POLITECHNIKA GDAŃSKA

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# XIV Międzynarodowa Konferencja Bezpieczeństwa Ruchu Drogowego

# GAMBIT 2023

## NOWA DEKADA – NOWE DZIAŁANIA – NOWE TECHNOLOGIE

### Politechnika Gdańska, 29-31 maja 2023

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**XIV Międzynarodowe Konferencja
Bezpieczeństwa Ruchu Drogowego
GAMBIT 2023
Nowa Dekada – Nowe Działania – Nowe Technologie**

**Politechnika Gdańska, 29-31 maj 2023**

# POSSIBILITIES OF APPLYING ARTIFICIAL INTELLIGENCE FOR THE EVALUATION OF ROAD SAFETY

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**Dipl.-Inf. Marek Skakuj, PMP**
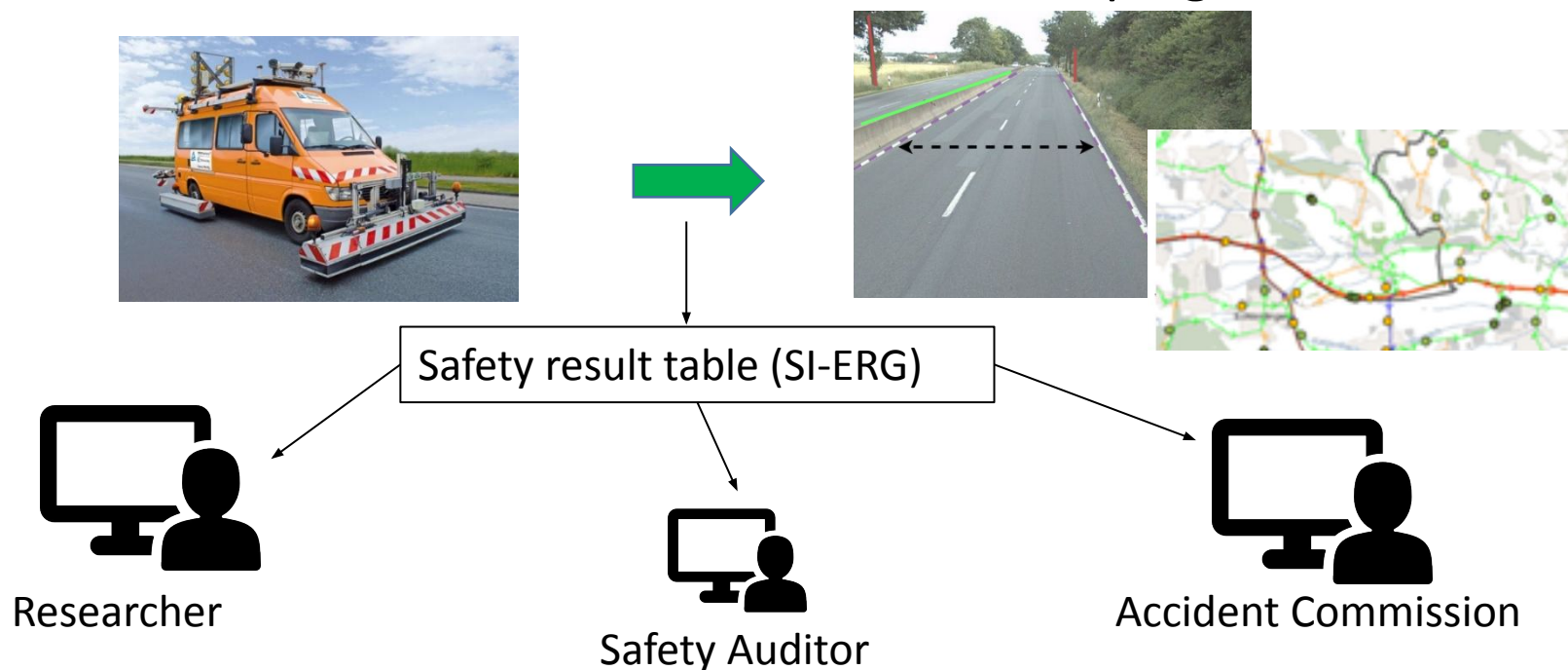
*HELLER Ingenieurgesellschaft mbH, Darmstadt*

# Motivation

Directive 2008/96/EC of the European Parliament and of the Council on road infrastructure safety management (revised as Directive (EU) 2019/1936 ).

- Extend reactive approach with **more preventive measures**
- **Road network** to be **visually inspected** and assessed, where possible **electronically**, for design features
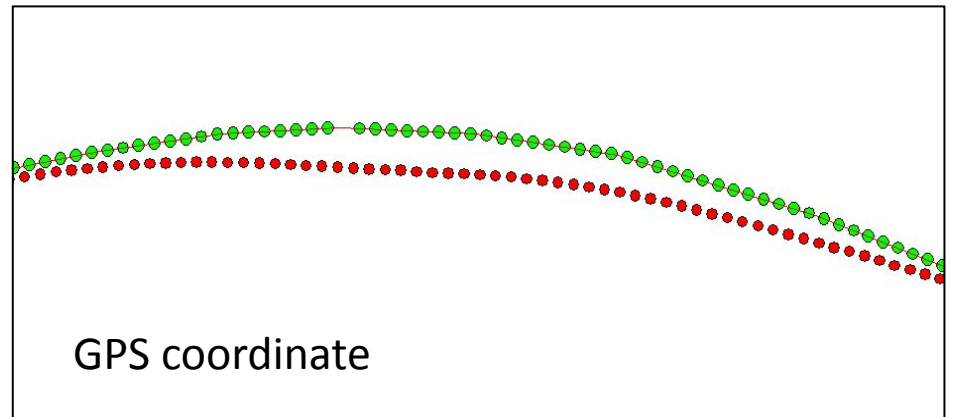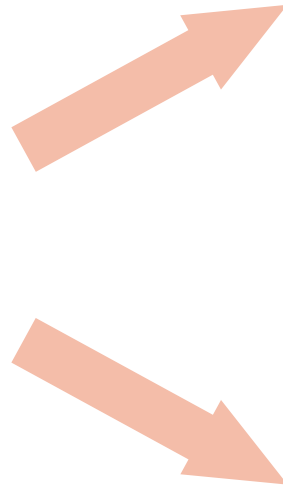- Develop appropriate **road safety monitoring**

# Motivation

Extension of the condition surveys to include an AI-supported calculation of safety-related parameters:
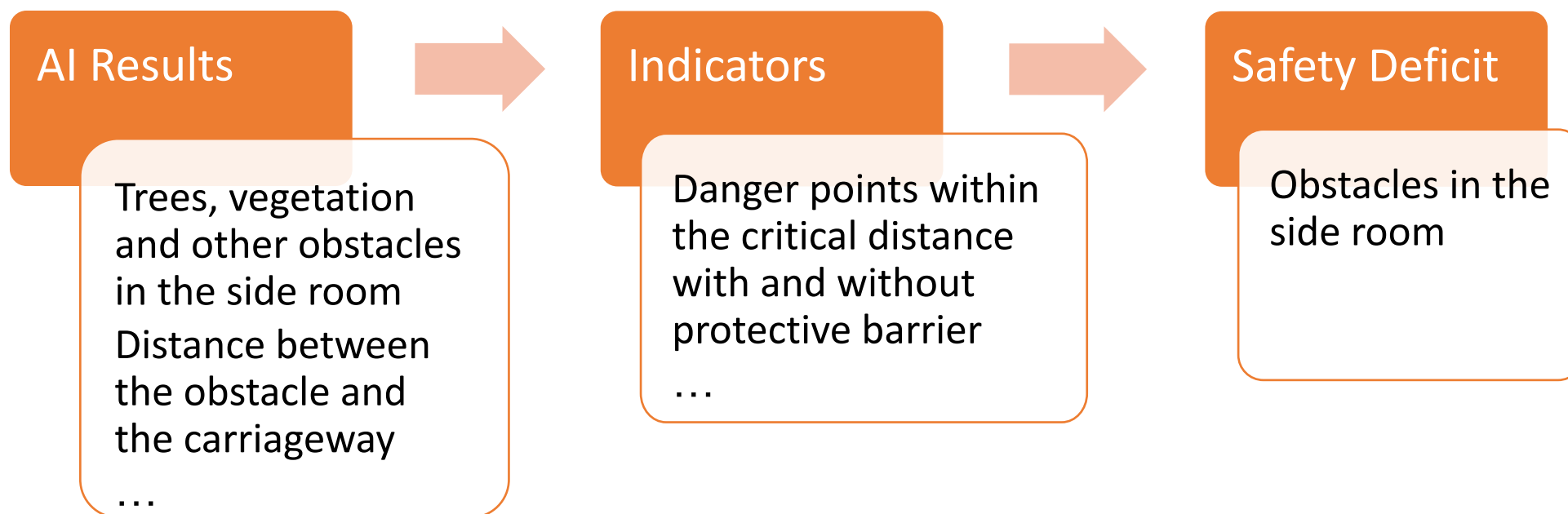
- Enables regular surveys every four years without additional inspection costs.
- Uniform data basis for a measurement campaign



Safety result table (SI-ERG)

Researcher

Safety Auditor

Accident Commission

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# Data utilization



Road picture



GPS coordinate

# Approach

**AI Results**

Trees, vegetation and other obstacles in the side room

Distance between the obstacle and the carriageway

…

**Indicators**

Danger points within the critical distance with and without protective barrier

…

**Safety Deficit**

Obstacles in the side room

# Safety deficit: Geometry

- Minimum radius not reached (R < min R), min R depending on standard cross-section

- Minimum length not reached (L < min L)

- Radius after straight line in the area to be avoided

- Radius following straight line only in usable range

- Radius relation in the area to be avoided

- Radius relation only in the usable range
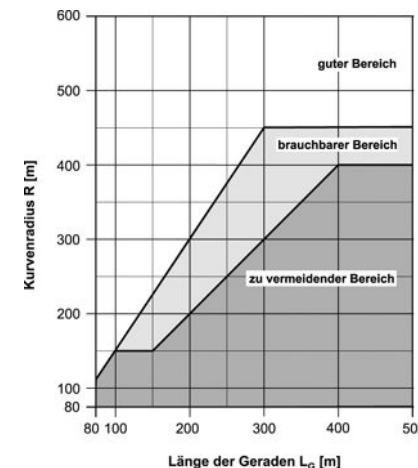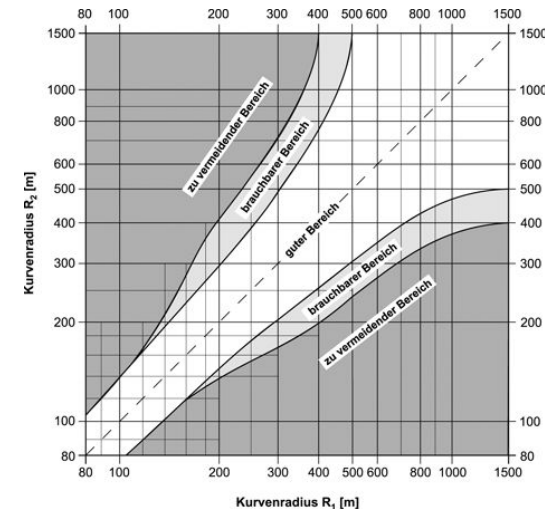


Source: RAL2012

# Safety deficit: Carriageway width

Types differ according to standard cross-section and lane width deviation e.g. for RQ11:

- Sum of lane widths 6.50 m ≤ B < 7.00 m

- Sum of lane widths 6.00 m ≤ B < 6.50 m

- Sum of lane widths B < 6,00 m

Standard cross-section 11
(Source: RAL2012)
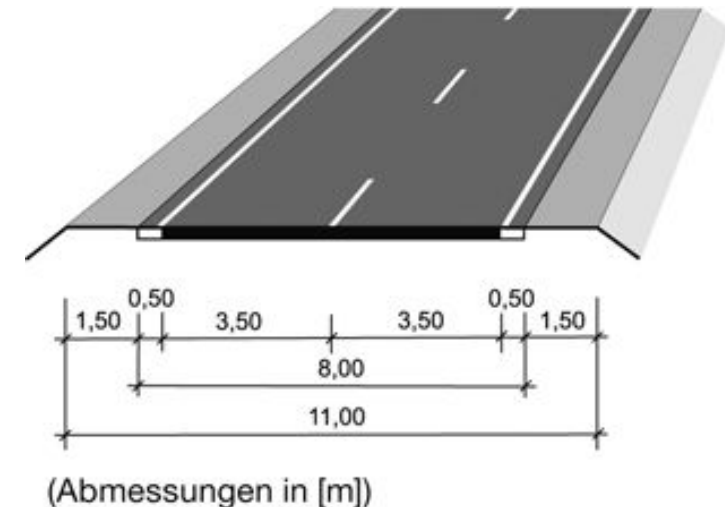
# Safety deficit: Obstacles in the side room

- Dangerous spot at the outer edge of the carriageway within the critical distance without protective device

- Dangerous spot at the outer edge of the carriageway within the critical distance with protective device
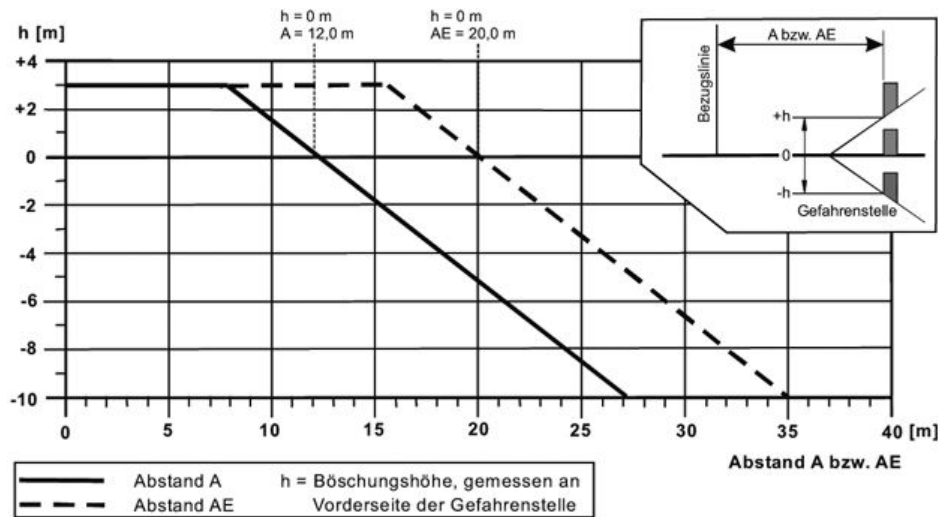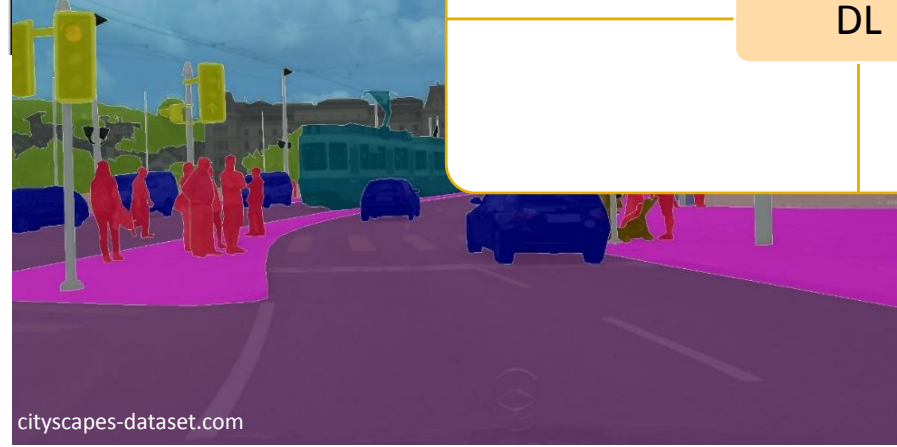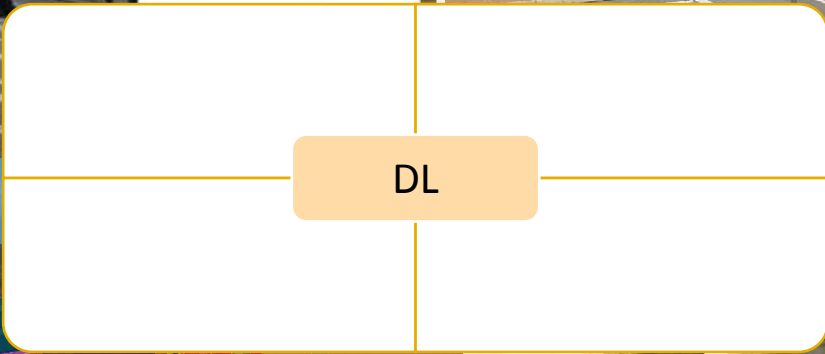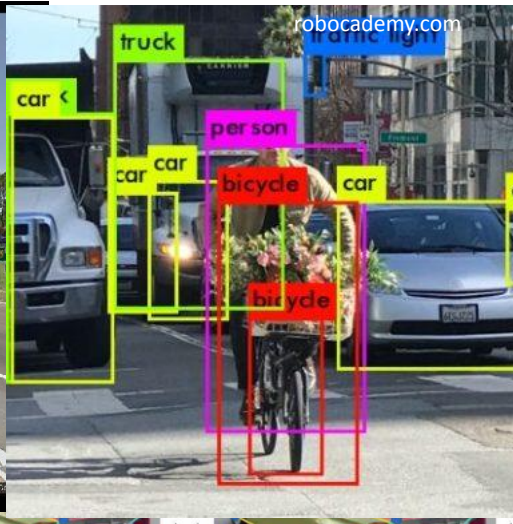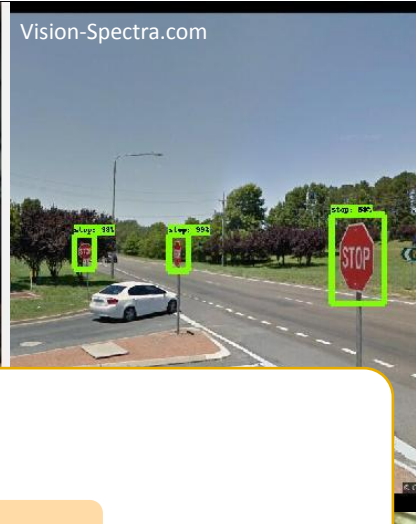


Critical distances for roads with Vzul = 80 km/h bis 100 km/h
(source: RPS2009)
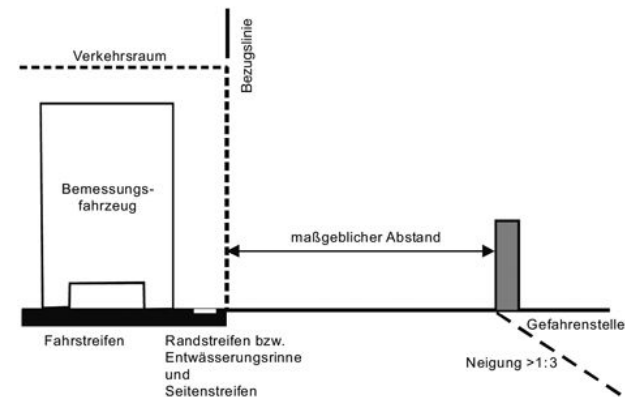
Determination of the relevant distance
(source: RPS2009)

# AI-Methods „ Supervised learning"



chatbotslife.com

Class: 16  Class: 4

Class: 4  Class: 12

Class: 18  Class: 26

input error  inner city

red traffic lights  green traffic lights

Vision-Spectra.com

robocademy.com

truck  traffic light

car

person

car  car  bicycle  car

bicycle
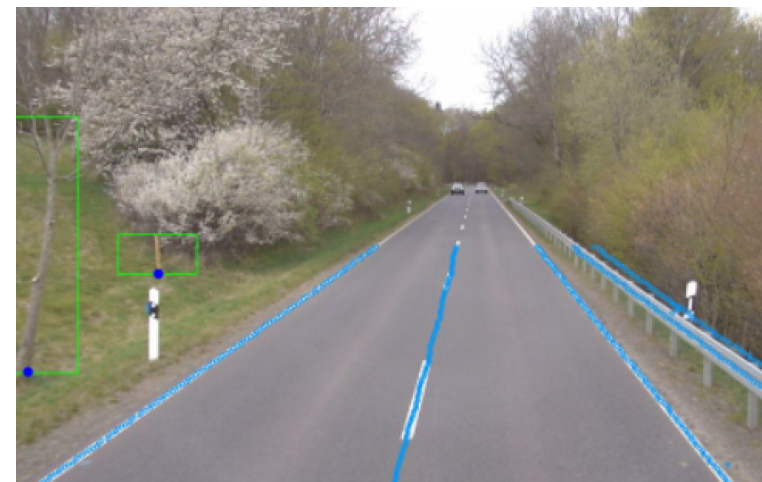
DL

cityscapes-dataset.com
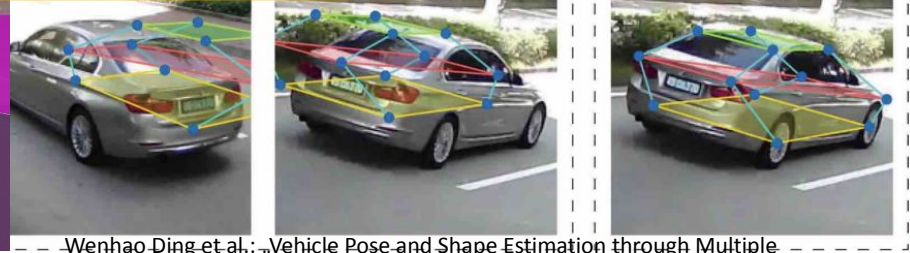
Wenhao Ding et al.: „Vehicle Pose and Shape Estimation through Multiple Monocular Vision"

# Convolutional Networks

RESA (Recurrent Feature-Shift Aggregator)

- Road markings
  - Standard cross-section
  - Lane width
- Tree line for dense vegetation
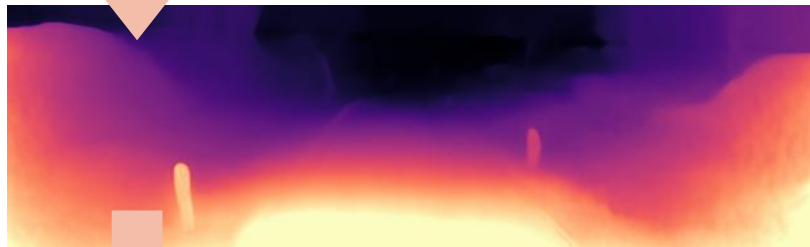- Passive guard devices

# Convolutional Networks

Faster RCNN + VGGNet

- Traffic signs:
  - Danger signs
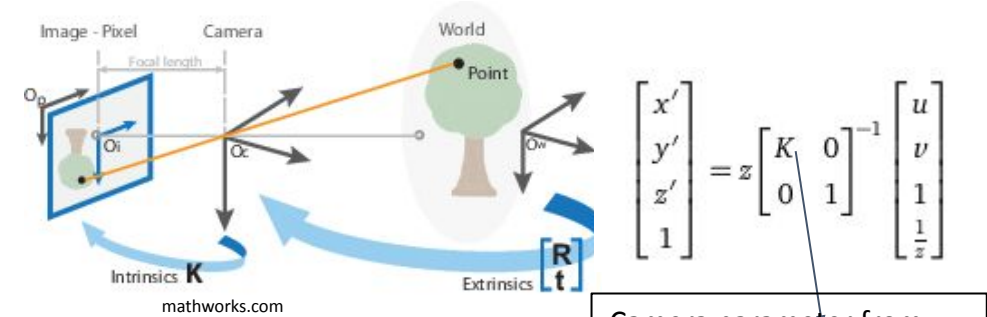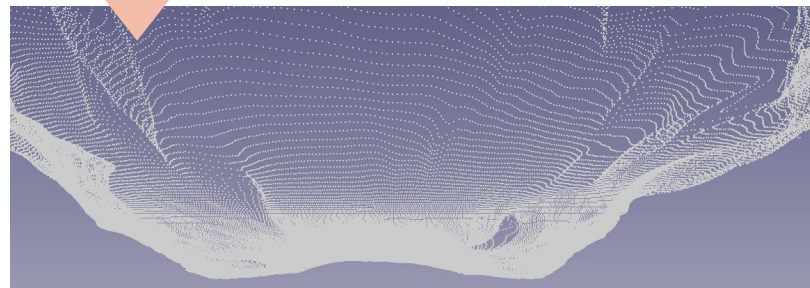  - Speed limits
- Single trees
- Side posts

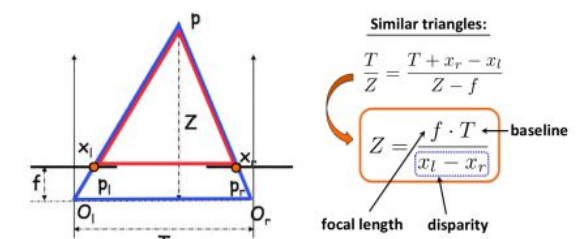# Estimation of geometric quantities and location of individual elements



Disparity map with monodepth2:

One 3D point per pixel:

$$\begin{bmatrix} x' \\ y' \\ z' \\ 1 \end{bmatrix} = z \begin{bmatrix} K & 0 \\ 0 & 1 \end{bmatrix}^{-1} \begin{bmatrix} u \\ v \\ 1 \\ \frac{1}{z} \end{bmatrix}$$

mathworks.com

Camera parameter from the survey

Similar triangles:

$$\frac{T}{Z} = \frac{T + x_r - x_l}{Z - f}$$

$$Z = \frac{f \cdot T}{x_l - x_r}$$

baseline

focal length    disparity

Sanja Fidler: „Intro to Image Understanding - Depth from Stereo"

# Test section 5421010O-5421012O

Location 1:

- Deficiencies in geometry and lane width also narrowed.

- Trees at a critical distance along the carriageway to the outside of the bend

- Passive protection only at the front of the bend (motorbike accident)

Location 2:

- Deficits in the geometry

- Critical distance is only not maintained at one point on the inside of the bend
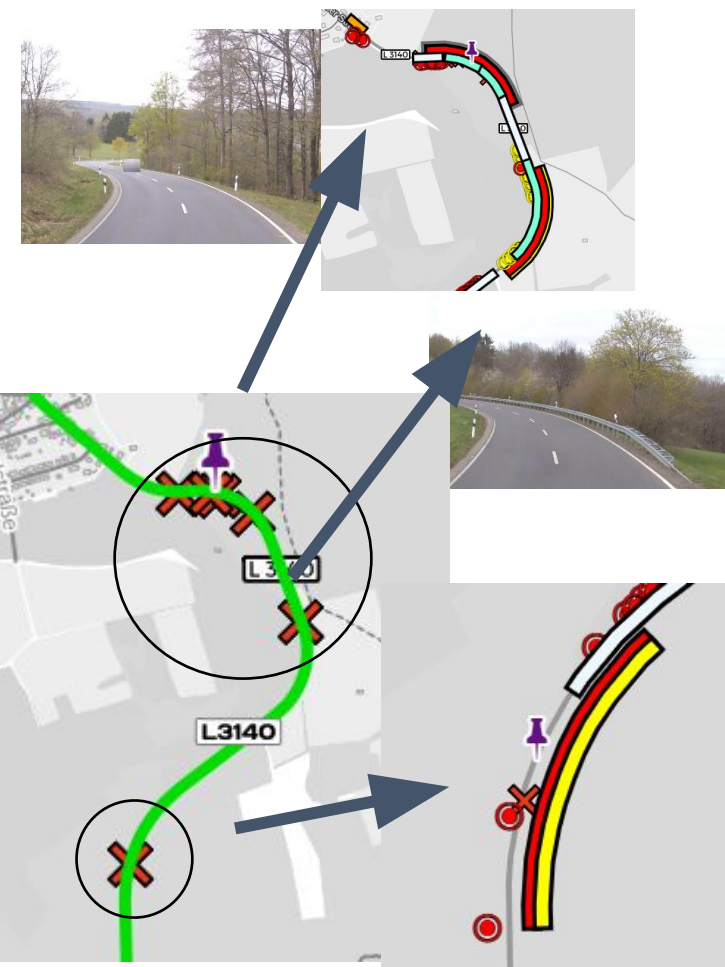
# Visualisation of results
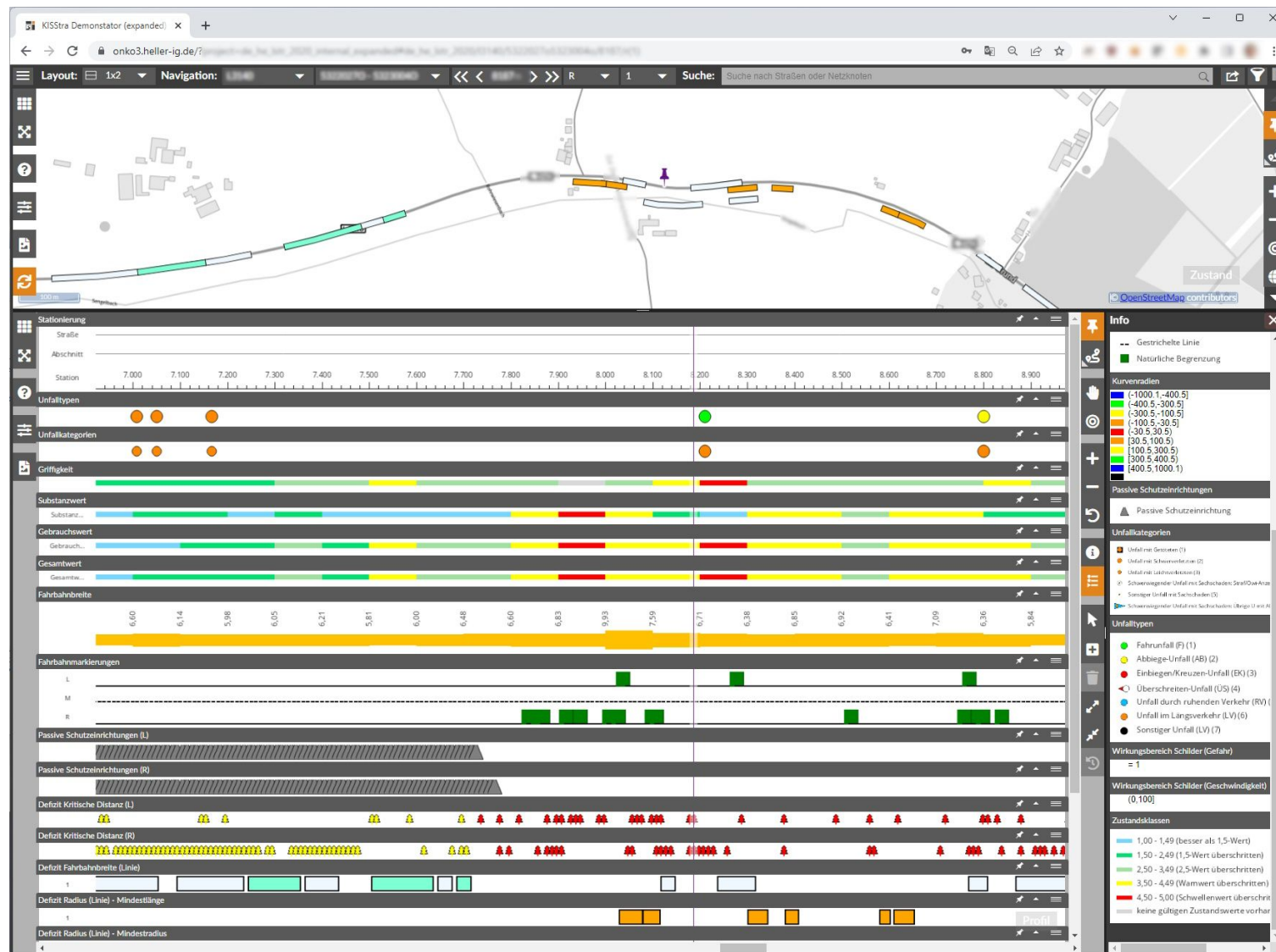
Map

Localisation

Accident data

Condition data

Lane width

Passive guard

Obstacles

Speed limits

# Outlook

- Improve AI (especially tree recognition)

- Further deficits like "sight distances"

- Practical application possibilities:
  - Integration with additional data similar to traffic safety screening in Baden-Württemberg.
  - Part of accident analysis for accident clusters on rural roads
  - Statistical analysis: Better characterization of the contribution of individual characteristics to accident costs

More about the project in the July issue of "Straße und Autobahn"