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

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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
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
Conceptual design

Hard and software components
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
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:

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

Class 4:
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

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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

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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

Genauigkeit der GNSS-Empfänger bei v: 10, 20, 30km/h und DG: 0, 52, 80%

- 4m
- 10m
- 20m
- 60m
- >60m

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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!