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An automated detection system for (forest) road conditions – FORMEC 2016

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- School of Agricultural, Forest and Food Sciences HAFL

An automated detection system for (forest) road conditions – FORMEC 2016

Structure

- Existing Systems
- Day-to-day business approach
- Conceptual design
  - Hardware components
  - Evaluation software
- Latest results
  - Reliability of the ultrasonic sensor use
  - Reliability of the wheel sensors in use
- Hardware changes
- Conclusions

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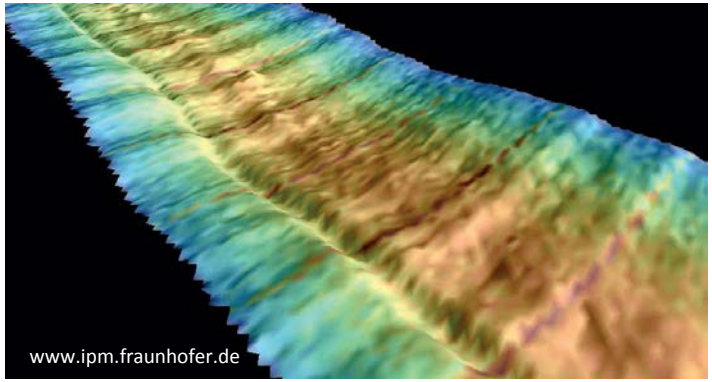
Existing systems and measurement principles

Existing Systems

- Laser based (for example PPS)
- Acceleration Measurements (OptiGrade, Smartphone)
- Light-Section principle
- Radar
- …



Time effort:

- Supplementary measuring campaigns
- Dedicated vehicles for data collection
- Time delay

Quality:

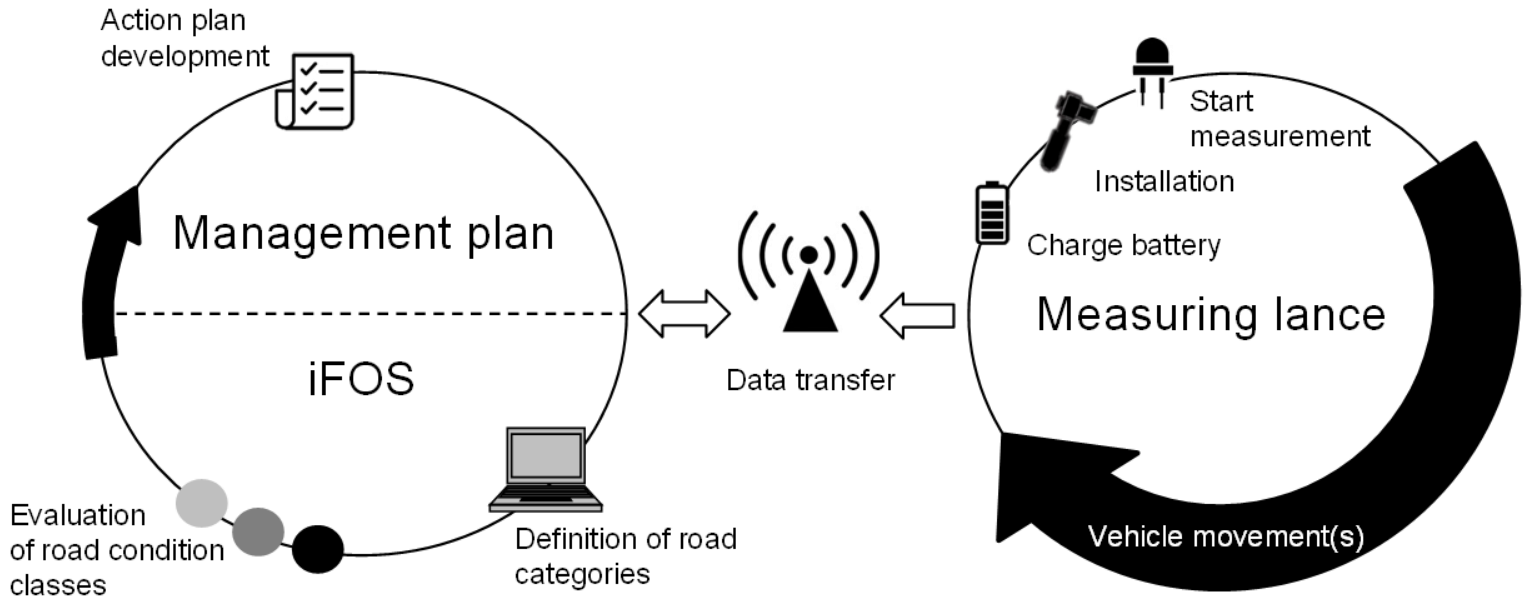
- Optimized for sealed road surfaces
- Weather and dirt sensitive
- Limited variables for predictive maintenance concepts

Financial aspects:

- Expensive

Day-to-day business approach

- Low purchase cost of the system
- Designed for aggregate surfaces and their maintenance
- Weather resistant
- Day-to-day business integrated measurements
- Automatic classification



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Conceptual design

Hard and software components

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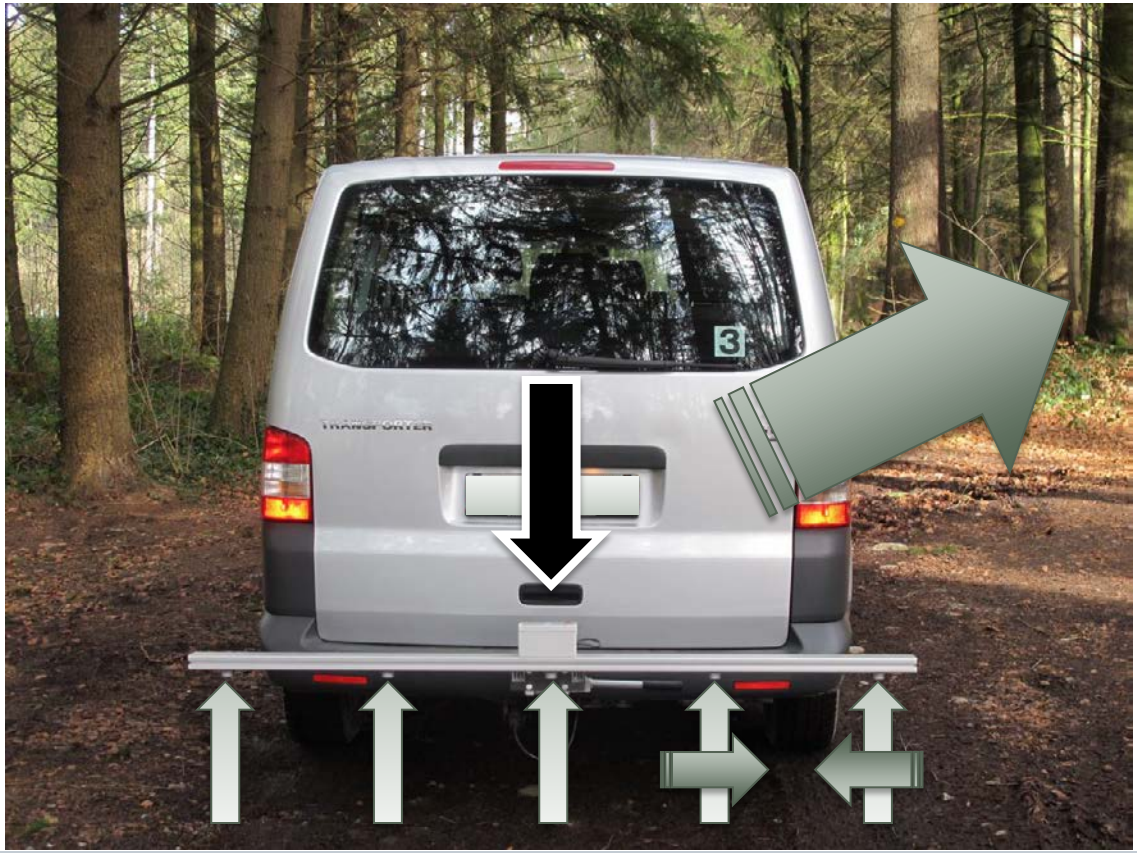
Hardware Components

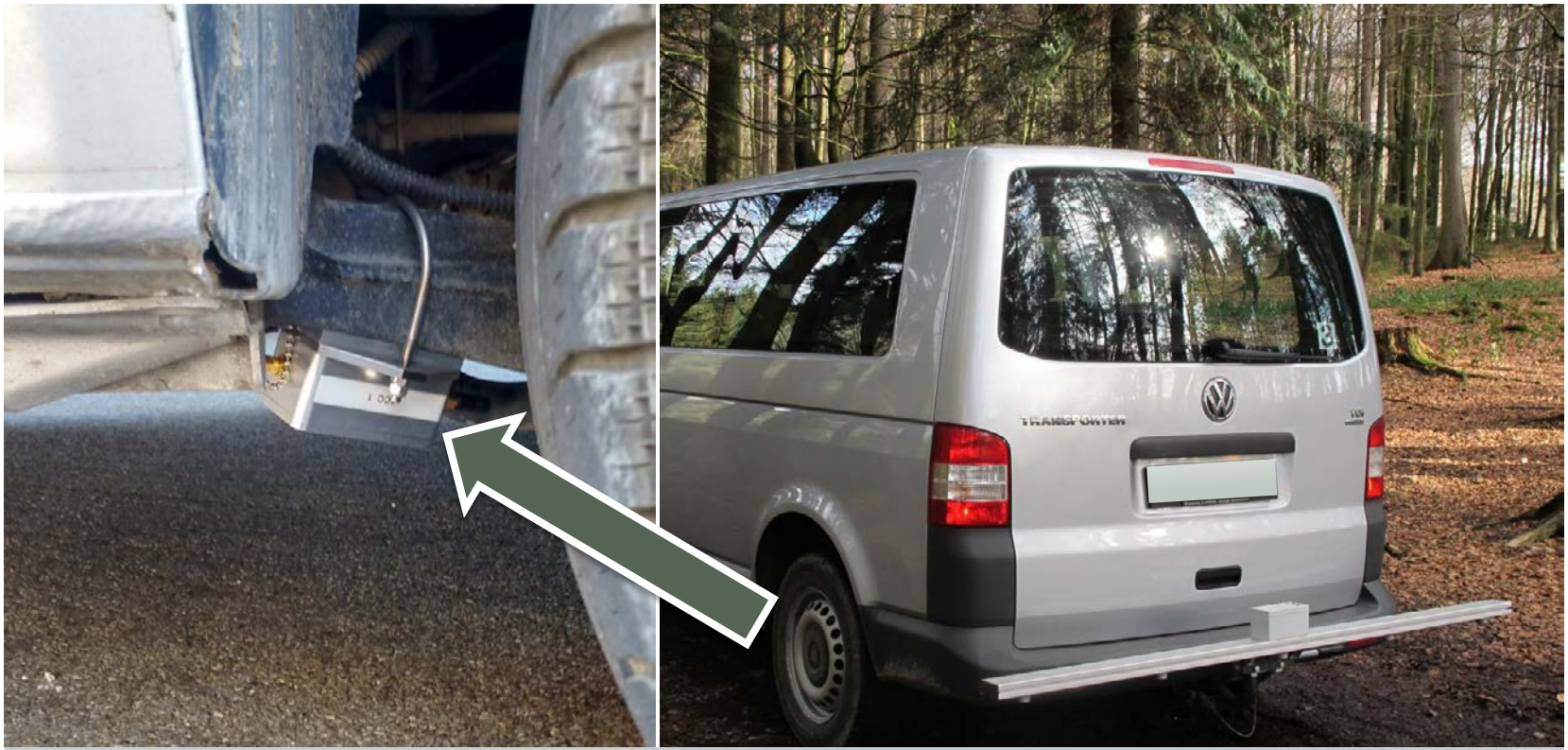
The measuring bar – scanning of the cross-section profile



GPS 1 Hz / Ultrasonic 10 Hz / Acc and Gyro 50 Hz

Hardware Components

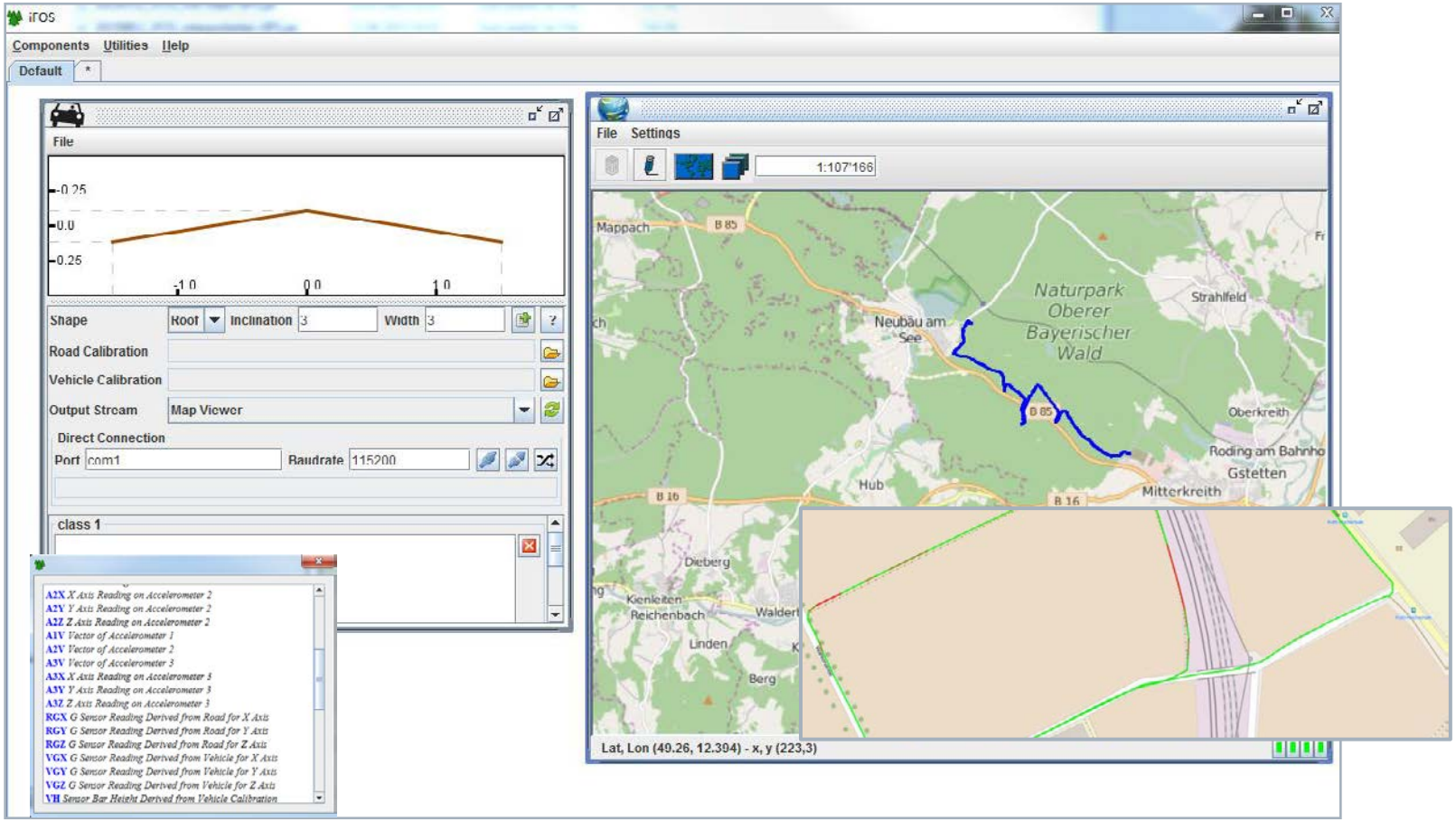
The wheel sensors – longitudinal roughness



Logging variant 50 Hz up to 800 Hz – mounted below shock absorbers

Evaluation software

iFOS



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Latest Results

Schuler 2014; Roos 2015; Hug 2016

Reliability of the ultrasonic sensors in use

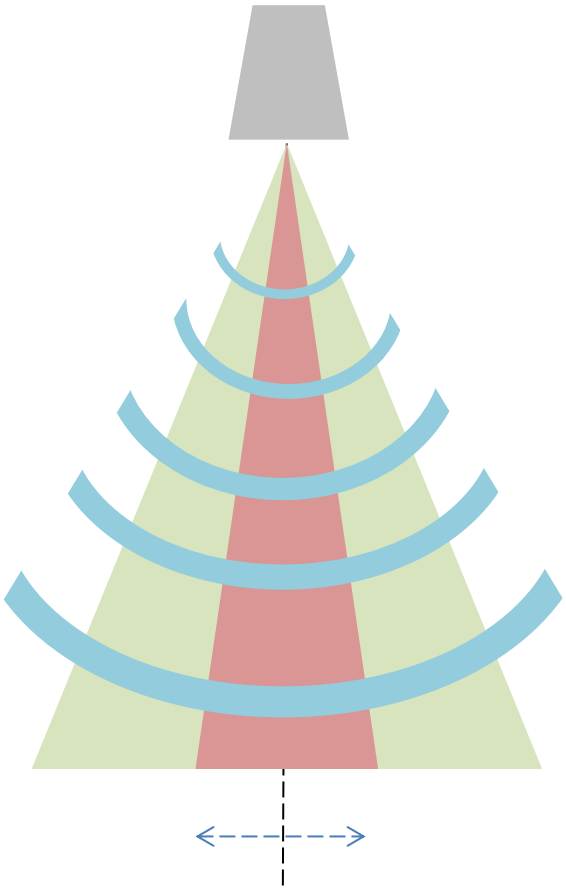
General specifications

Recording the cross section profile
(profile distresses, ruts)

- water or dust influence
- low cost

- distance measurement setup
- designed to detect nearest object

- highest probability of object / distance detection in the center-beam



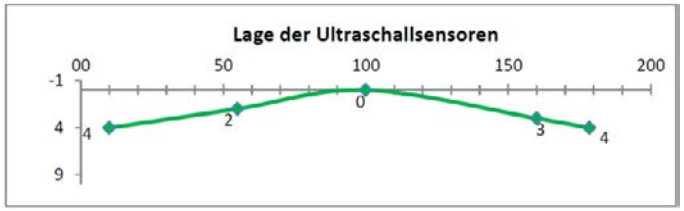
For small objects, more information is necessary

Reliability of the ultrasonic sensors in use

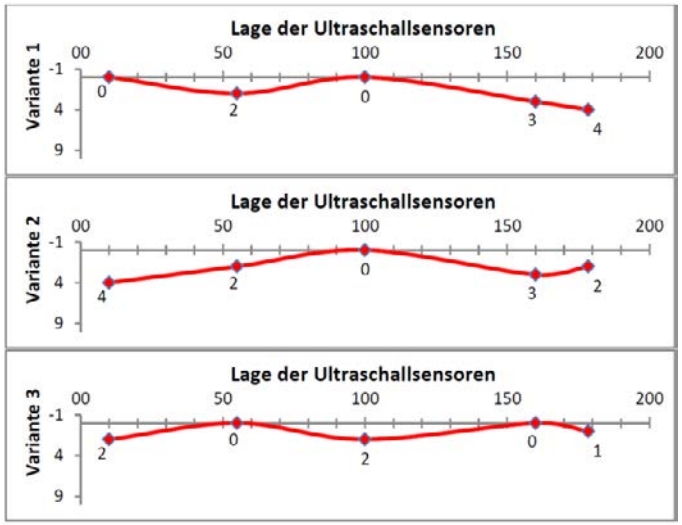
Cross-section profile

Classification Thüringen Forst (Roos 2015)

Class 1:



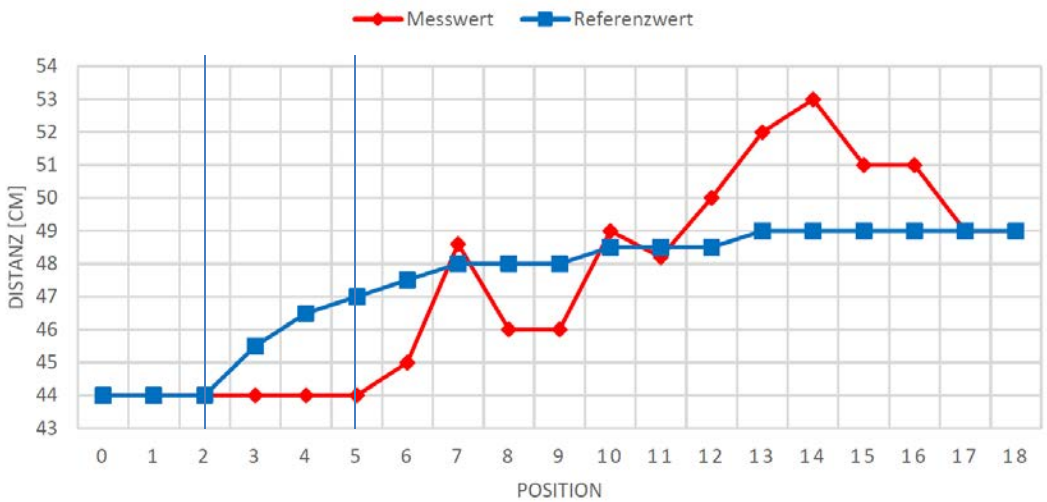
Class 4:



Logging and dividing geometry distresses in the cross-section profile in four classes:

Reliability of the ultrasonic sensors in use

Cross-section profile - Hug 2016 – Detecting ruts



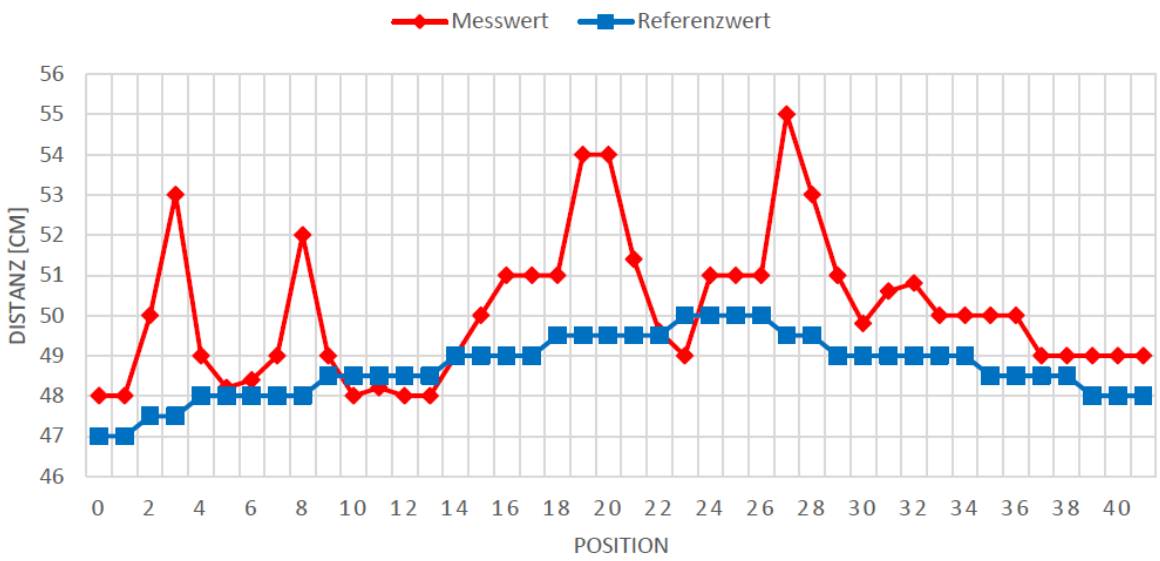
Significant correlation (Hug 2016) - rut detection is possible

Confirming Schulers' (2014) and Roos' (2015) observations

Reliability of the ultrasonic sensors in use

Longitudinal roughness - Hug 2016 - Detecting potholes

Even under laboratory conditions not possible.

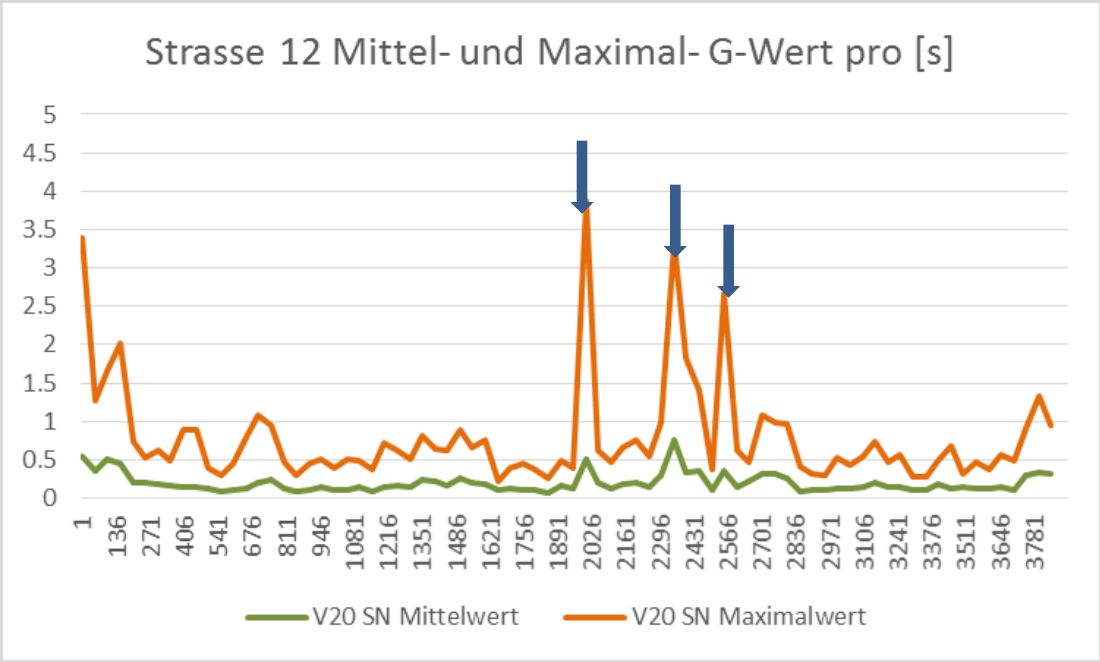


Will not be considered for this purpose

Reliability of the wheel sensors in use

Longitudinal roughness – Schuler 2014 - Detecting potholes

Pothole detection for mean and maximum values of the wheel sensor acceleration data



Suitable approach for the missing data – currently under research
Roughness as a proven variable at this time still missing in the post processing

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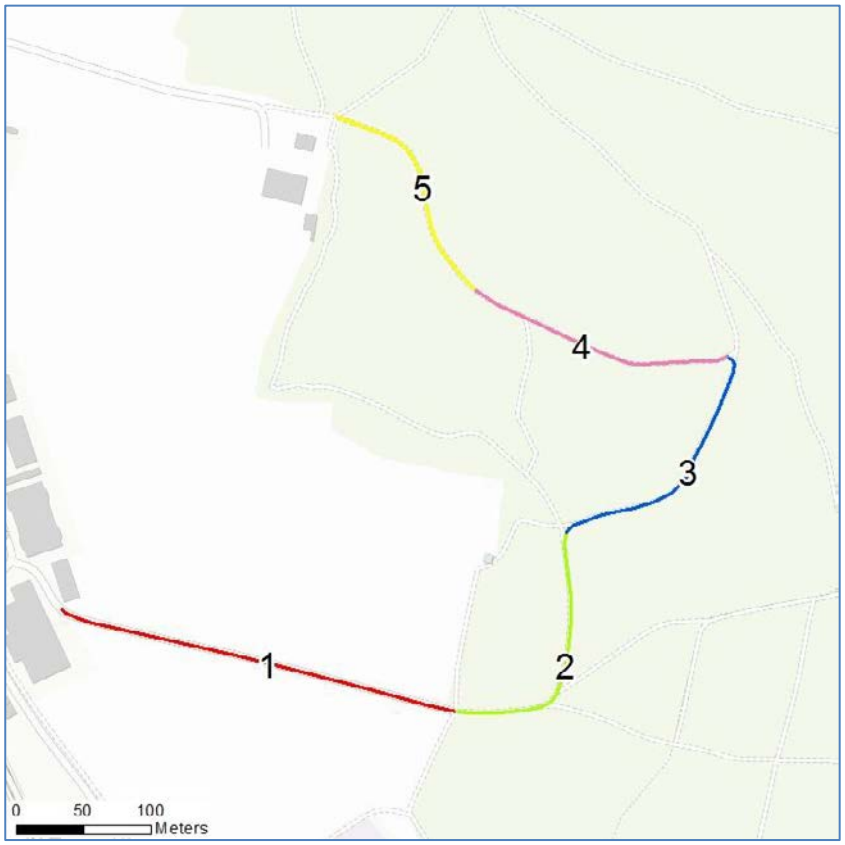
Hardware Changes

Hug 2016

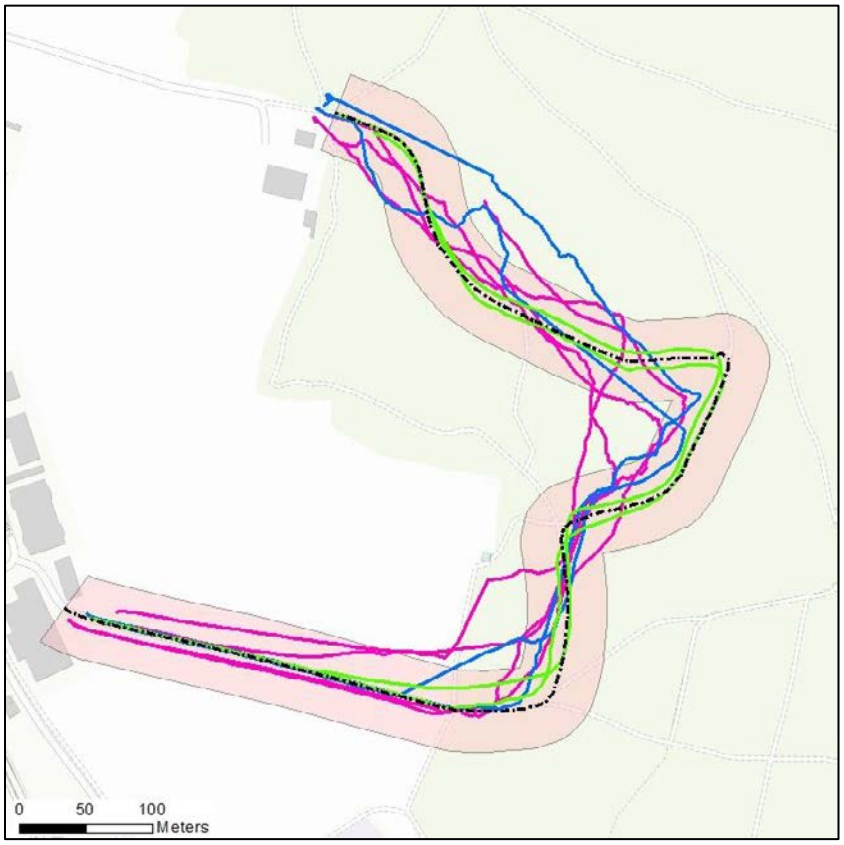
GPS and distress locating accuracy – line based

Hug 2016

NEO 6M (red); EVK – M8 (blue) incl. ext. antenna (green)



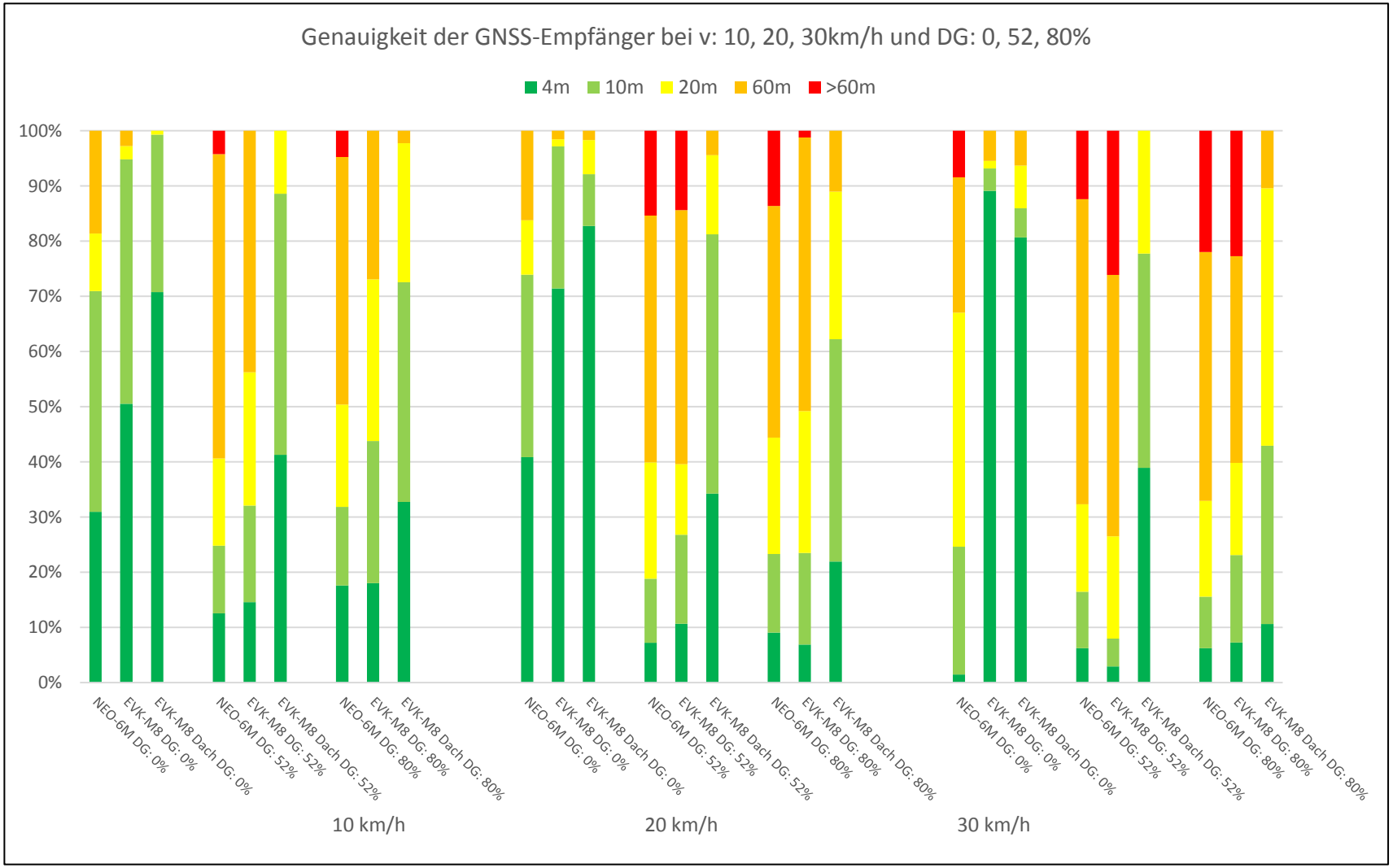
Segment 1 – CP 0 % ; Segments 2+4 – CP 80 % ; Segments 3+5 – CP 52 %



v=30 km/h

GPS and distress locating accuracy – line based

Hug 2016



Conclusions

Ultrasonic sensors suitable for cross section monitoring and rut detection
Ultrasonic sensors essential for maintenance survey

Wheel sensor data suitable for longitudinal road roughness

Evaluation of the sensor data needs further research

GPS hardware update (NEO M8) offers substantial boost in localization accuracy

Thank you!