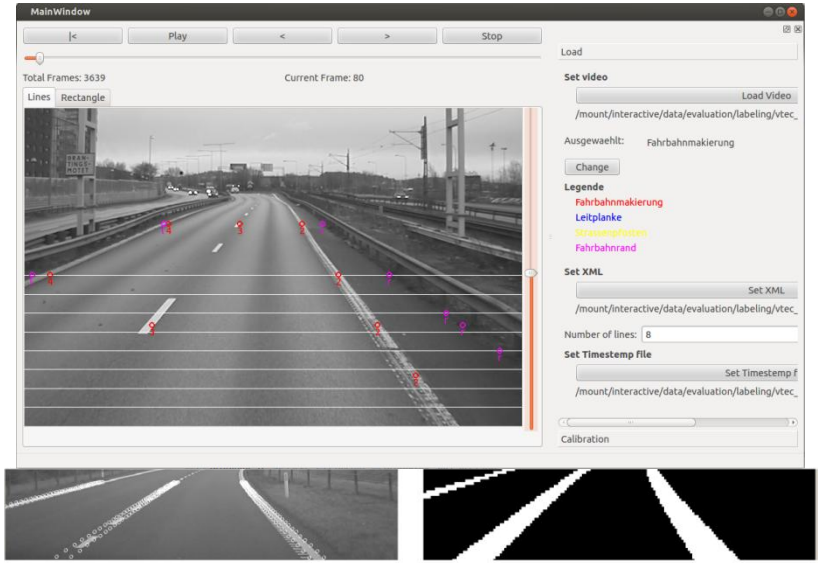
- Video scene classification based on combined motion/visual vocabulary

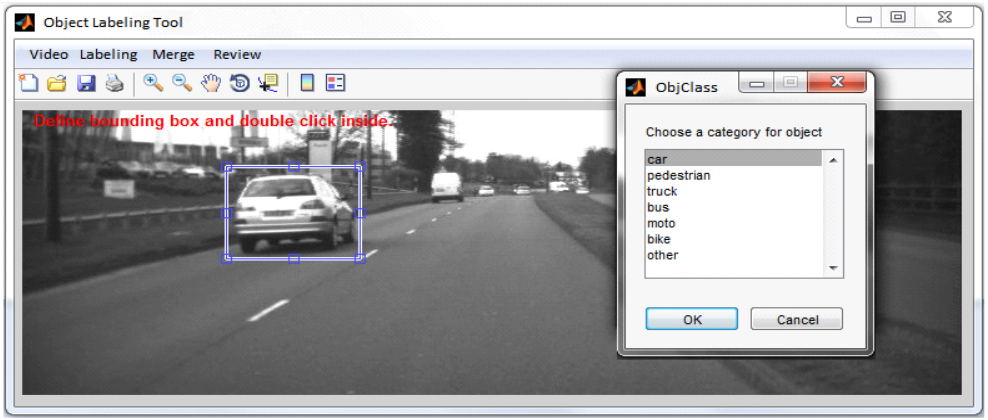


Perception Platform – Results (4/4)

Tools developed specifically for evaluation by interactIVe SP2







Perception Platform – Future work

✓*Multi-sensor platform*

Reliable real-time performance in complex urban environments is still under pursuit

- Reduce object detection false alarms by filtering of non-moving targets
- Surrounding object tracking for track ID maintenance
- Reliable road boundary detection for run-off road prevention
- V2X integration for collaborative perception and safety

✓*Path control algorithms (path prediction, situation assessment, driver intention)*

- Reliable road geometry estimation: Arc spline-based digital maps for vehicle self-localisation using landmarks
- Humanlike motor primitives (uniform motion assumption) to build optimal control systems for driver intentions identification and vehicle trajectory prediction;

✓*Evaluation of Perception system on the field*

- While very good performance in dedicated test tracks, more false detections on real roads (complex scenarios)
- Need for dedicated tools for data collection, synchronization and analysis (e.g. equipped vehicles, data mining techniques)

Conclusions – Lessons learned

- Avoid low-level time consuming processing with sophisticated sensors
    - High-level fusion based on reliable object-level information (especially valid for time-critical applications)
- Vision based object/scene recognition is promising and has the advantage of low-cost sensor set-up
- Surrounding Track ID maintenance can contribute in decreasing Rear-End Collisions (highest position in the GIDAS accident database)
- Fusion from multiple sensors especially in combination with cooperative systems is more suitable for complicated scenes
- Further investigation is needed in urban scenarios
- Need for high precision road boundary detection ground-truth data
- Linux based OS are recommended for real-time integrated Perception systems (flexible, real-time capable, multi-threads handling)

Acknowledgments

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Accident avoidance by active intervention for Intelligent Vehicles

Thank you. Questions?

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SEVENTH FRAMEWORK PROGRAMME

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