VisLab's latest Autonomous Driving challenges:
from intercontinental to urban tests

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Outline

- Short presentation of VisLab
- VisLab's technology
  - Approach and key ideas
- Real road experiments

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VisLab

VisLab

23 people as of Nov 2013

VisLab Expertise

- Perception
  - Multispectral Vision (Daylight, Near/Far IR)
  - Single or multiple vision sensors (Monocular, Stereo, Motion Stereo, Tetravision, data fusion)
- Data fusion (laser, radar, vehicle data)
- Real Time, multithreaded software environment

VisLab Peculiarities

- Long experience on the field with:
  - Real prototypes: cars, trucks, off-road, mining, road construction, maritime, military
  - Different companies and governmental institutions worldwide

VisLab's Autonomous Vehicles

1998

2007

2005

2009

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...not only cars

VisLab approach and technology

VisLab concept and business model
compared to other research centers/companies

Main Challenges

- Driverless technology:
  1. Environmental sensing
  2. Intelligent decision
  3. Vehicle actuation

- Product
  - Cost, Integration, Robustness, Redundancy, Security,…

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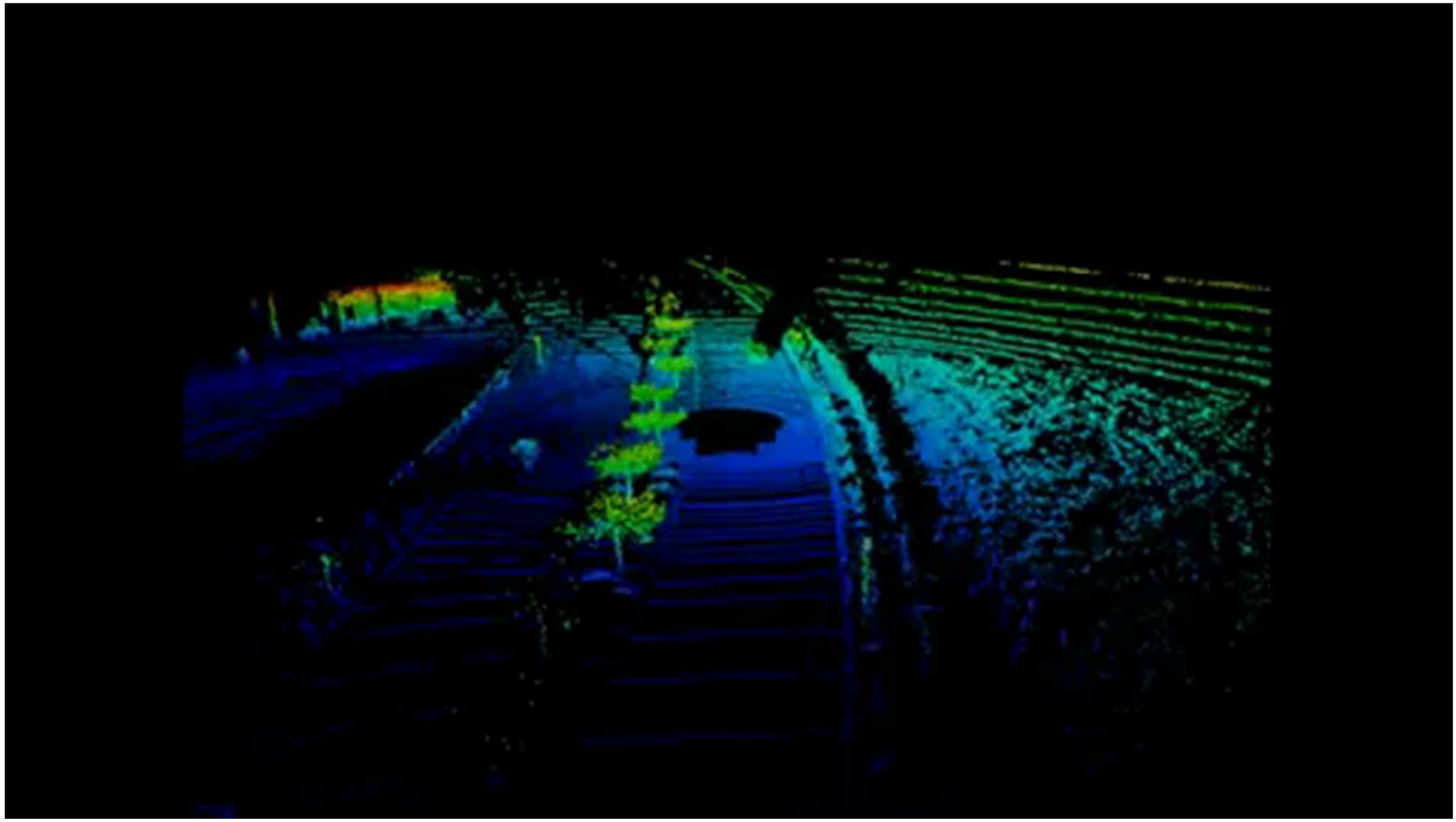
Two solutions

Sensing: VisLab's approach

- VisLab's approach is based on:
  - low-cost and
  - highly integrated sensors

LIDAR-based sensing



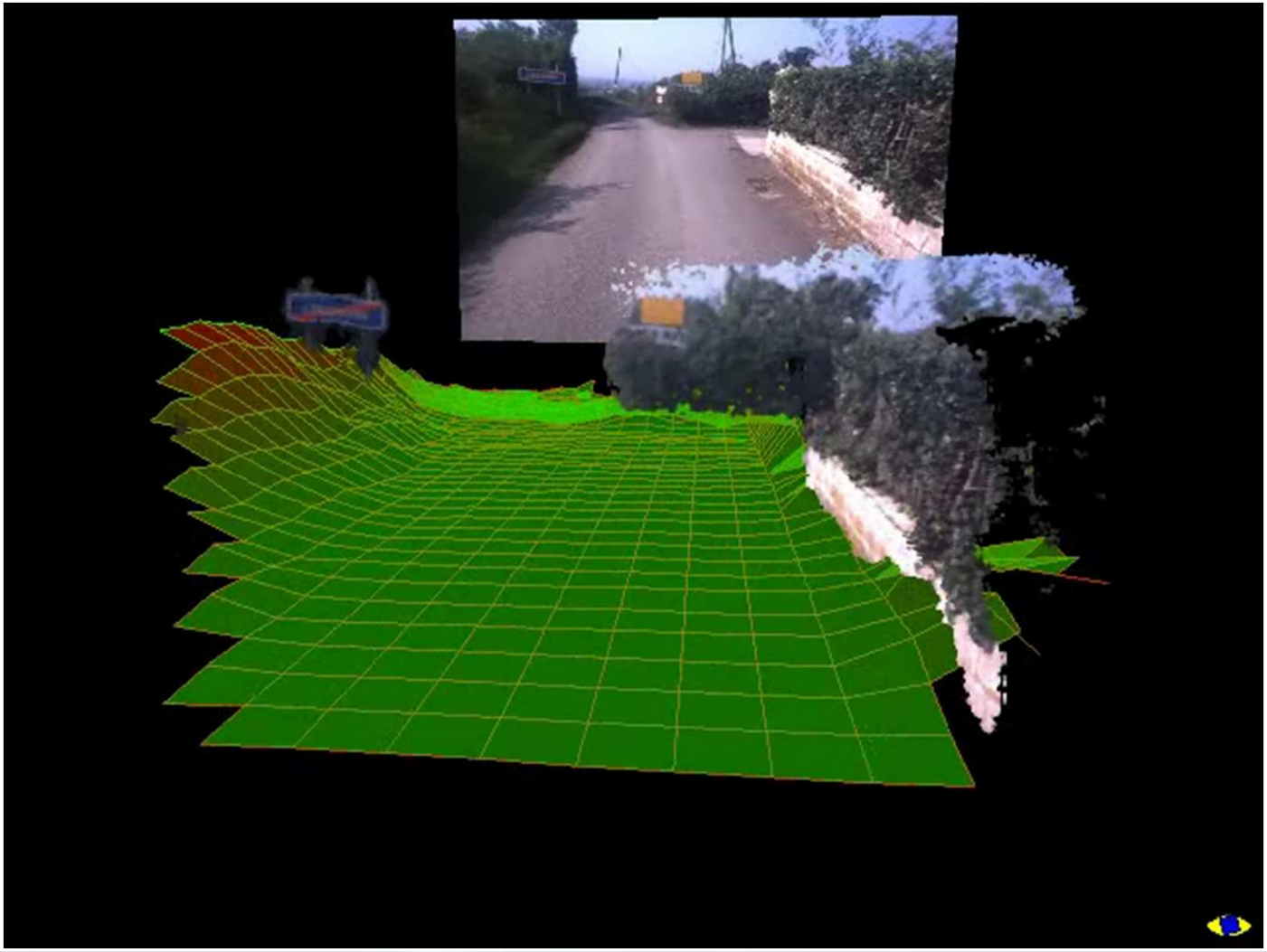
Vision-based sensing

- Stereo vision
  - with a *'smart'* algorithm

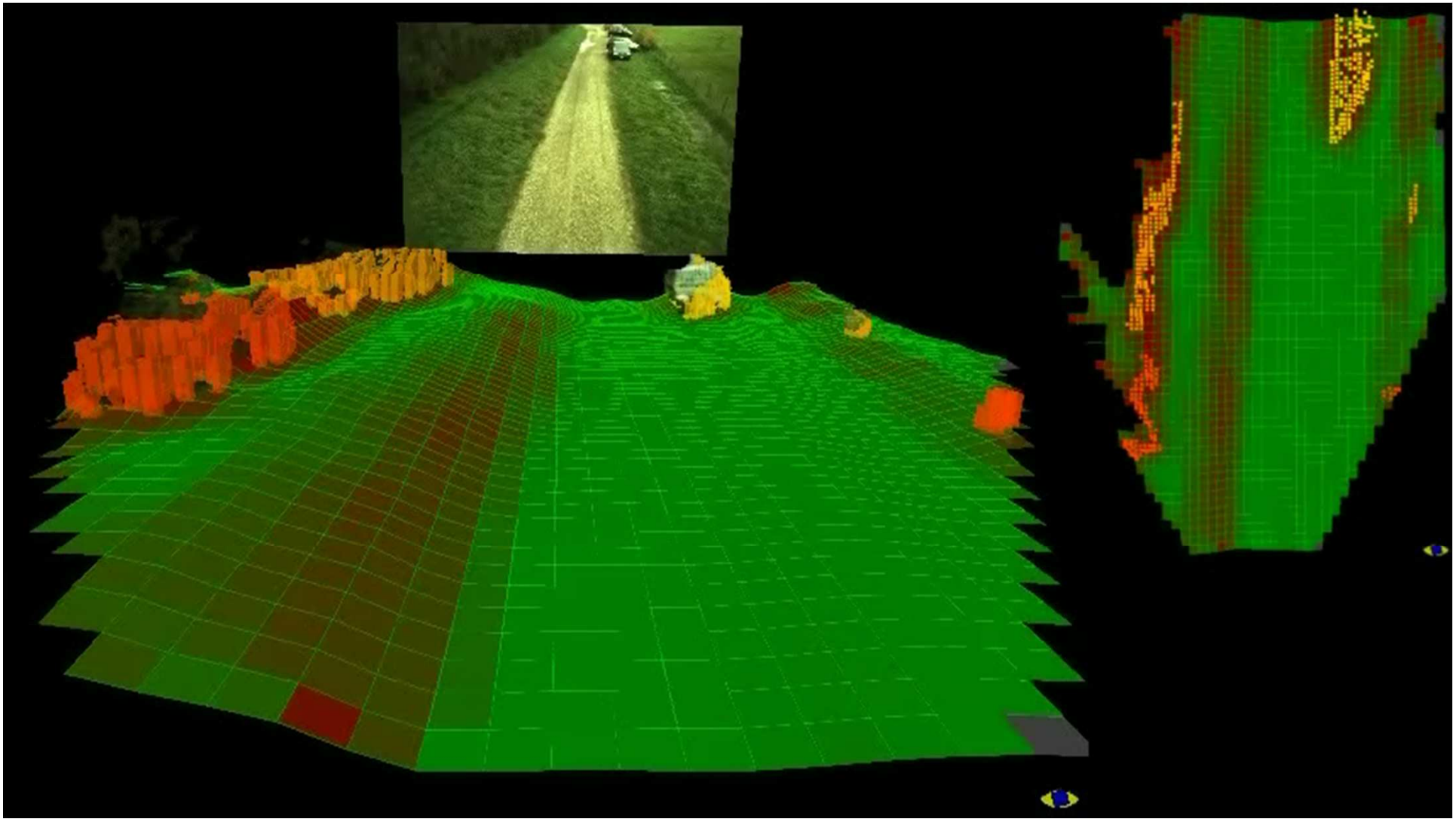
3D vision

- Performance example:
  - 640x480 pxl @12.5Hz -> 3.800.000 pixels/s
  - Stereo processing (with 90% density) delivers ~3.500.000 distance estimations per second

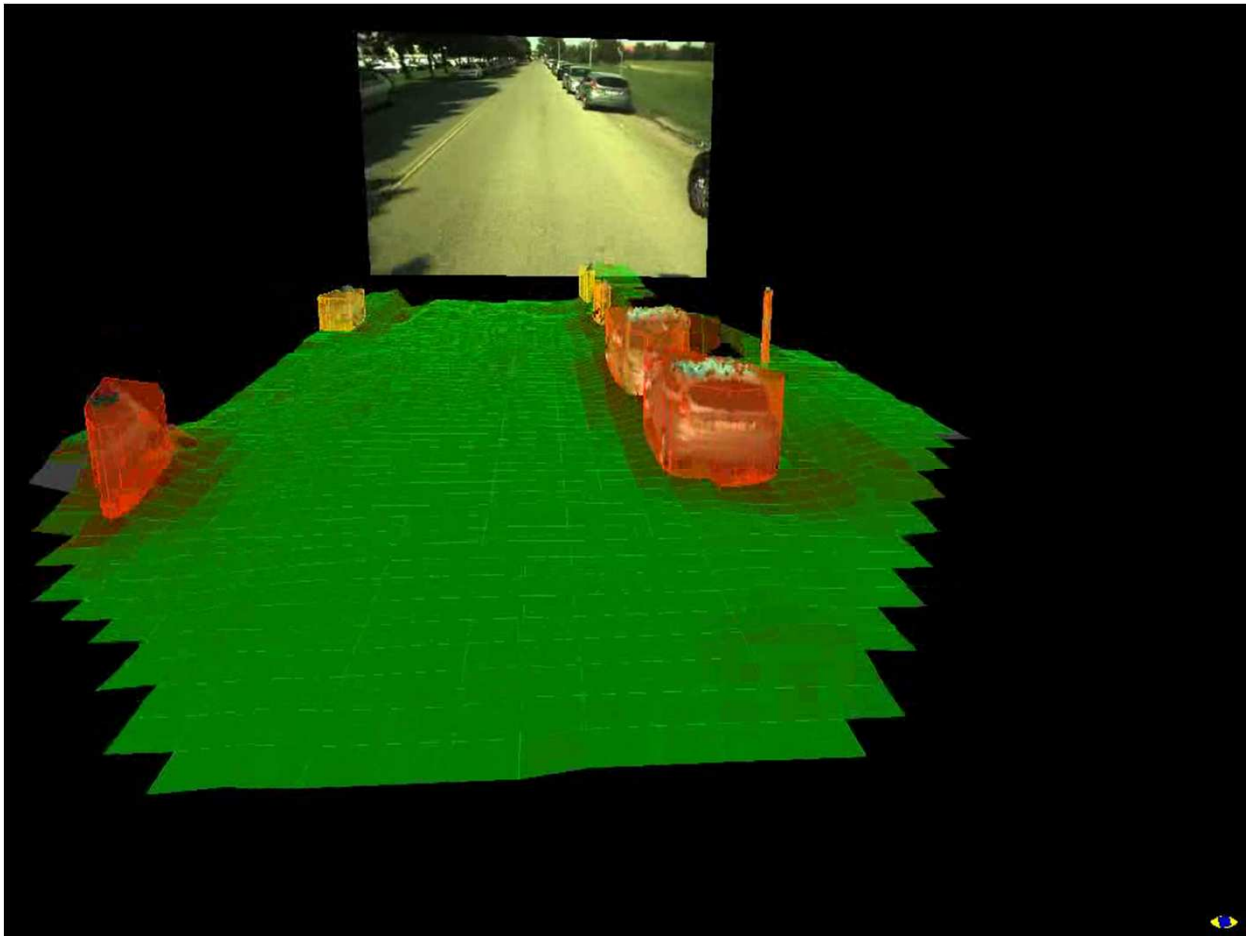
Terrain Mapping



Obstacles & Free Space



3D World Perception



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Online calibration

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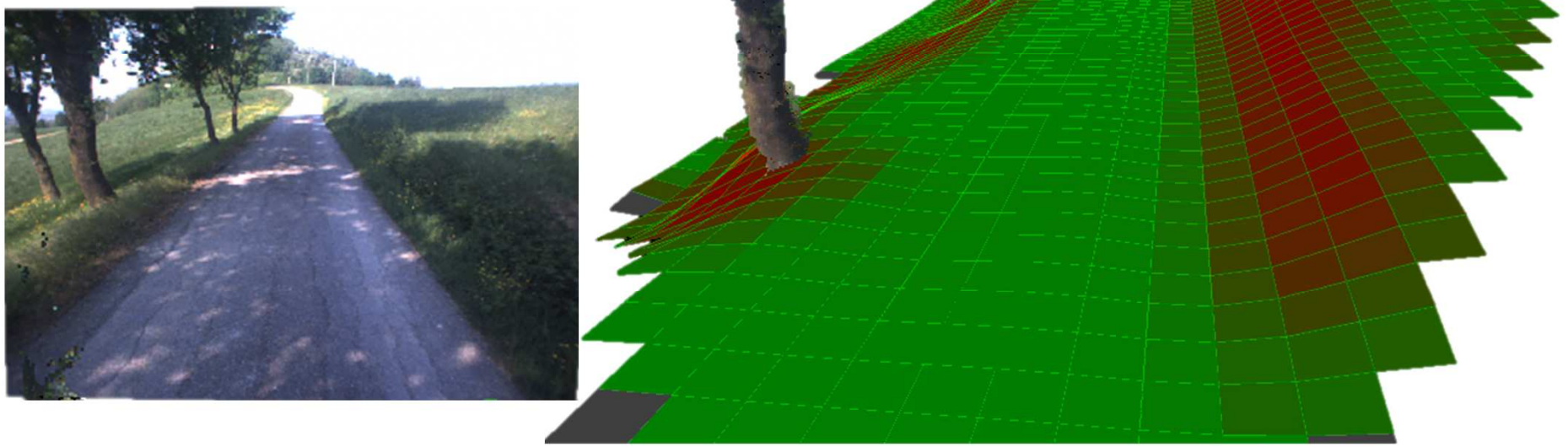
VisLab stereovision technology



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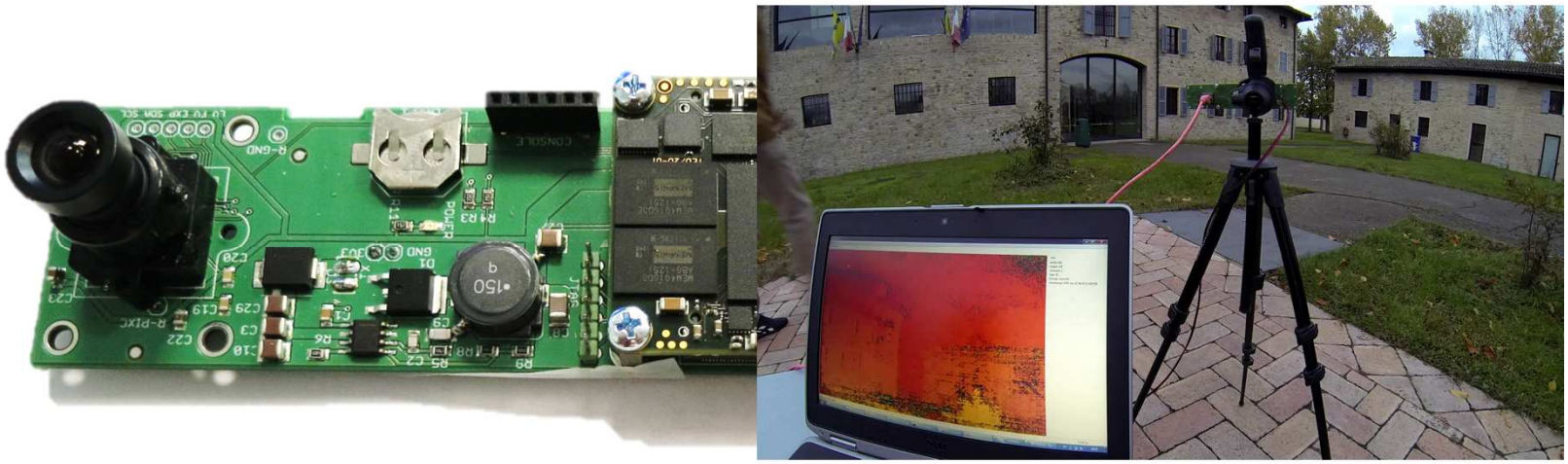
Current VisLab technology

Preview of VisLab research

- FPGA-based 3D processing
  - ✓25fps @ 640x480 pxl (~6M 3D point/s)
  - 15, 20, 40cm baseline
  - Ethernet/CAN output



Road experiments

Testing with BRAiVE

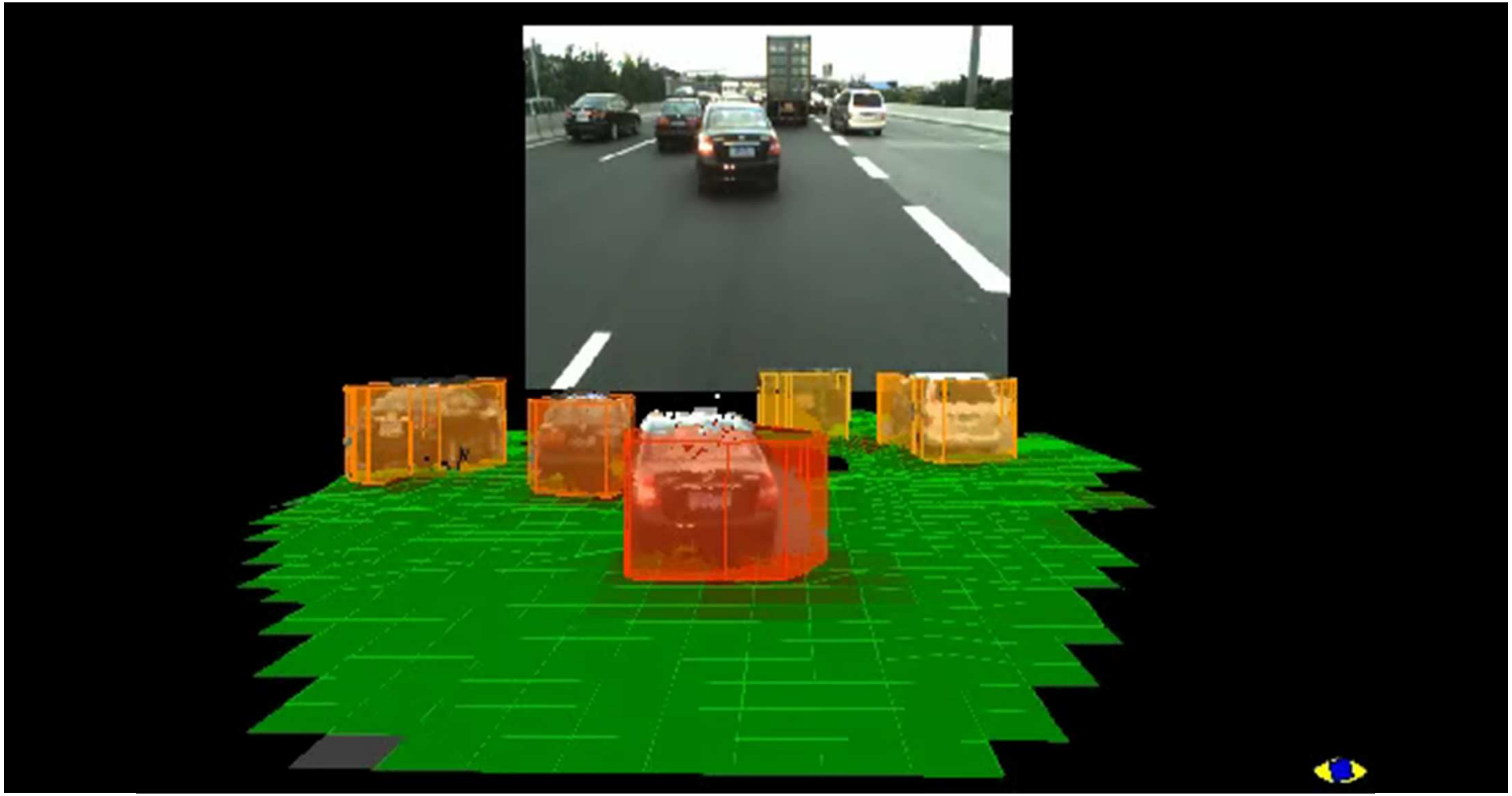
- Perception to be further tested…

Test Expedition

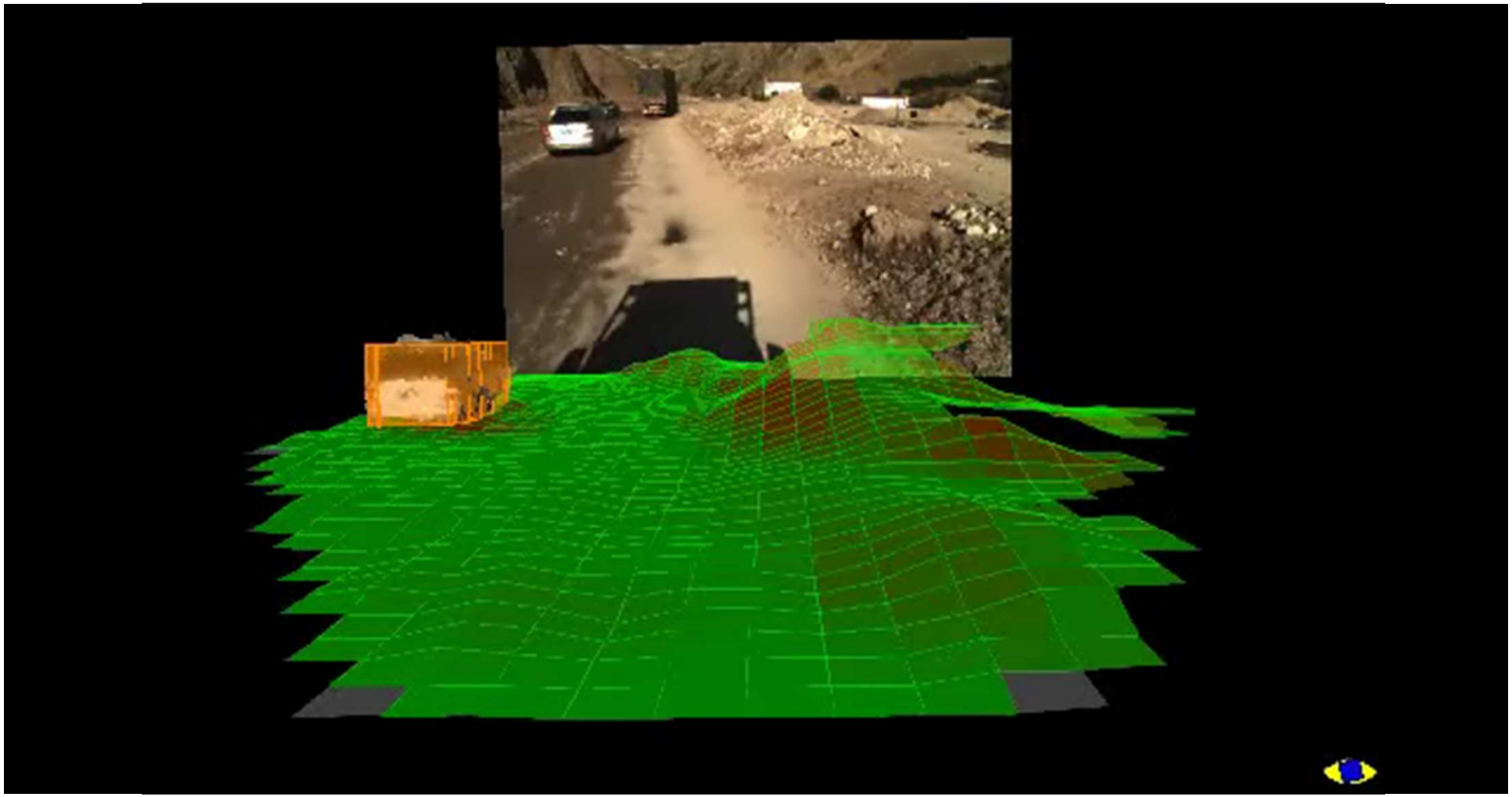
The Expedition


13.000 km,
three months,
no driver

Examples: traffic



Examples: terrain mapping



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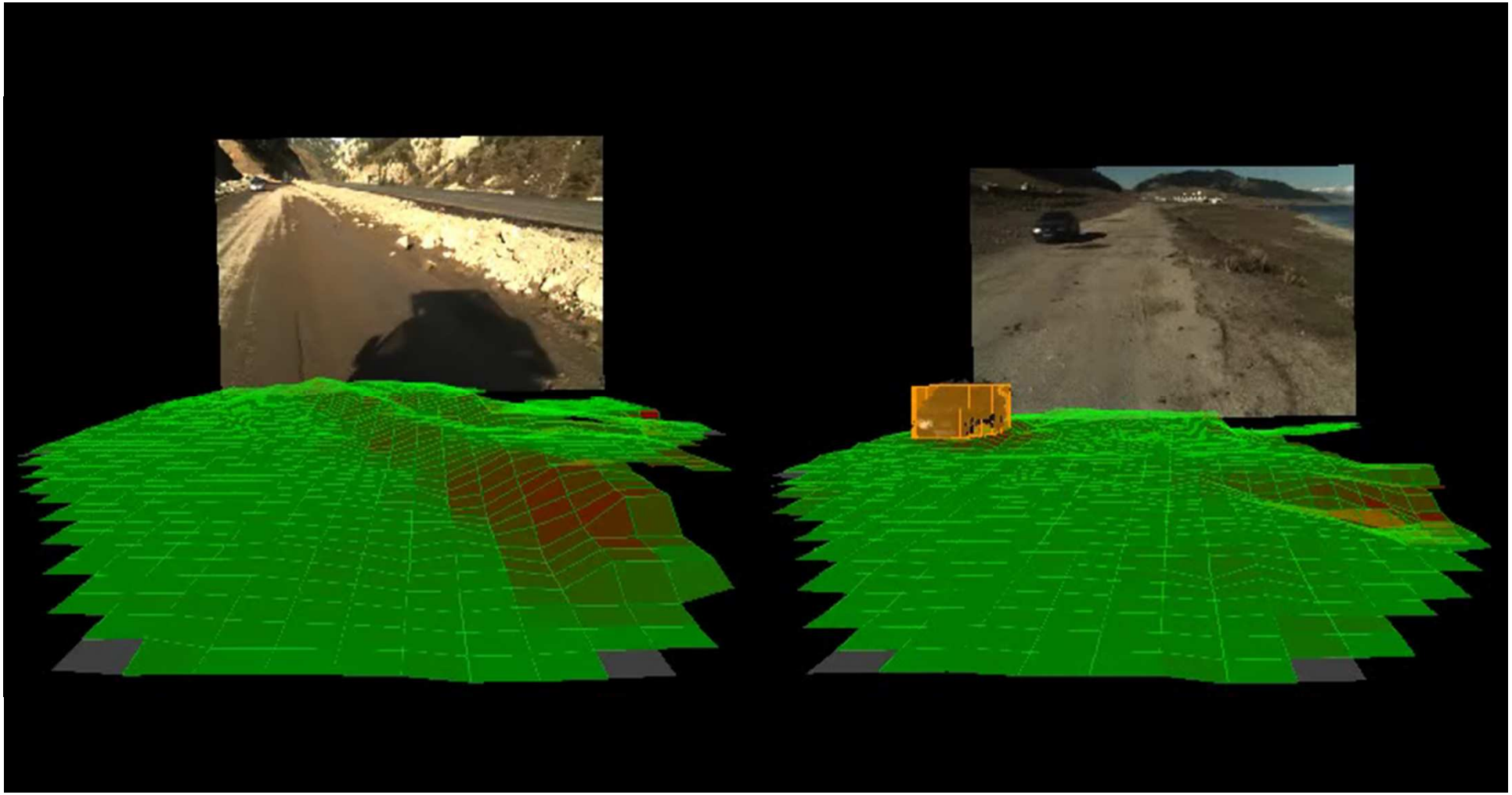
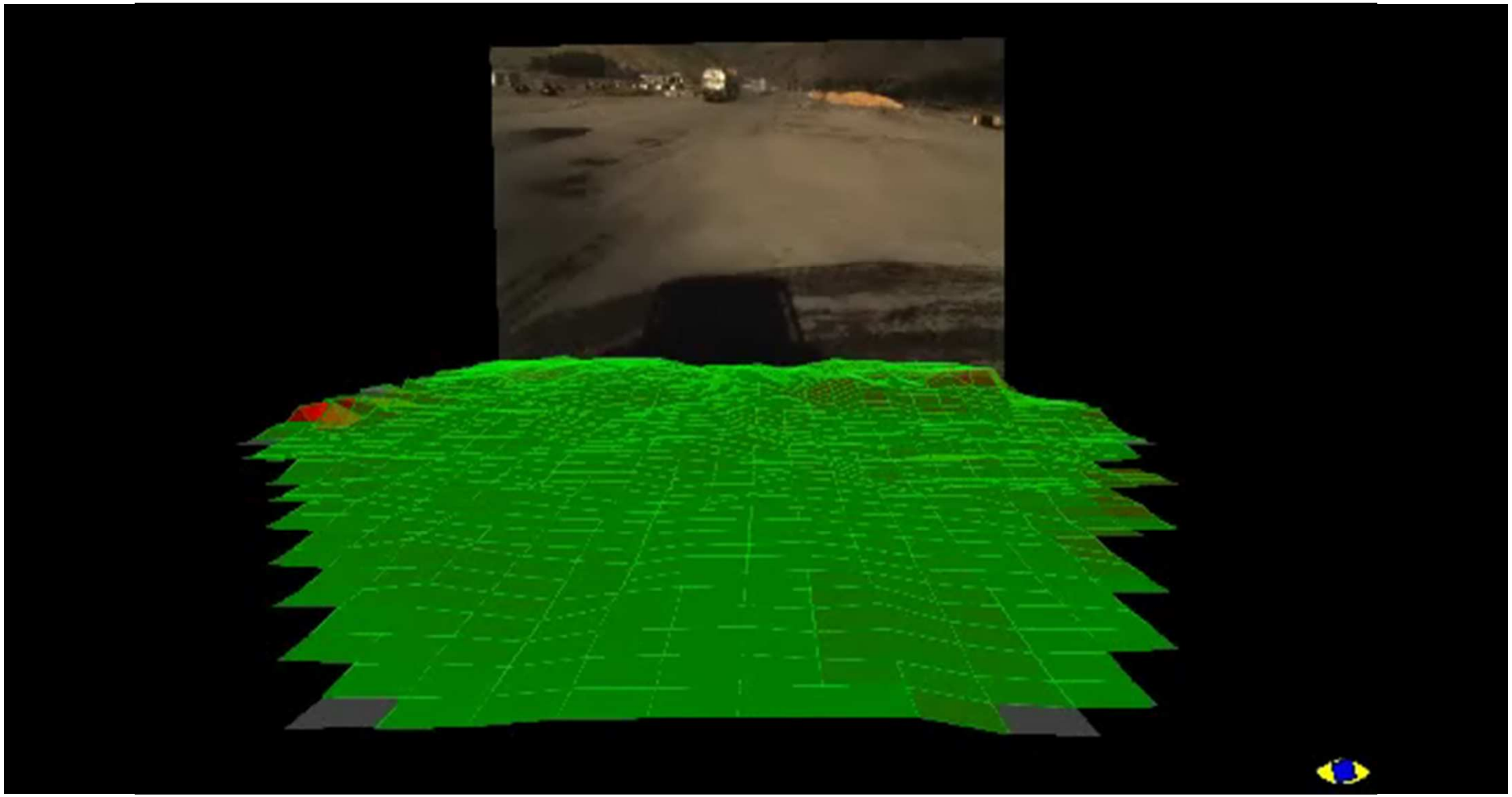
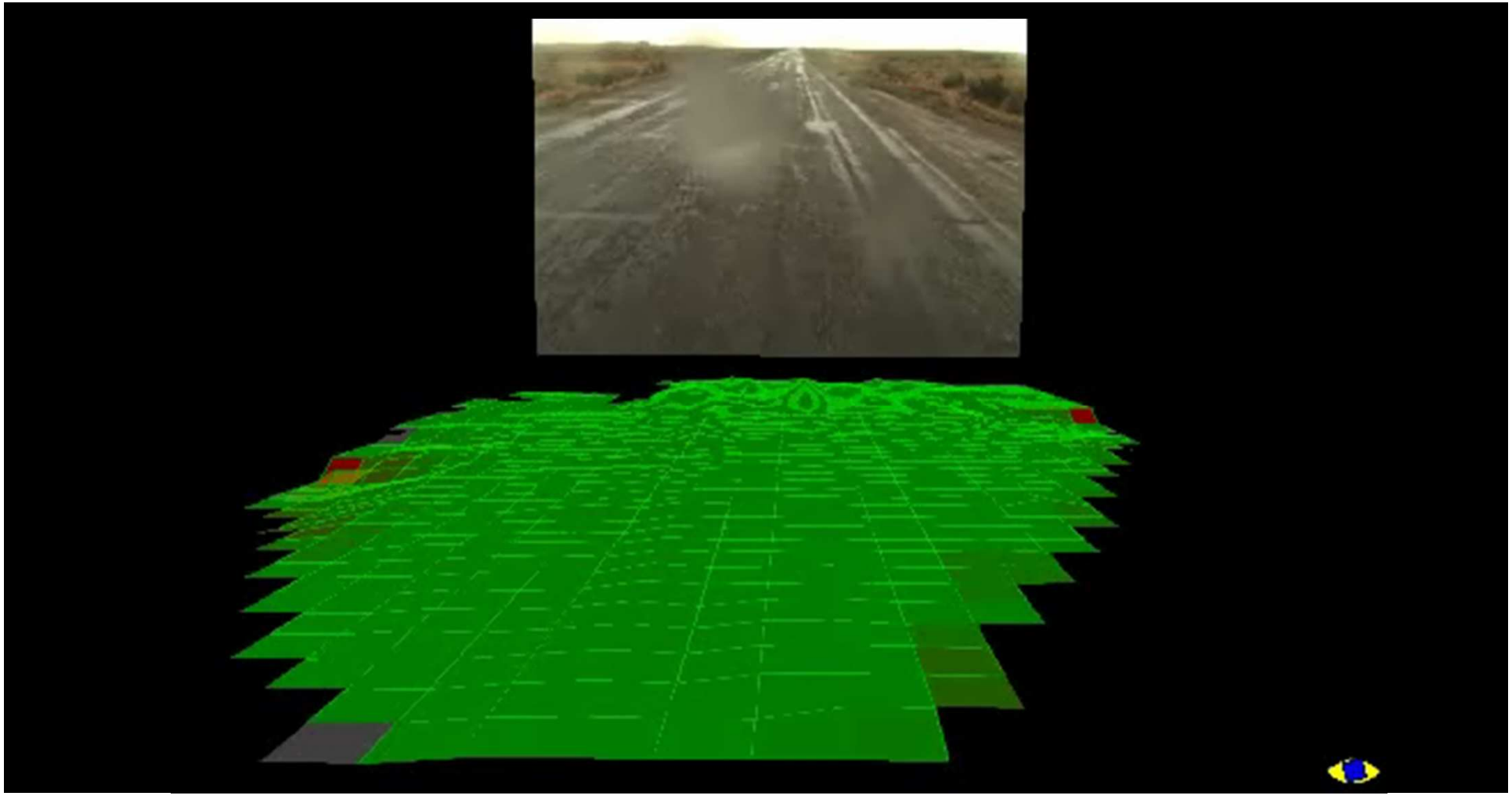


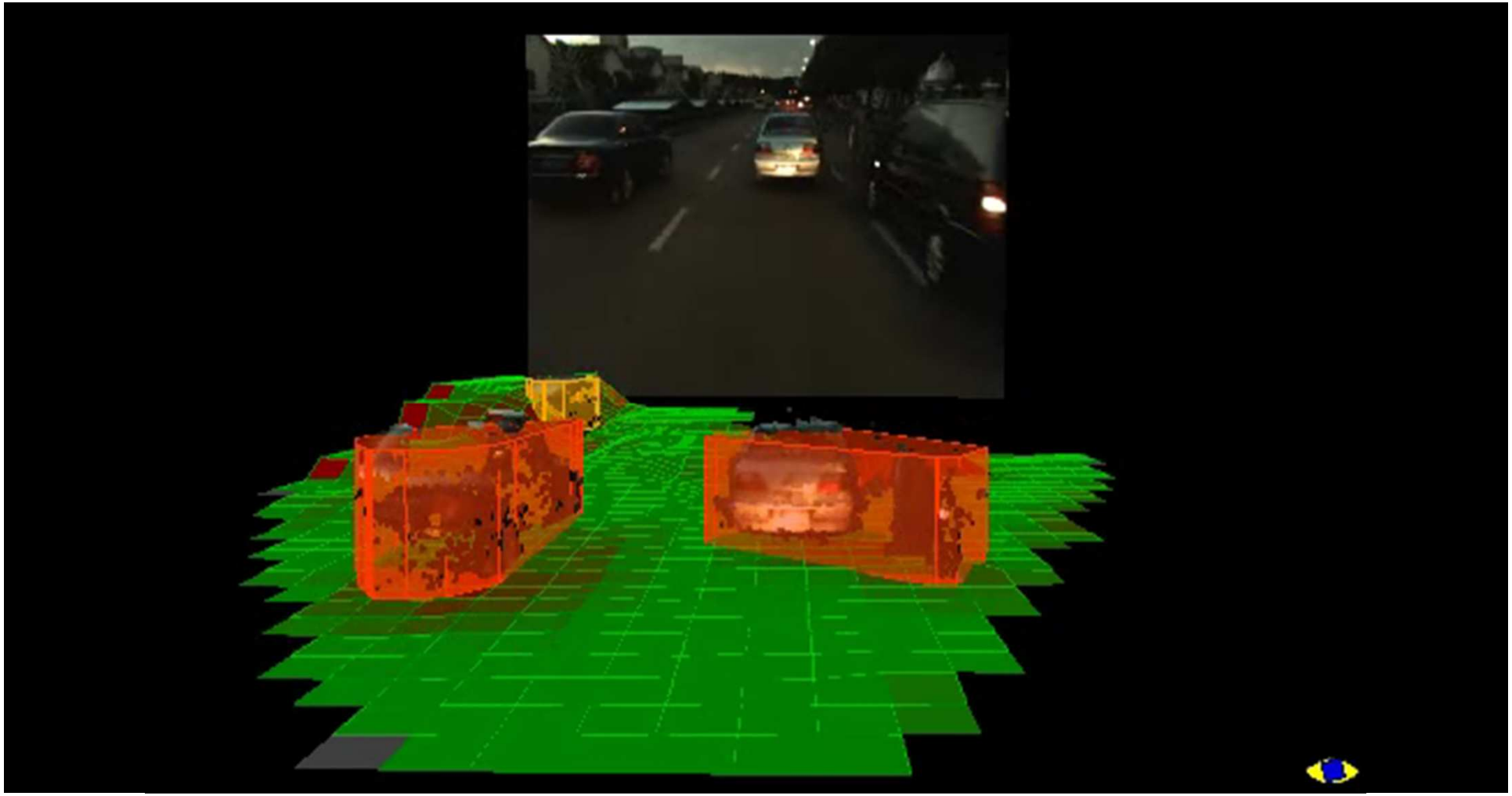
Examples: dust/smoke



Examples: rain



Examples: traffic in the dark



PROUD Car Test 2013

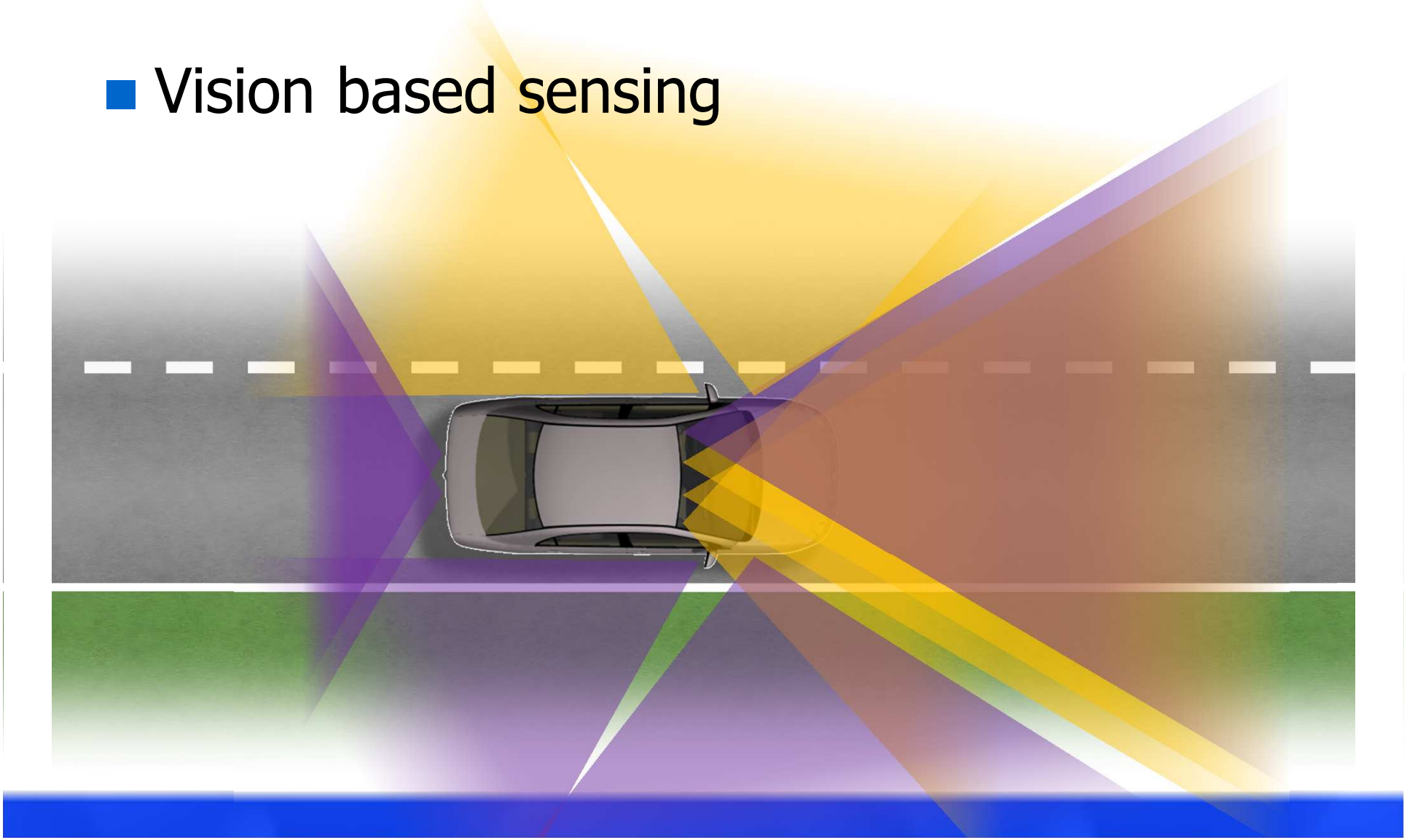
Public Road Urban Driverless-Car Test 2013

July 12, 2013, downtown Parma, Italy

The Vehicle, the Test, the Approach

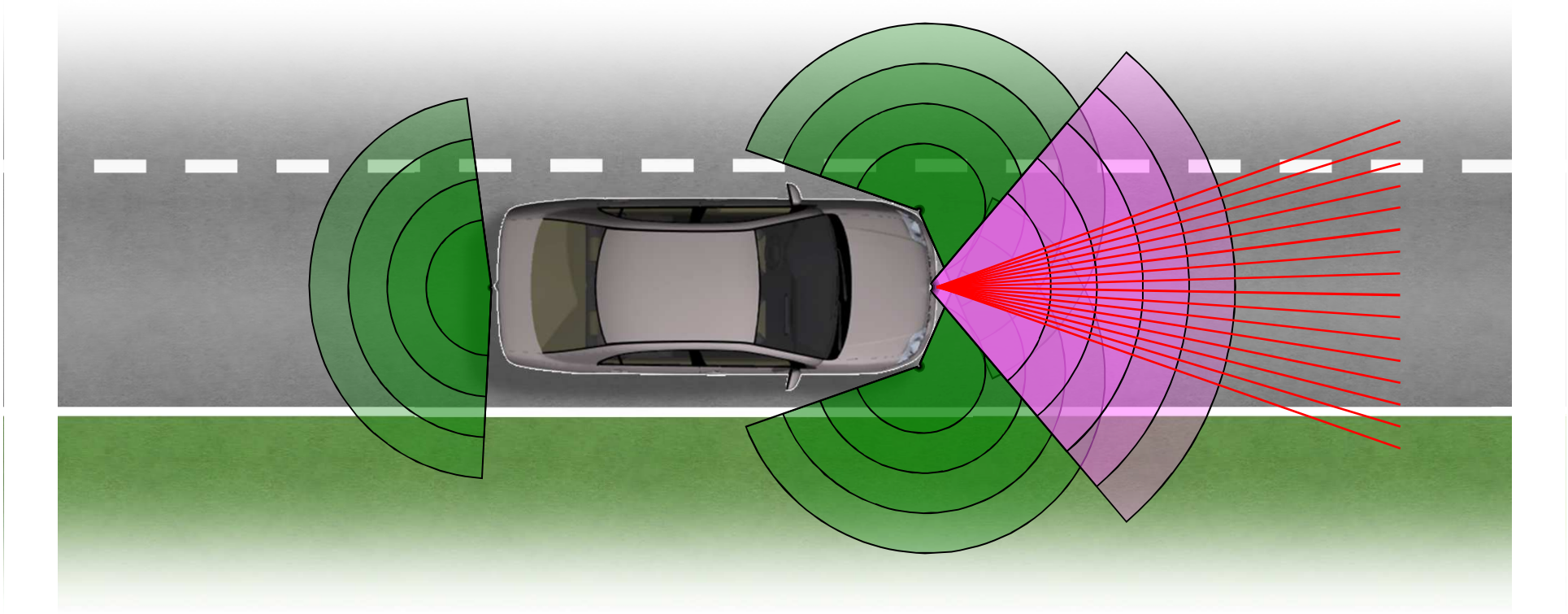
The BRAiVE Vehicle

- Vision based sensing



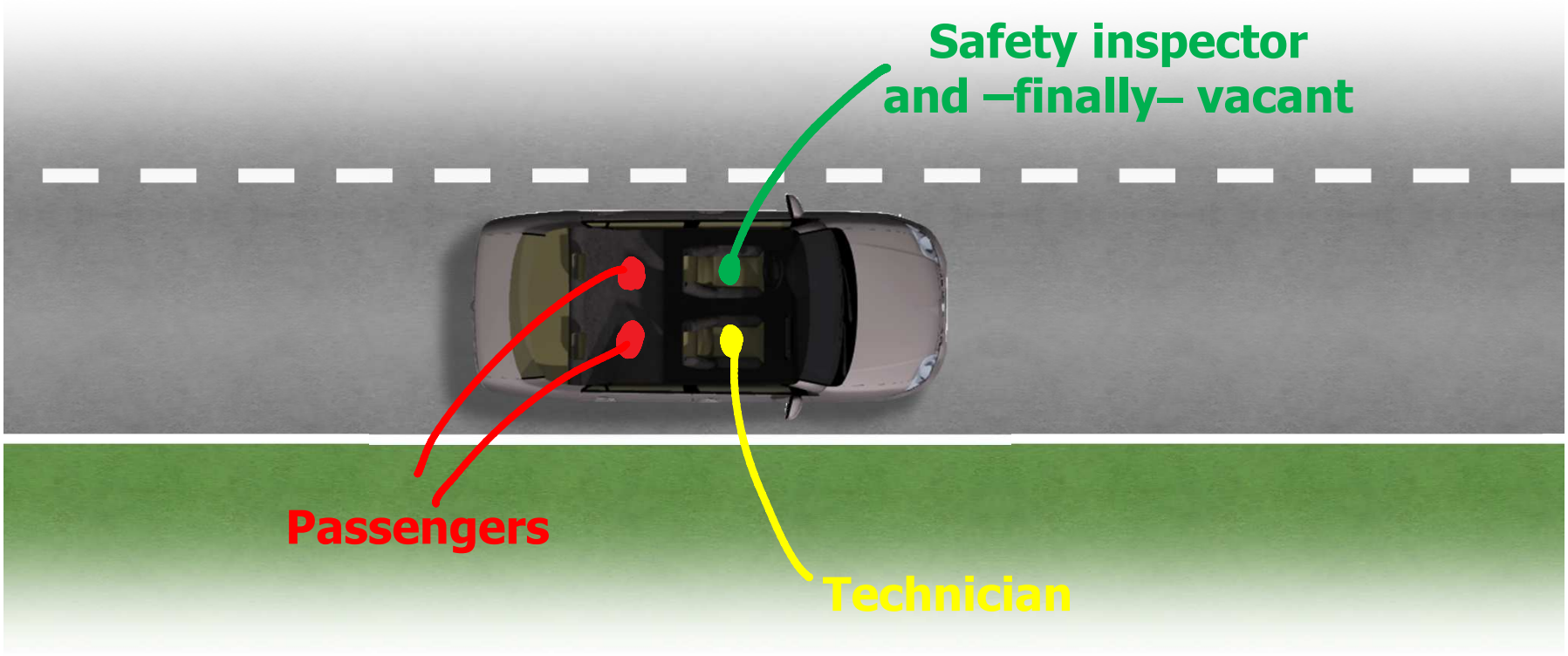
The BRAiVE Vehicle

- Laser based sensing

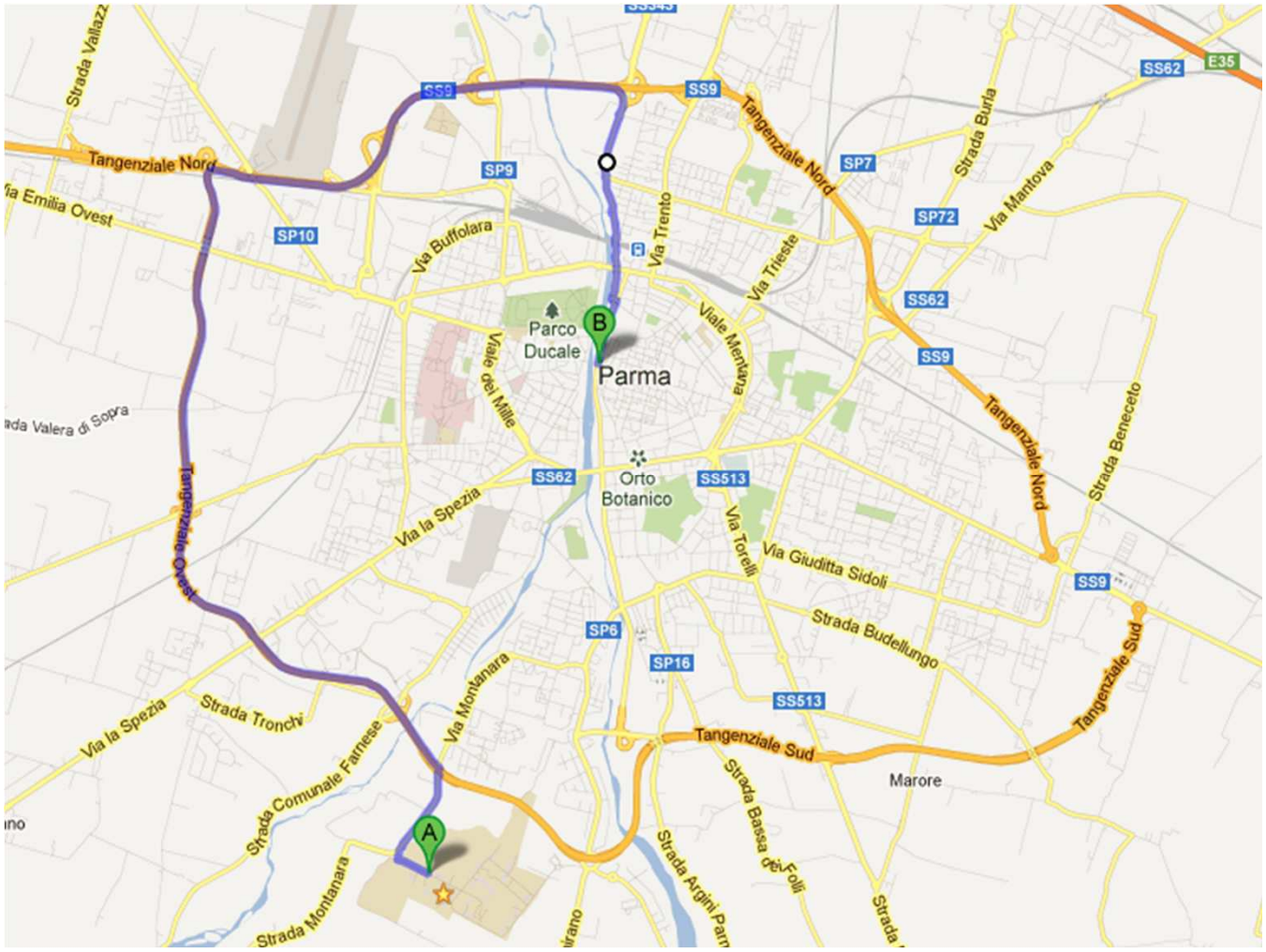


The BRAiVE Vehicle

- Internal configuration



The Test Scenario



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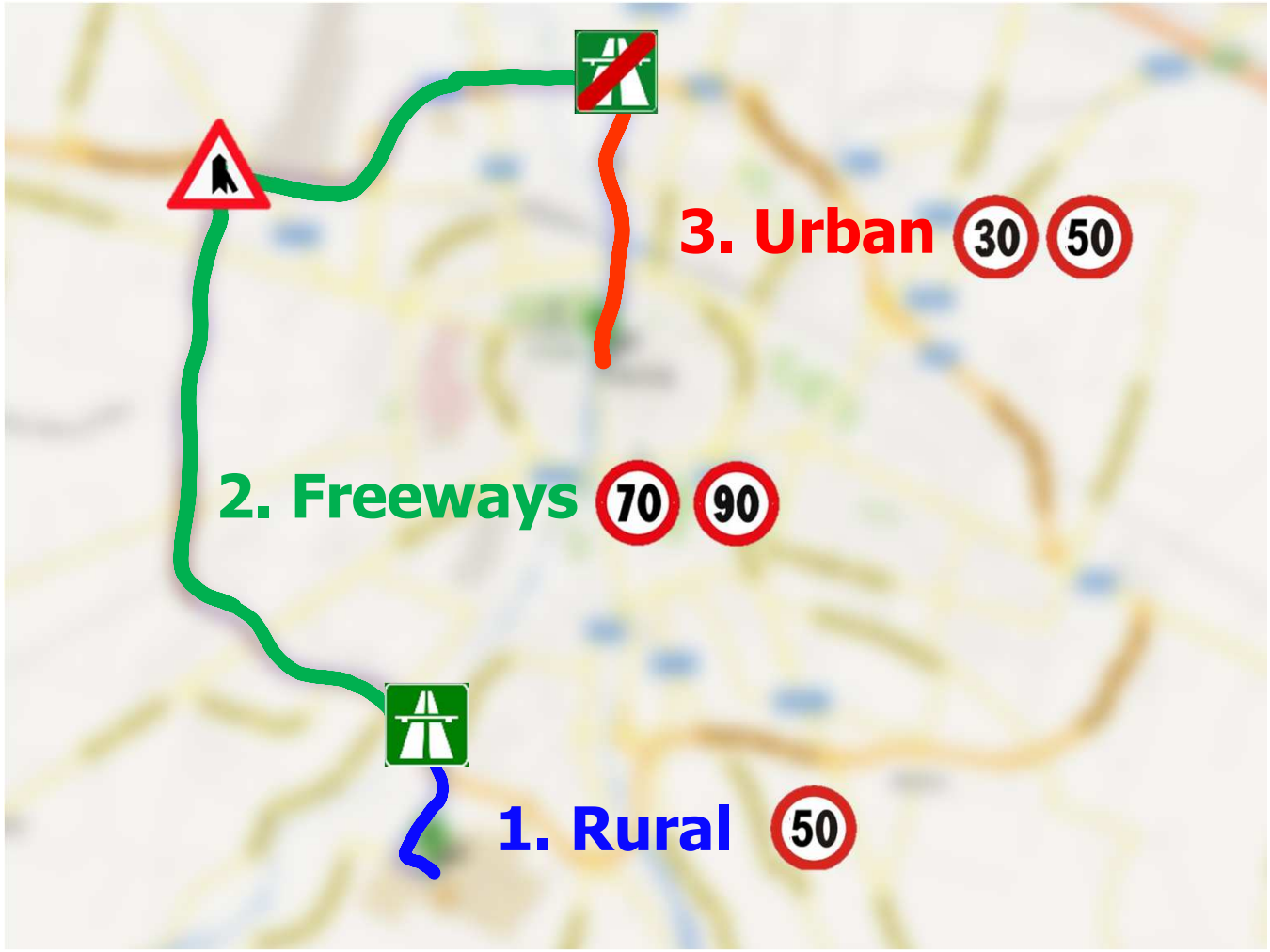

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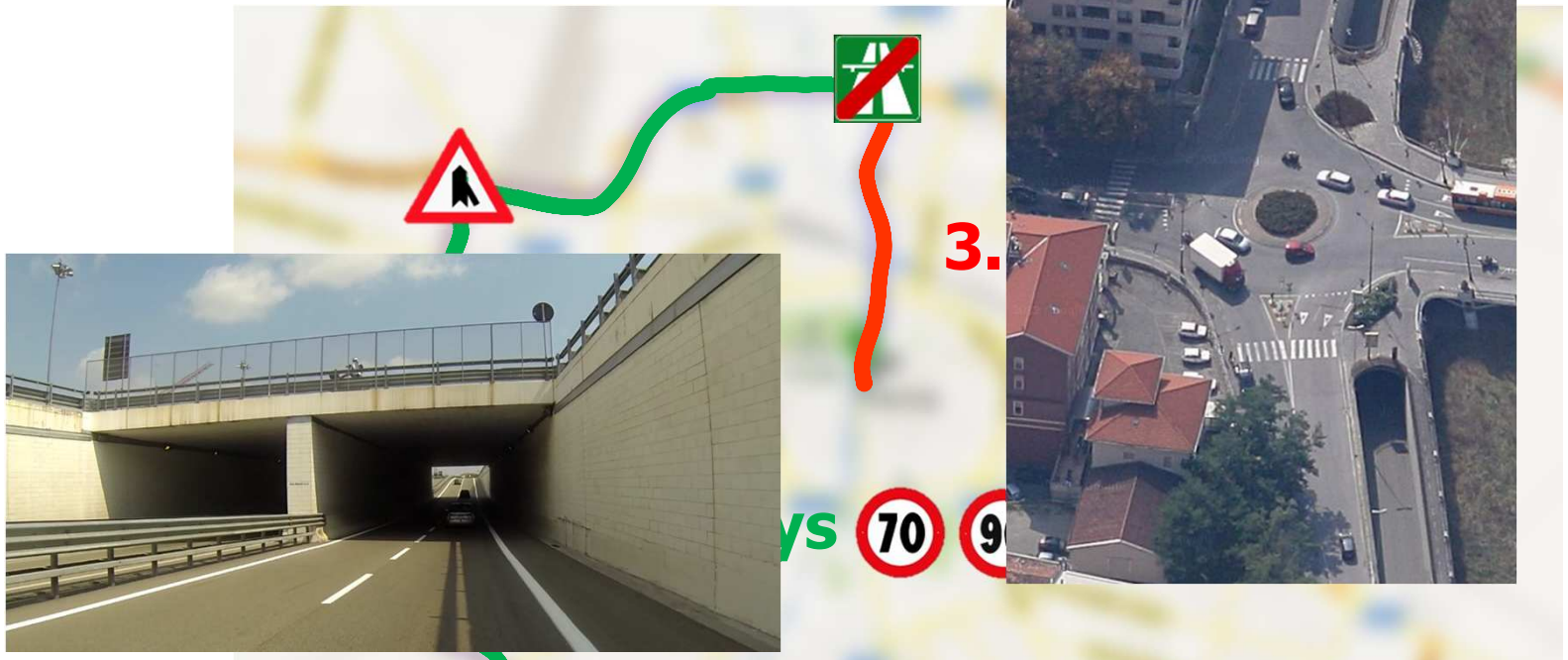
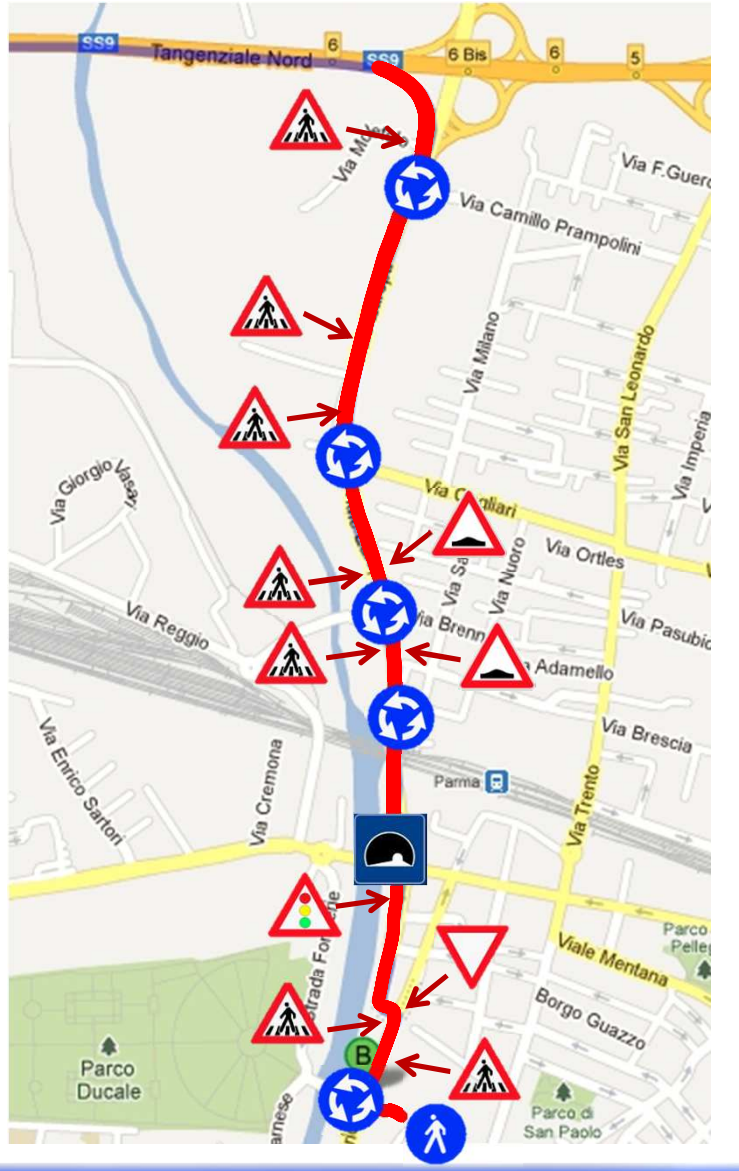


Urban area

- 5 roundabouts
- 7 pedestrian crossings
- 1 traffic signal
- 1 tunnel
- 1 give way
- 2 speed bumpers



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Examples

Examples


Vehicle Speed
Steering Angle
Forward Driving
Freeway Merging
Junction Merging
Roundabout Merging
Pedestrian Crossing
Traffic Light

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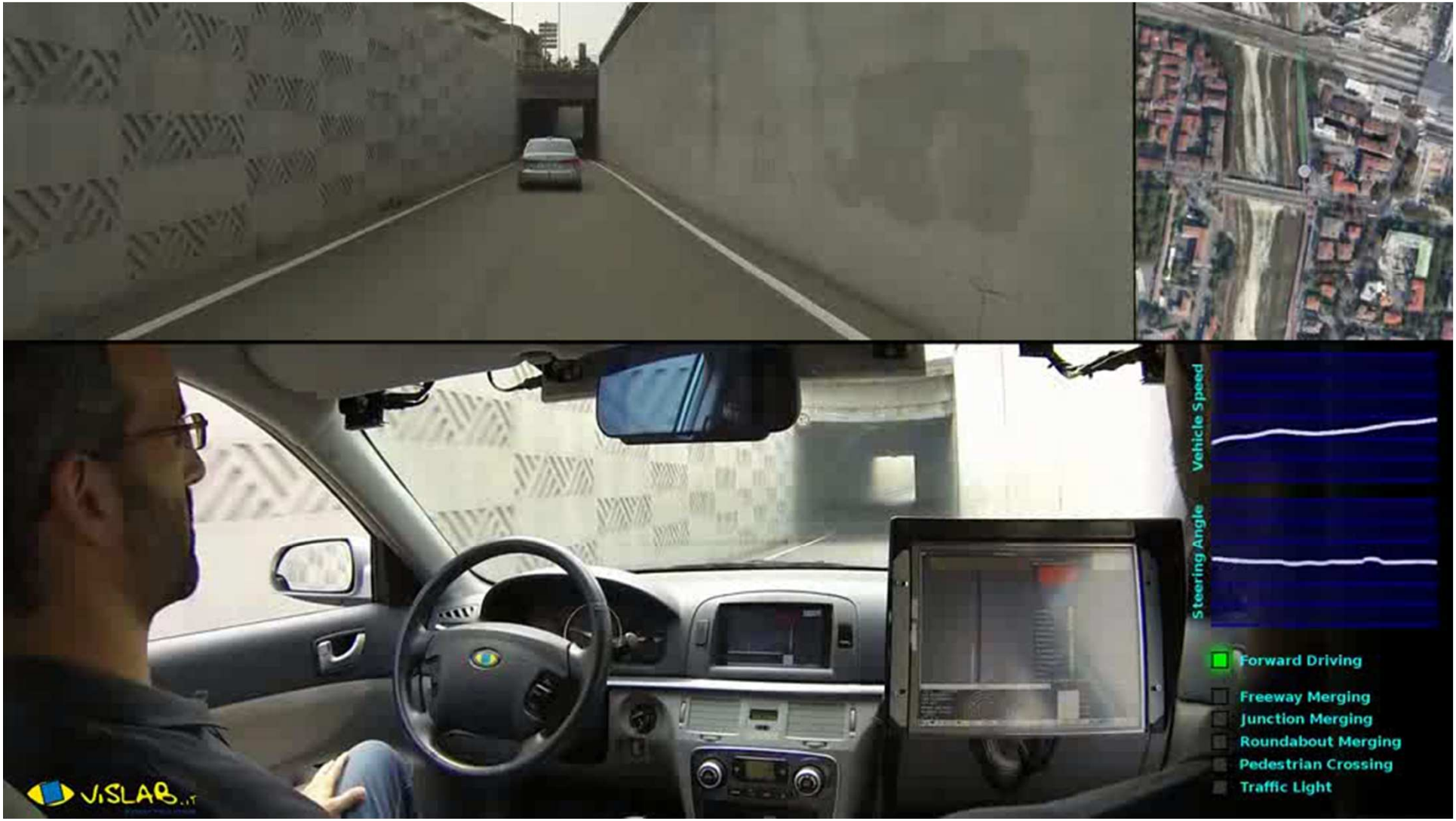
Examples



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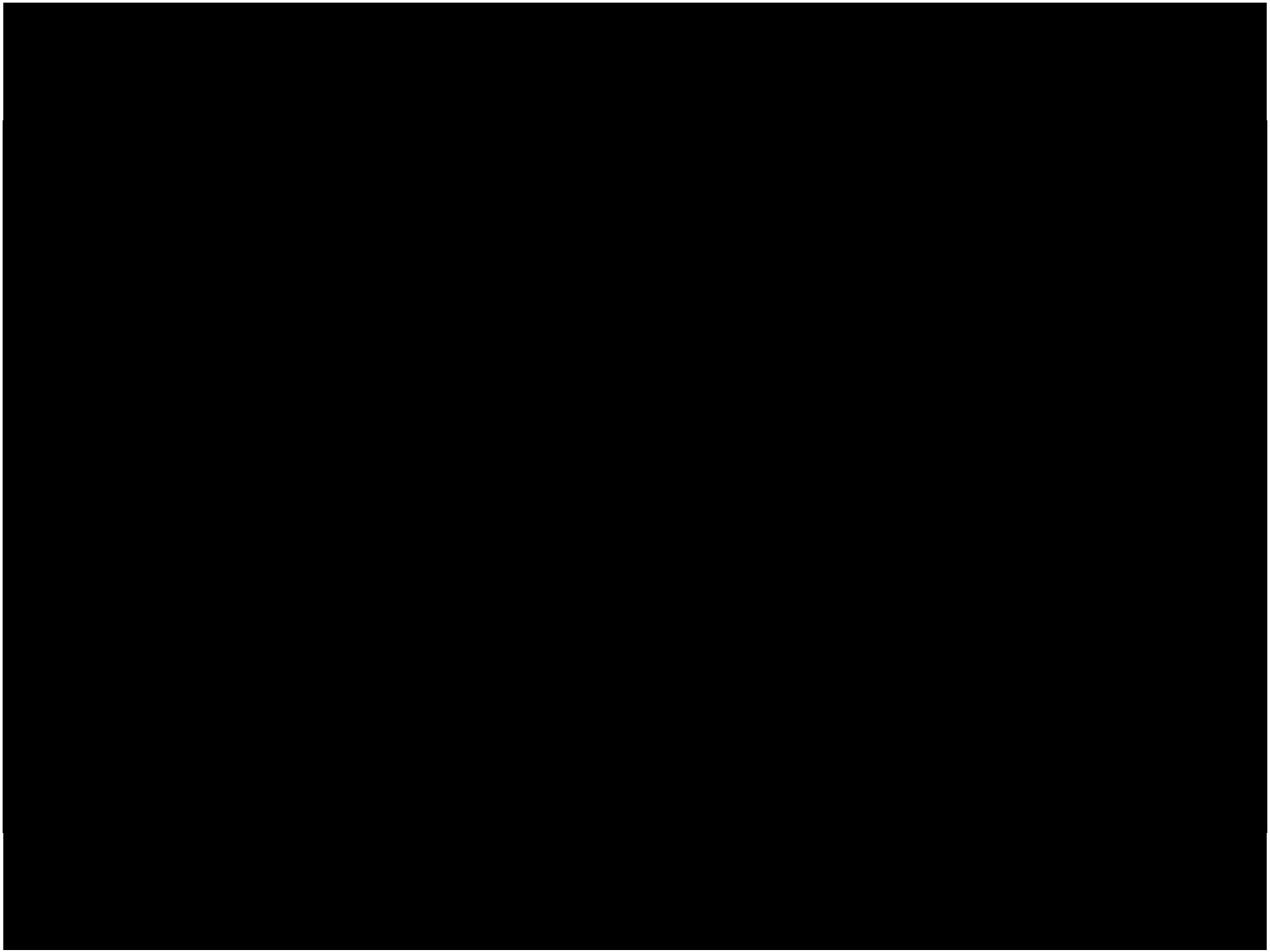
Examples



Results

- About 13 km (3km in urban area)
- Driven in about 18 minutes (at 11am on a working day)
- No human interventions

- Is autonomous driving solved?

New Test Vehicle

- Vision to replace 3D laserscanner for low-cost, 360 all-round perception
- Vision to replace precise GPS

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