

INTER SAFE2

On-board Perception for Intersection Safety

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SICK
Sensor Intelligence.

BMW Group
Research and Technology



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SEVENTH FRAMEWORK
PROGRAMME



European
Commission

TRW

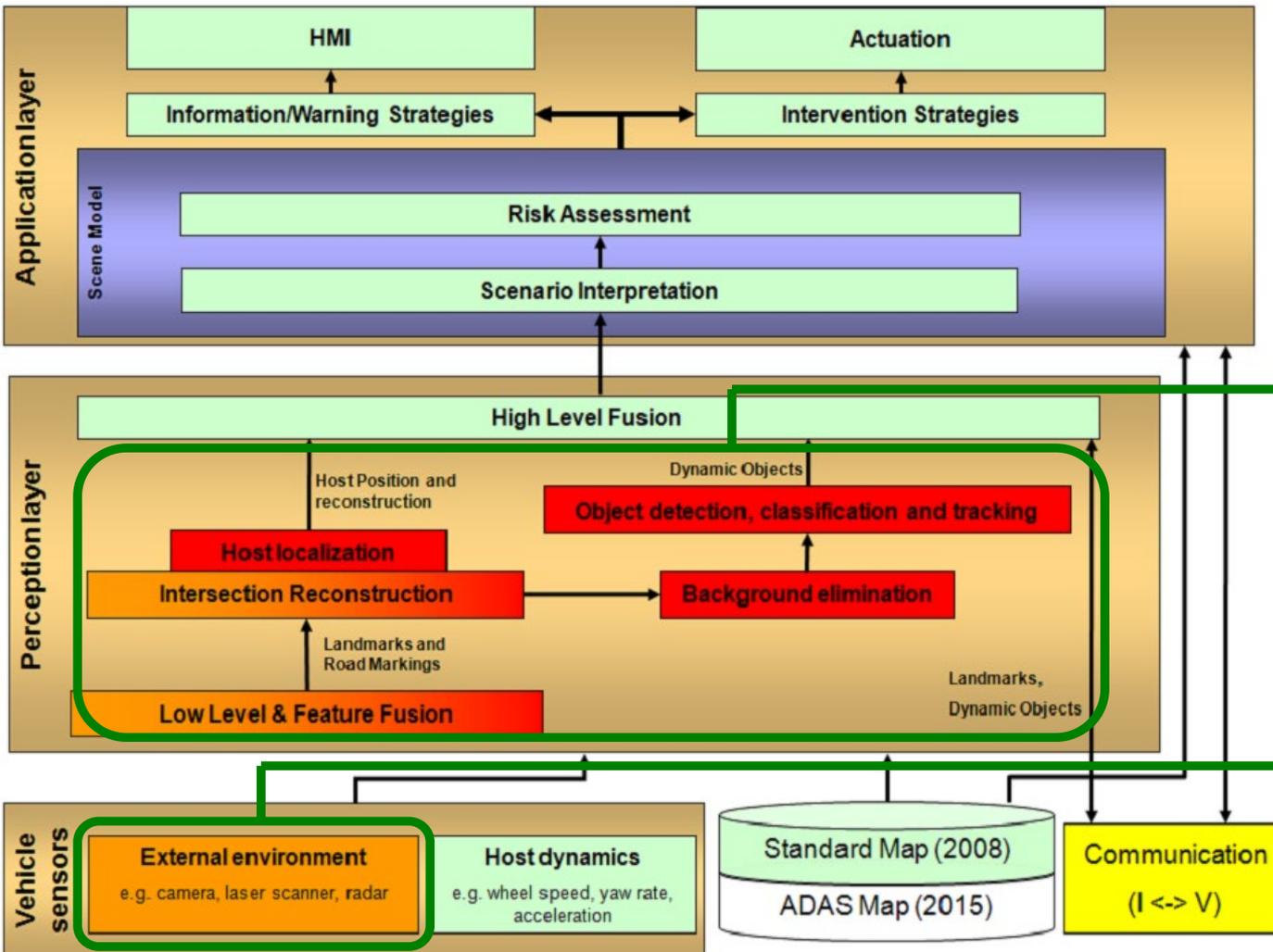
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VOLVO

VTT

VOLKSWAGEN
AKTIENGESELLSCHAFT

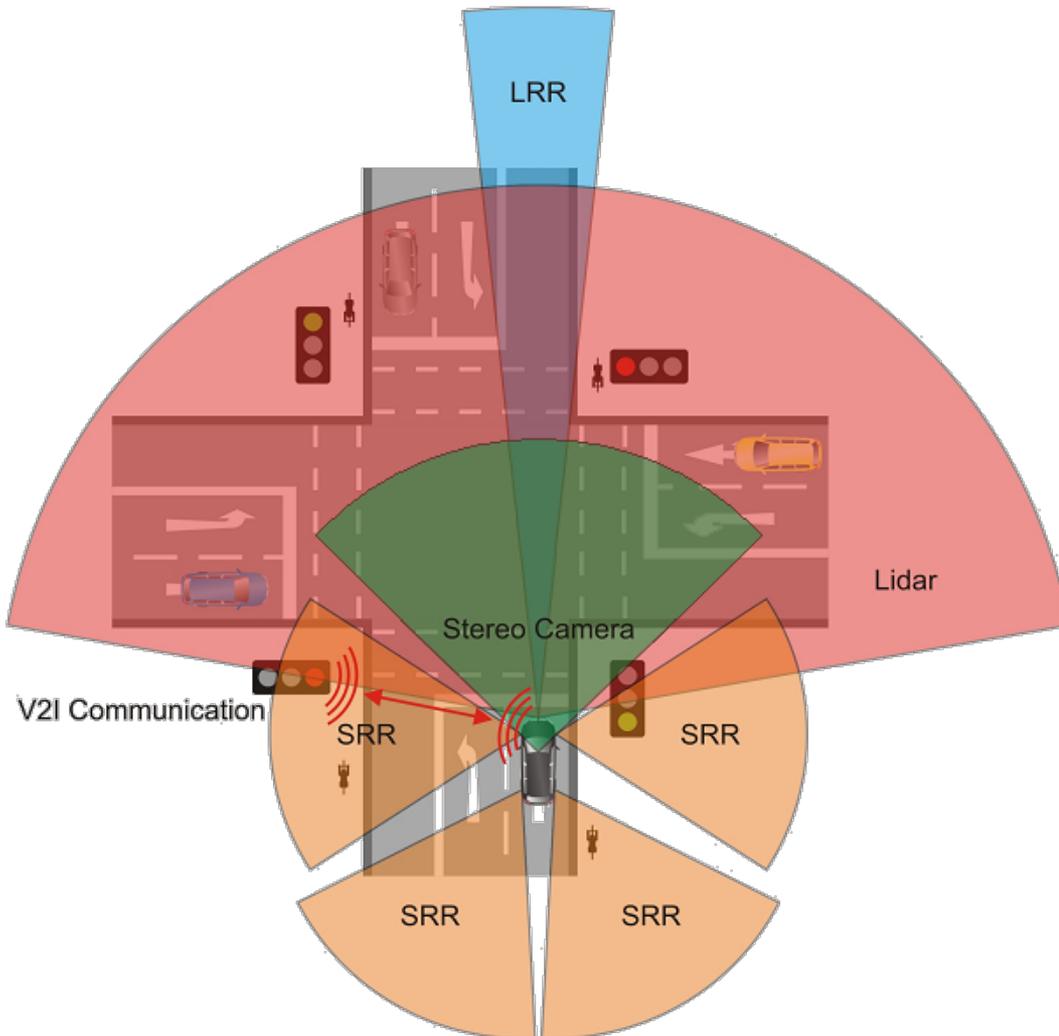


Low Level Perception layer:

- Localization of host vehicle within the intersection
- Detection, classification and tracking of obstacles
- Road Markings Detection, Lane Detection

Vehicle Sensors:

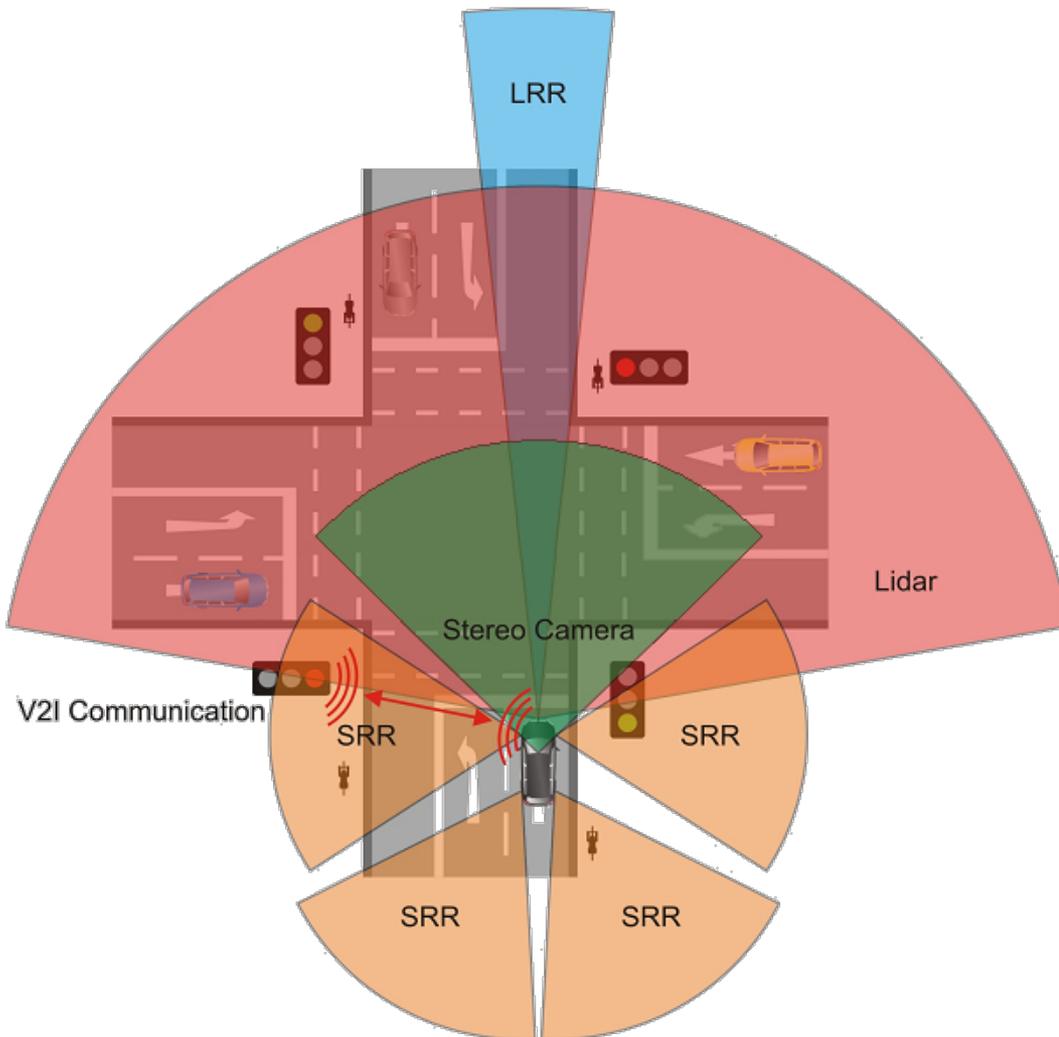
Synchronized Camera Pair,
Laser scanner



Stereo Camera

- Medium range sensor
- High density, medium accuracy 3D information
- Sensing of road and obstacle features





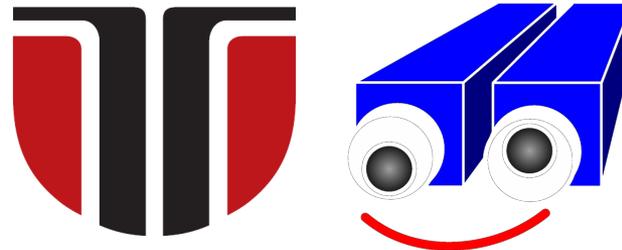
Lidar

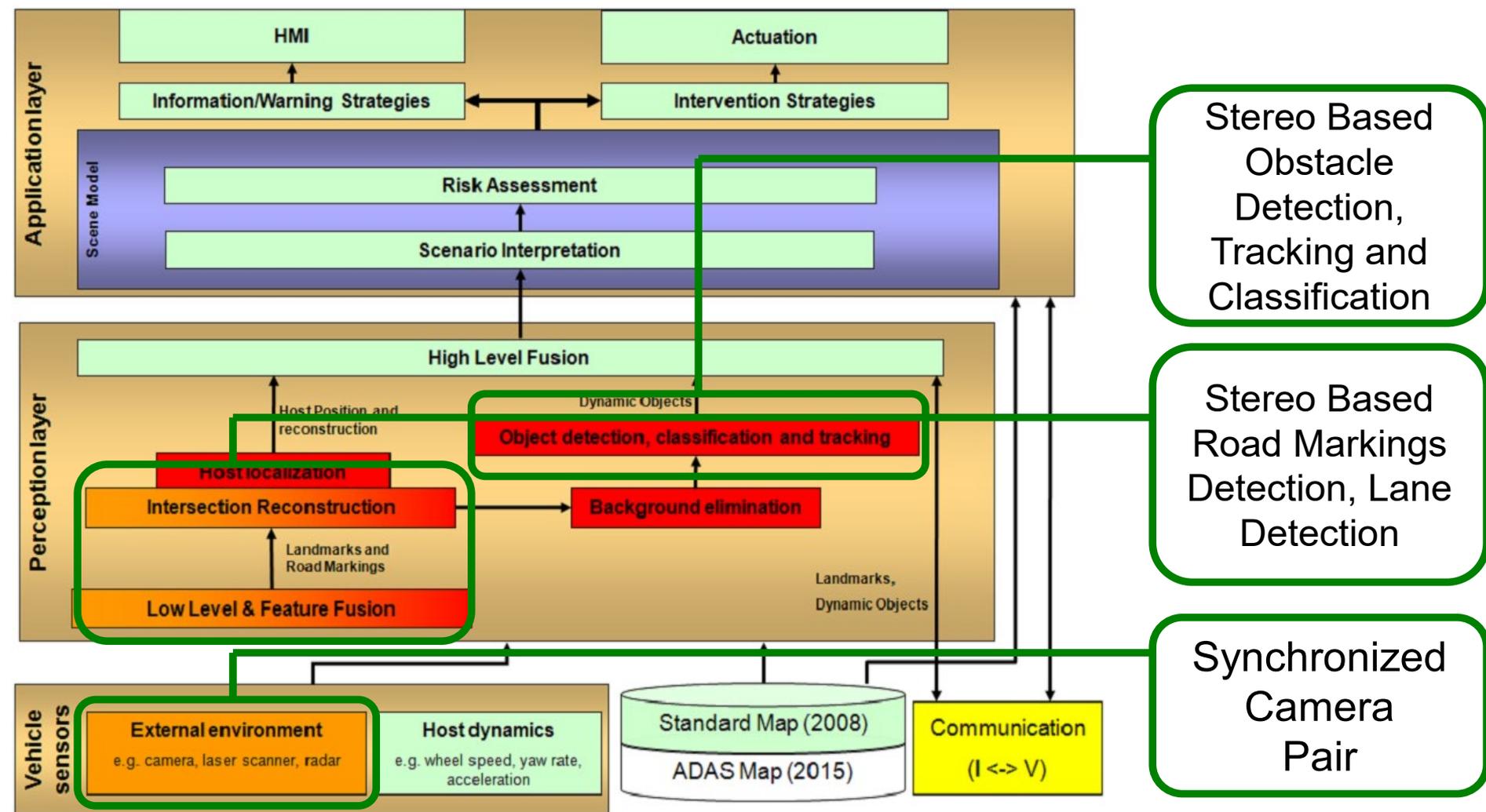
- Long range sensor
- High accuracy 3D information
- Sensing, tracking and classification of obstacles
- Intersection reconstruction



Perception through Stereovision

Technical University of Cluj-Napoca

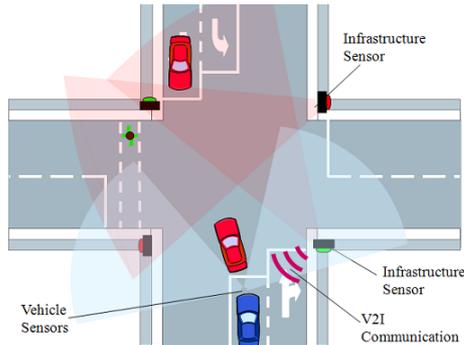




Requirements for the Stereo Sensor



1. Detect the presence and measure the relative position and velocity of the oncoming vehicles.
2. Detect the presence of the crossing vehicles and crossing vulnerable road users and measure their position and velocity relative to the host vehicle.
3. Locate the host vehicle within the intersection.
4. Detect road markings and lane boundaries in front of the host vehicle and measure their relative position to the host vehicle.
5. Localize the host vehicle when it is close to the stop line.
6. Detect painted road signs in front of the host vehicle and measure their relative position to the host.





Stereo Camera Setup

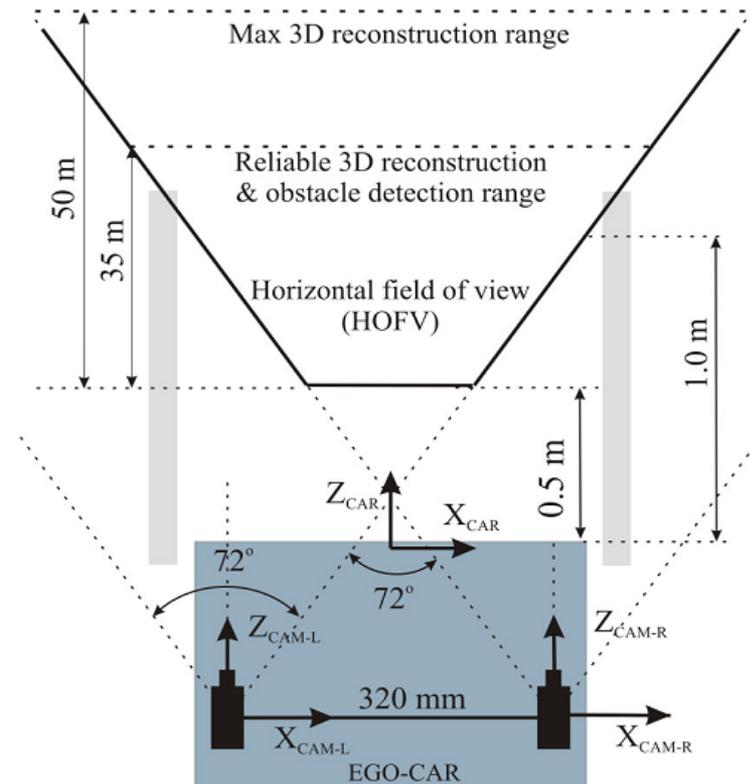


Specifications

- Focal length: 6.5 mm
- Imager size: 2/3"
- Digital image size: 1380x1030
- Baseline: 320 mm

Capabilities

- HFOV: 72 degrees
- Frame rate: 20 Hz





Stereo Image Acquisition

Specifications

- Synchronized image pair acquisition using a dual port CameraLink framegrabber.

Capabilities

- Image acquisition from multiple camera setups
- Adaptation to lighting conditions
- Real-time image rectification and downsampling





Dense Stereo Reconstruction and Dense Optical Flow Computation

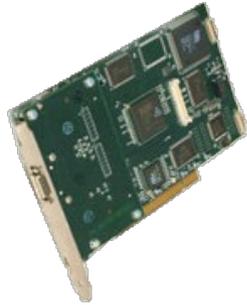
Specifications

- Real-time stereo reconstruction using a dedicated TYZX board
- Real-time stereo reconstruction using original algorithms
- Real-time computation of optical flow

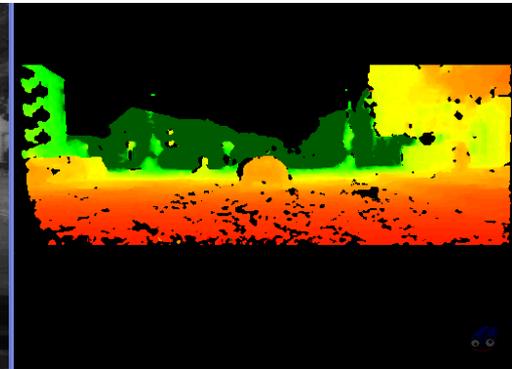
Capabilities

- Range: 0.5 – 50 m
- Frame rate: 20 Hz (limited by camera speed)
- Maximum error: 3% from depth





Dense Stereo Reconstruction and Dense Optical Flow Computation



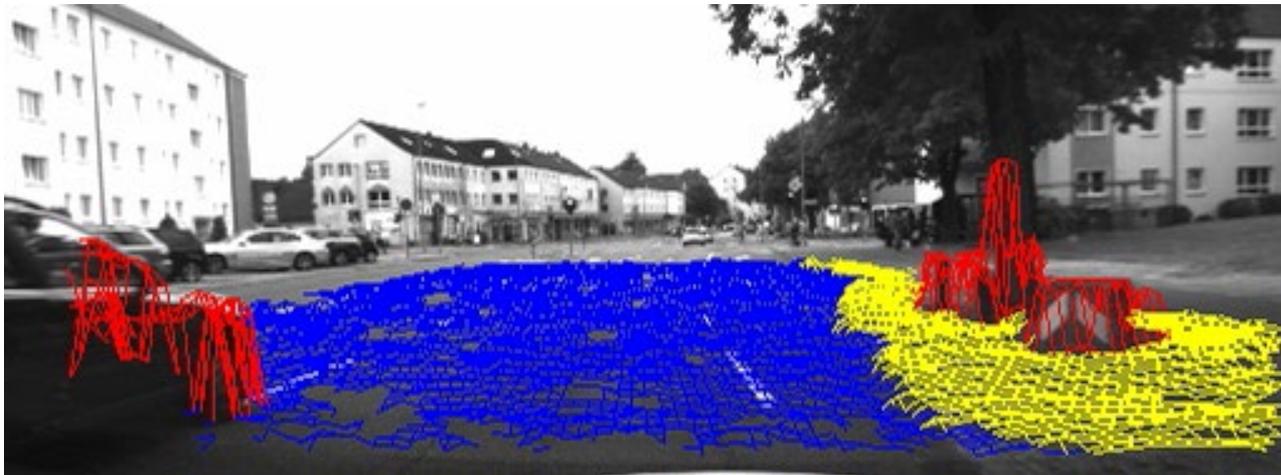
Higher Level Functions

- Environment perception by the use of digital elevation maps.
- Current and side lanes detection and tracking.
- Road painted signs detection, localization and classification.
- Obstacle detection and tracking.
- Classification of relevant obstacles.

Environment Perception Using Elevation Maps

Specifications

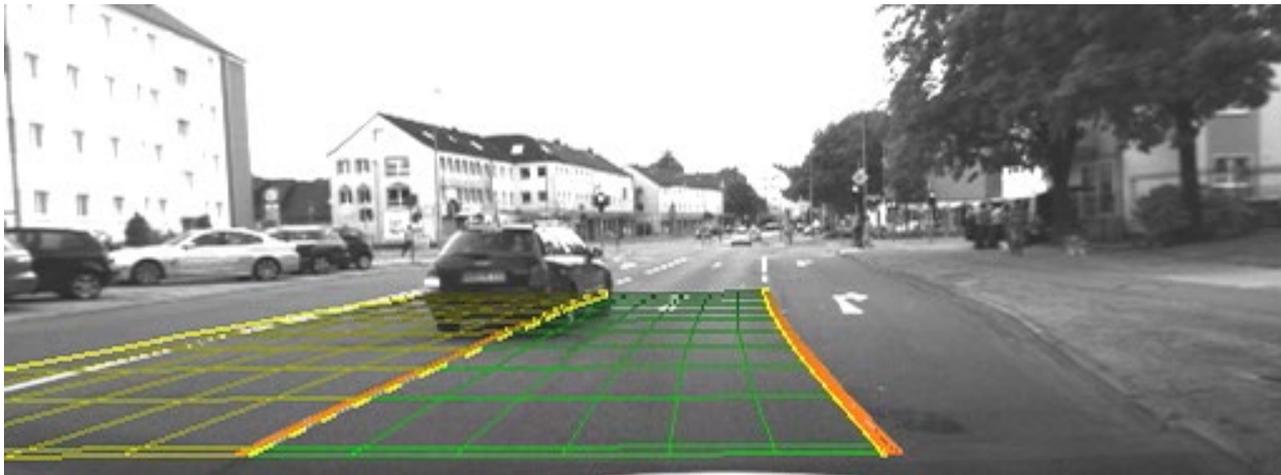
- Cell size: 10 cm x 10 cm
- Grid size: 240 x 500 cells
- Scene covered: 24 m x 50 m
- Height (elevation) computed for each cell
- Class for each cell (road, obstacle, sidewalk)



Lane Detection and Tracking

Specifications

- Lane width: 2 – 5 m
- Vehicle pitching: $\pm 2^\circ$
- Curvature radius: 50 m - infinity
- Range: 3 – 40 m
- Minimum visible road required for detection: 5 m



Road Painted Signs Detection, Localization and Classification

Specifications

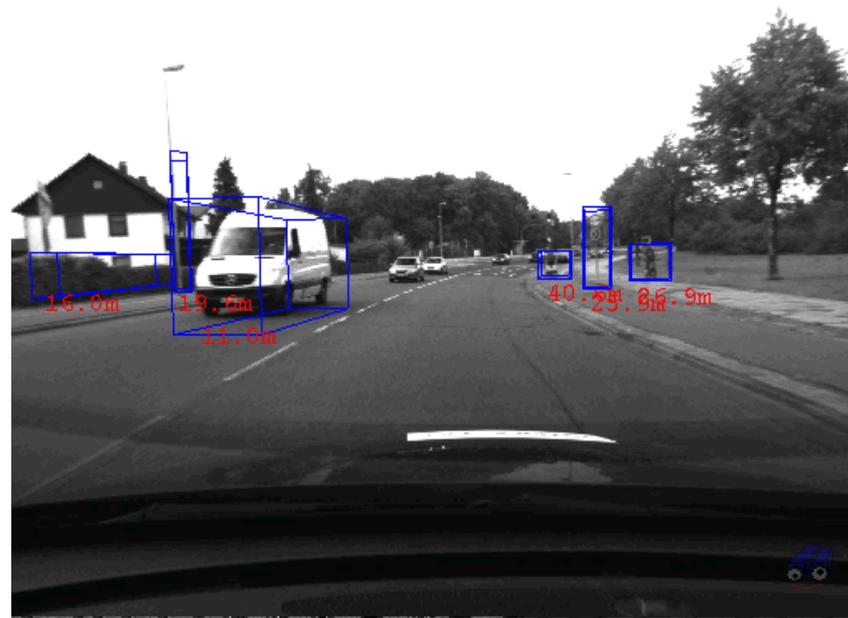
- Detection range, limited by the perspective effect: 3-15 m
- Classification accuracy: 90%
- Types of objects: Stop lines, Interrupted crossing lines, Lane markings, Arrows (forward, left, right, forward-left, forward-right)



Obstacle Detection and Tracking

Specifications

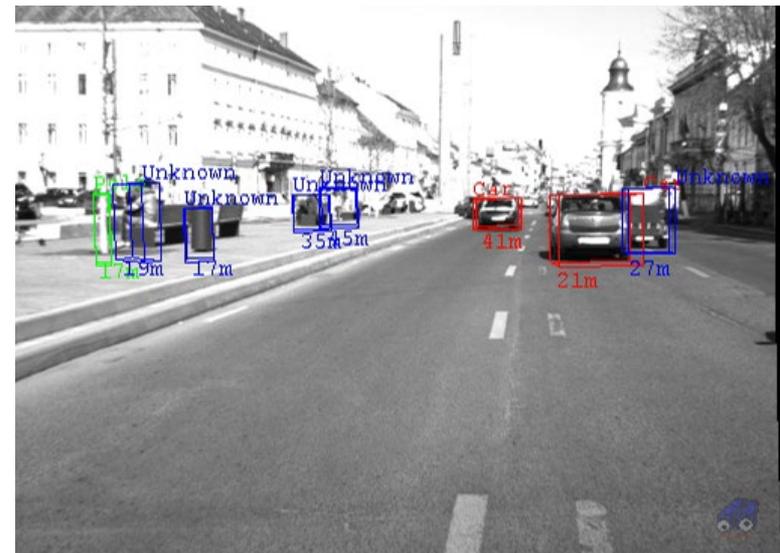
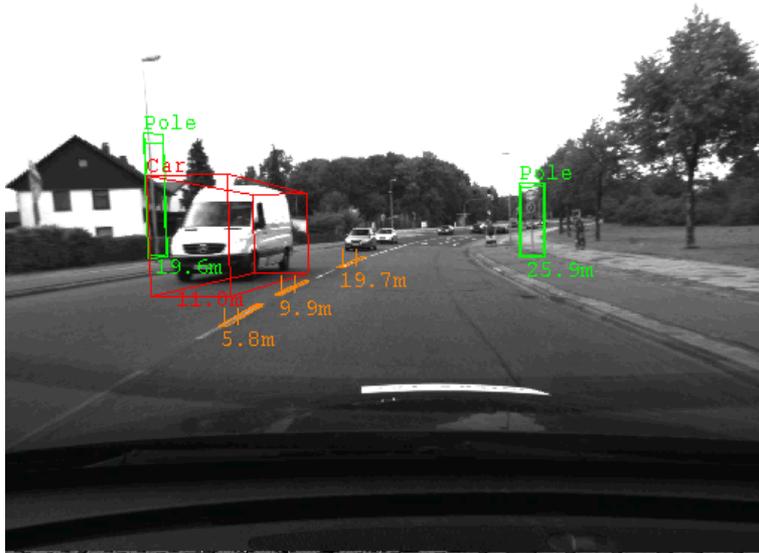
- Detection range: 0.5-40 m
- Positioning error: 3 % from range
- Detection rate: >95%



Classification of Relevant Obstacles

Specifications

- Types of objects: Cars, Pedestrians, Bikes, Poles, Others: generic obstacles
- Classification accuracy: 90%

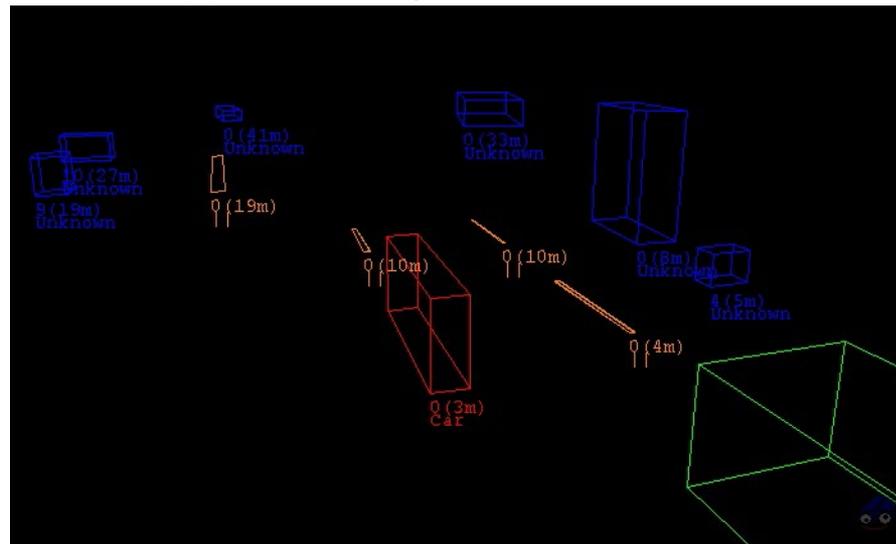


Communication of Results

Output structure

- Digital elevation map, with cells classified as curbs, obstacles and drivable area.
- Road data: list of painted road objects, description of lane geometry.
- Obstacle data: list of tracked and classified traffic objects.

The outputs are supplied through CAN or Ethernet.





Accurate perception of the vehicle position in intersections

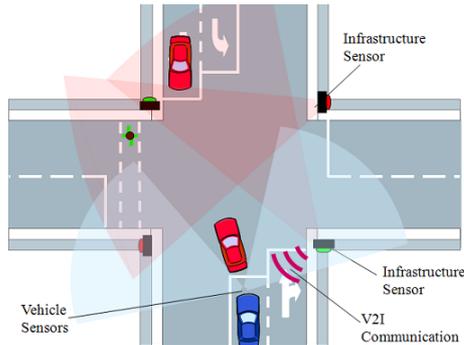
- Stereovision results can be fused with GPS and map information for precise determination of location and orientation in intersections.

Static and dynamic environment reconstruction

- Medium accuracy perception of most relevant aspects of the environment contributes towards a rich description of the driving environment.

Stereovision-based driving assistance applications: lane keeping assistance, automatic cruise control, stop and go, pedestrian avoidance, emergency braking.

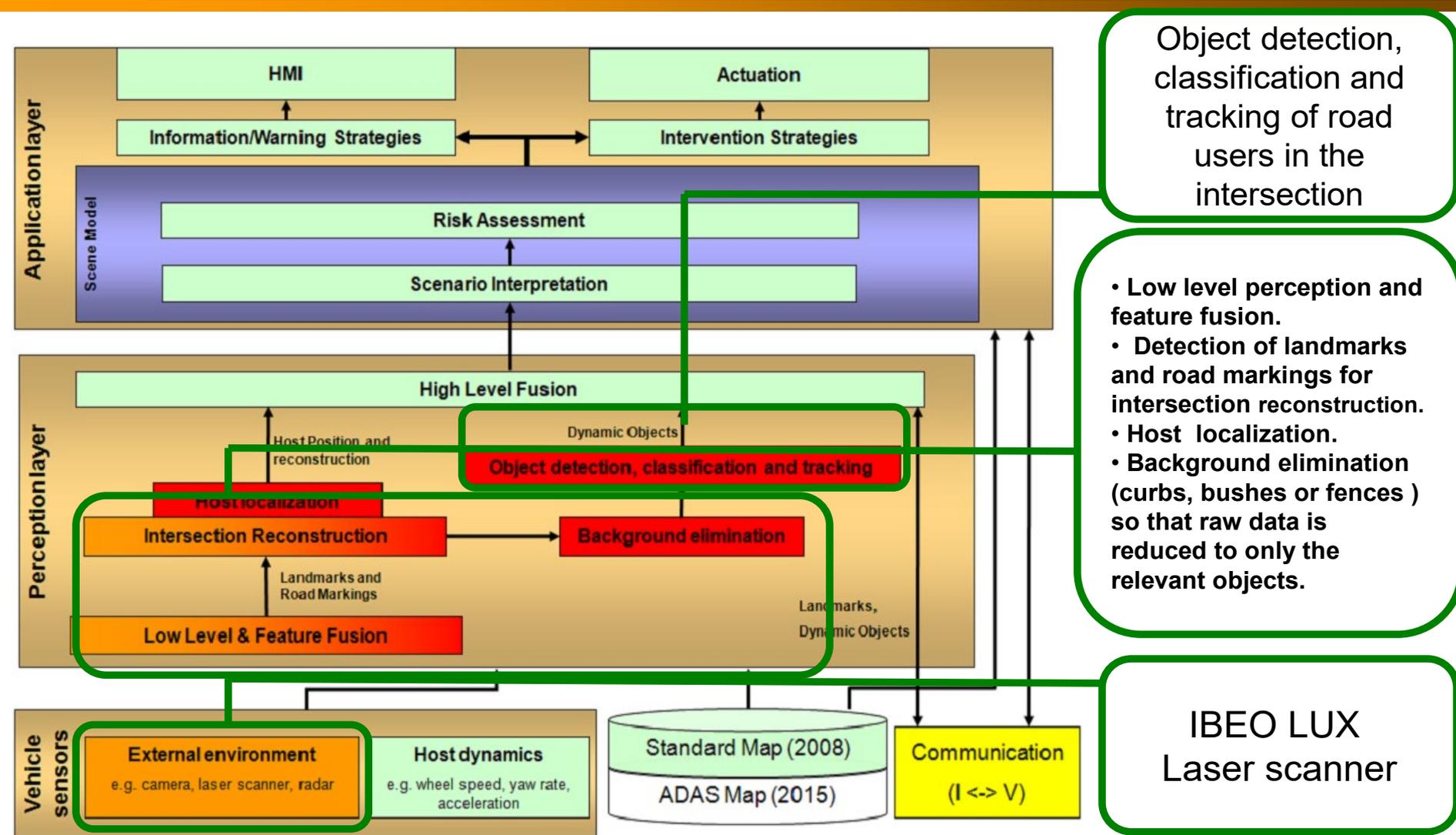
- The stereovision sensor can provide most of the static and dynamic information needed for the most common driving assistance applications.



Perception through Laser Scanner



Perception Through Laserscanner INTERSAFE2





Specifications

Inputs

- Installation parameters (e.g. height, orientation, offset to vehicle coordinate system)
- Host vehicle data (e.g. yaw rate, vehicle speed)
- Map data

Outputs

- Object data (tracked and classified)
- Intersection reconstruction

Performance

- The device is eye-safe (laser class 1)
- Scan frequency: 12.5/25 Hz
- Field of view (horizontal): 100°
- Range: 0.3m to 200m
- Angle resolution: 0.1° to 1°
- Built-in processing
- Parallel and simultaneous scanning layers

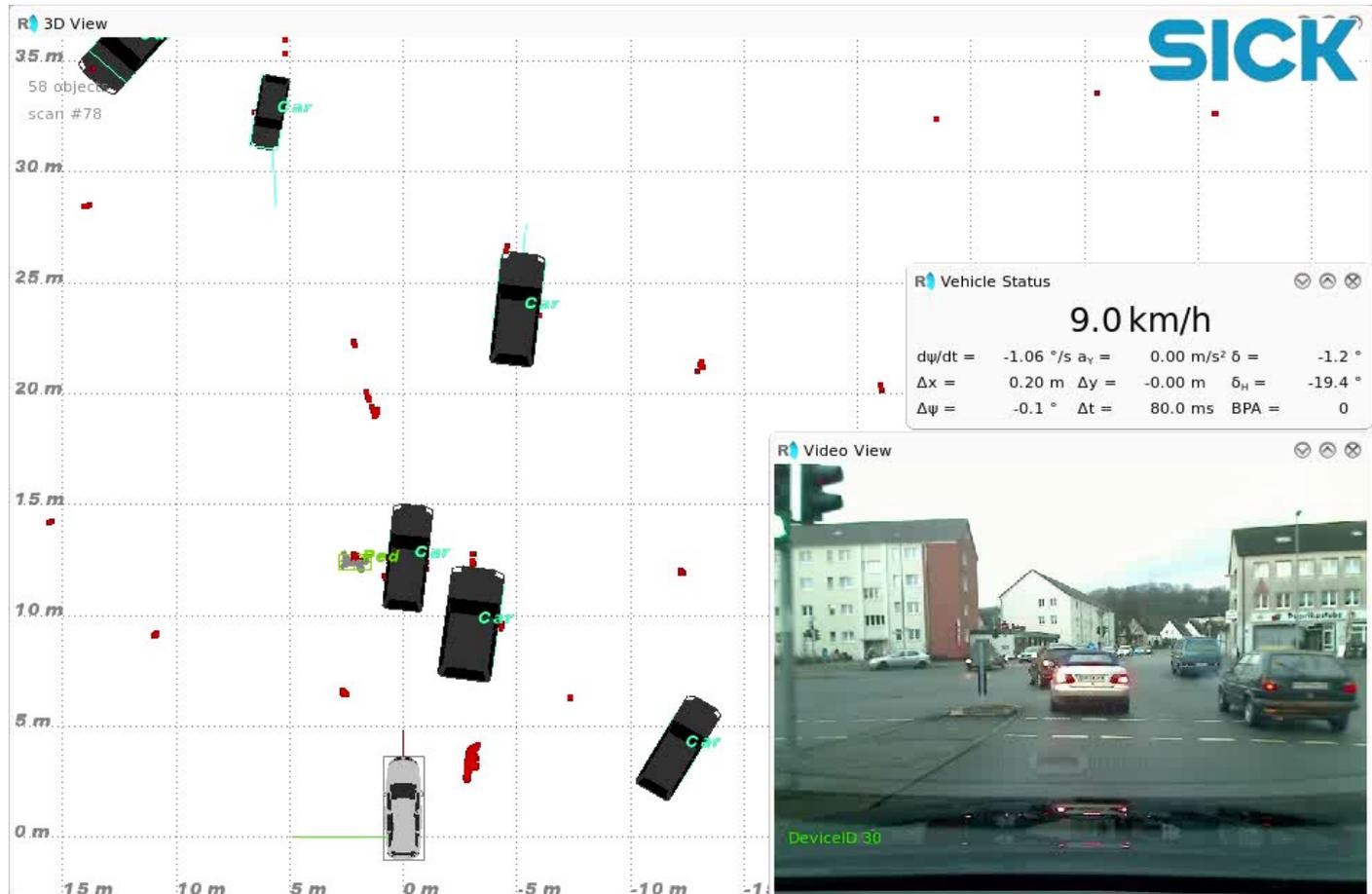


Detection, classification and tracking of obstacles





Detection, classification and tracking of obstacles



Laser Scanner-based Applications for Intersection Safety



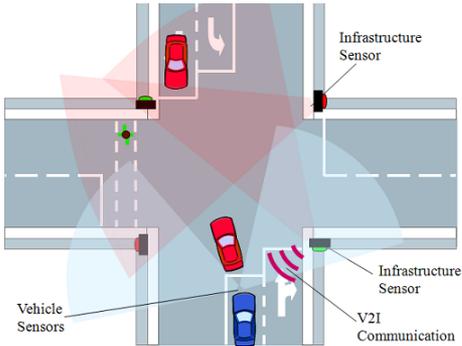
Accurate perception of the vehicle position in intersections

- Laser scanner results can be fused with GPS and map information for precise determination of location and orientation in intersections.

Static and dynamic environment reconstruction

- High accuracy perception of most static and dynamic obstacles in the intersection

Laser scanner-based driving assistance applications: automatic cruise control, stop and go, pedestrian avoidance, emergency braking.



Thank you !
Questions ?
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2009

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