Automated Driving Applications and Technologies for Intelligent Vehicles

Sensing the vehicle environment

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- What is advanced perception?
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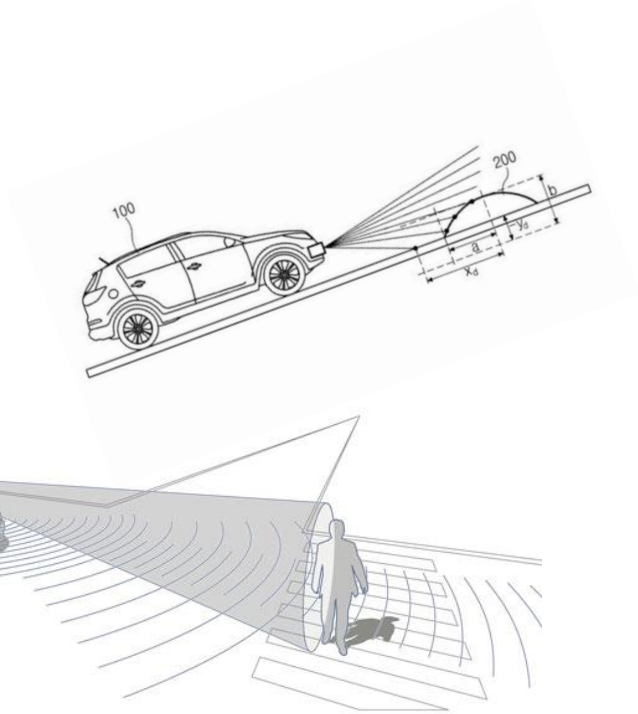


// Moving: (More than) sensing a dynamic environment

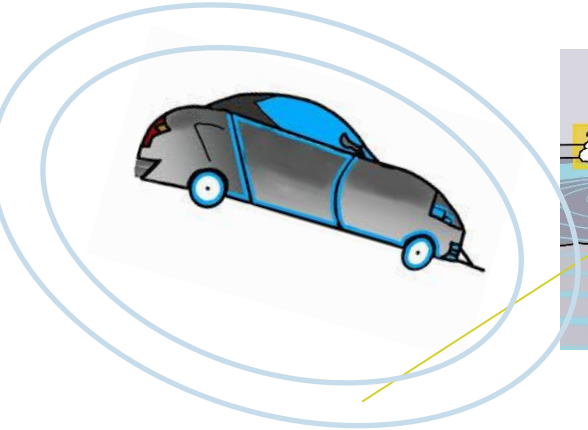


Image source: https://automated-driving.at/

Ego-vehicle localization

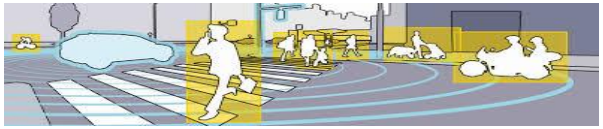
Road surface detection and classification

Pedestrian detection

On road object detection and classification

Lane line marking detection

// Advanced perception (1/3)



Robust ego-vehicle **positioning**

(myself)

Precision
High update rate

Static object **mapping**

(surrounding)

Online Mapping for spotting differences from apriori map

Robust moving obstacles **tracking and classification**

(the others)

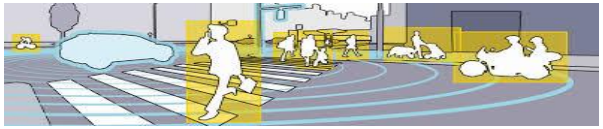
Minimize false positives, no false negatives

Scene actors' **action recognition**

(synthesis)

Infer context (other road users in the area of interest)

// Advanced perception (2/3)



Robust ego-vehicle **positioning**

(myself)

Static object **mapping**

(surrounding)

Robust moving obstacles **tracking**

(the others)

Scene actors' **action recognition**

(synthesis)

Fast and accurate GNSS updates

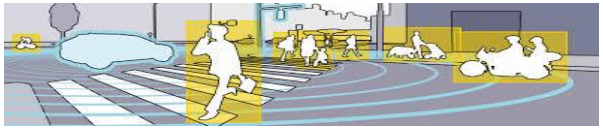
High resolution dynamic maps

✓ Parking static map

Seeing beyond sensor horizon

✓ V2X

// Advanced perception (3/3)



Robust ego-vehicle **positioning**

(myself)

Static object **mapping**

(surrounding)

Robust moving obstacles **tracking**

(the others)

Scene actors' **action recognition**

(synthesis)

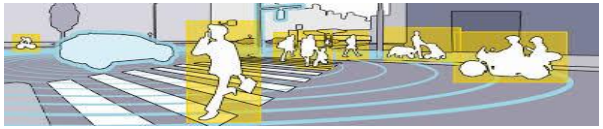
Fail-Safe perception mechanism to support high ASIL levels

✓

Real time processing

✓

//Challenges (high-level)



- Real world poses limitations to sensing (**bicycles**, **low reflectance objects**) (conditions bad for sensors: sunlight, snow, dust, potholes; the night)

- Detailed prior maps are rarely available and generating/updating them is laborious;
- Scene understanding and learning from training data cannot cover the novel situations (+environment is changing)

- V2X not standardized yet; Mixed traffic scenarios should be handled
- Balance between sophisticated processing and real-time requirements should be maintained

// Challenges as recorded from a camera mounted on a vehicle and a truck (VTEC courtesy)

// Perception hints per AdaptIVe case

0-30 km/h

- Low visibility
- High localization accuracy needed
- GNSS shortage

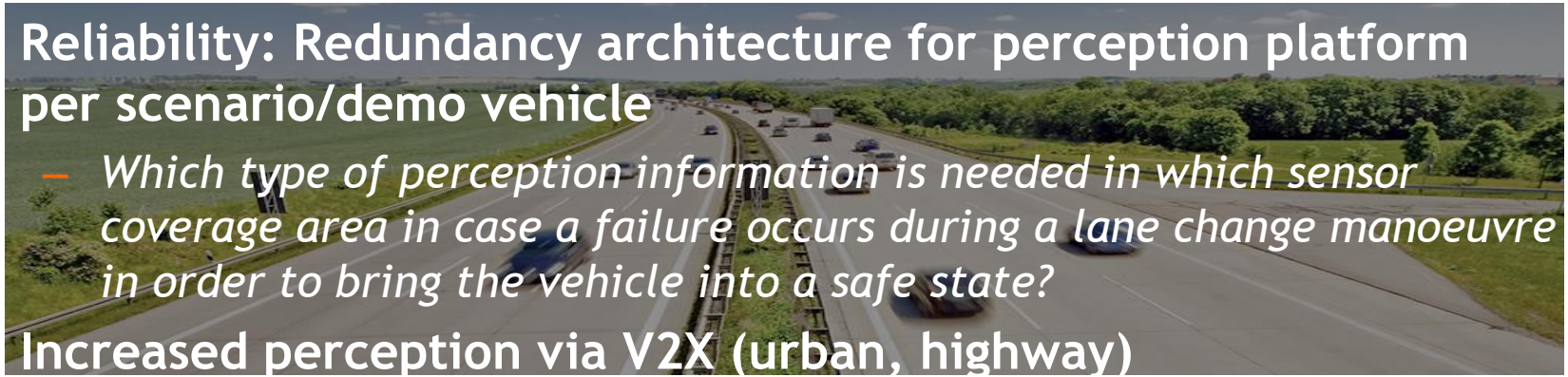
0-70 km/h

- Dense traffic (mixed)
- Several type of road users (incl. VRU, public transport)
- High complexity due to dynamic unstructured environment and occlusions
- Roundabouts, traffic lights, intersections

0-130 Km/h

- The traffic flow can vary from free flow to traffic jam (mixed)
- Cooperative automated driving using on-board sensors and digital map data; extensions to the existing V2V communication protocols
- Fully automated minimum risk manoeuvre, e.g. bring the vehicle to safe halt in a safe location e.g. emergency lane if available.

// Considerations



- **Reliability: Redundancy architecture for perception platform per scenario/demo vehicle**
  - *Which type of perception information is needed in which sensor coverage area in case a failure occurs during a lane change manoeuvre in order to bring the vehicle into a safe state?*
- **Increased perception via V2X (urban, highway)**
- Different methods + sensor set ups for close distance vs. urban/highway
  - new approaches are also studied, like simultaneous localisation and mapping (SLAM) and the enhancement of digital maps
- Cost efficiency: re-use sensors already in production vehicles

//Specific features

0-30 km/h

0-70 km/h

0-130 Km/h

Fail-tolerant perception platform

- SLAM technique to cope with GNSS restricted environment
- A priori map information by blueprints digitalization (OSM format extended)
- Map helps filtering out erroneous sensor detection e.g. on inclined ramps

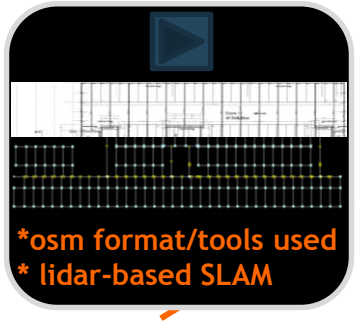
V2X

- Intersections handling (V2V)
- Traffic light detection (+colour)
- VRU detection
- "Cooperative" perception for merging in highways entrances with lane change and speed adaptation
- Multimodal lane perception

//Snapshot from

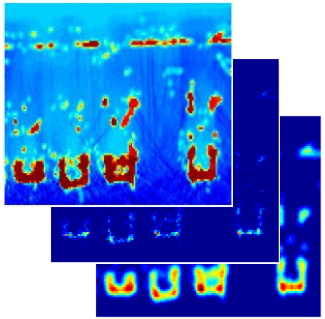
0-30
km/h

Ground truth
detailed map

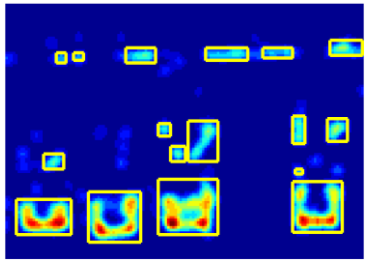


(lidar)

Custom radar-based Grid Maps

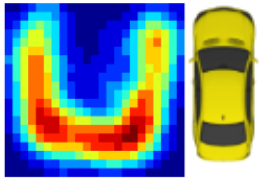


Clustering



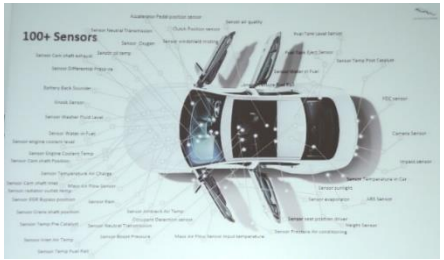
(long range radar, short range radar)

Classification

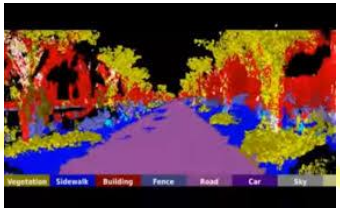


Cognitive-Mapping

// Beyond AdaptIVe (1/2)



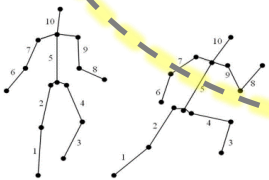
Sensor Data fusion | Object Tracking

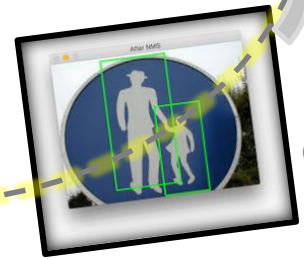


Represent better
(fusion, segmentation, mapping)

Linked data and semantics

Predict road actors' actions
(time series data analysis)





Understand learnt categories (ML)

// Beyond AdaptIVe (2/2)

- While how much data needs to be collected is still an open question…
  - Better sensors coupled with better learning and prediction are expected (actions against sensor spoofing)
  - Holistic map/traffic/transport consideration: a multi actor cooperative game – towards ATS
  - Redundancy from design is always needed (AdaptIVe proved this can be cost-efficient too)

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the European Union

Adapt/:/Ve

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Thank you.

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