How Smooth is Your Ride?

A Comparison of Sensors and Methods for Surface Quality Assessment

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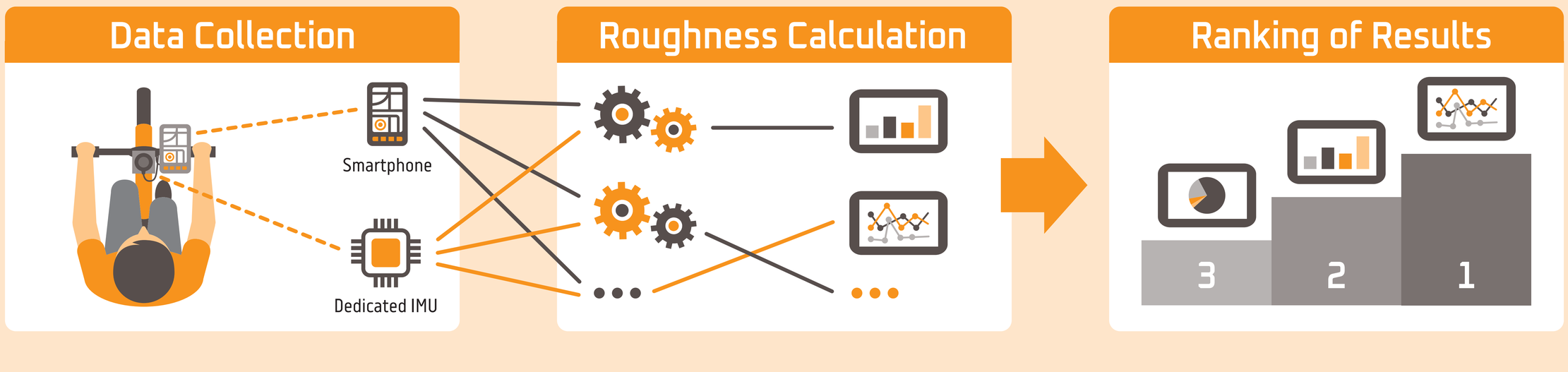
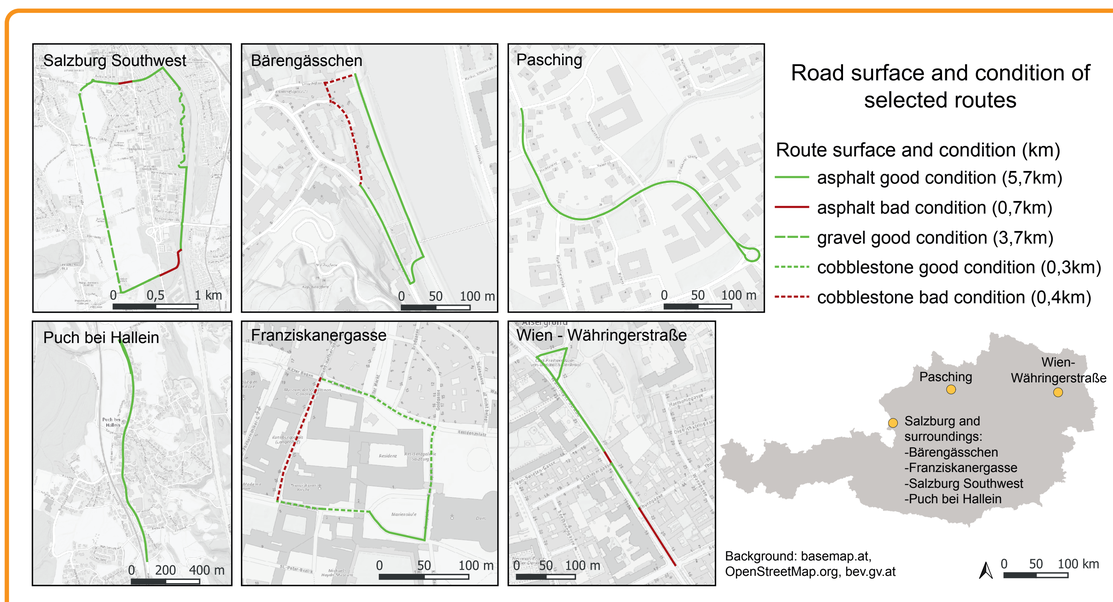
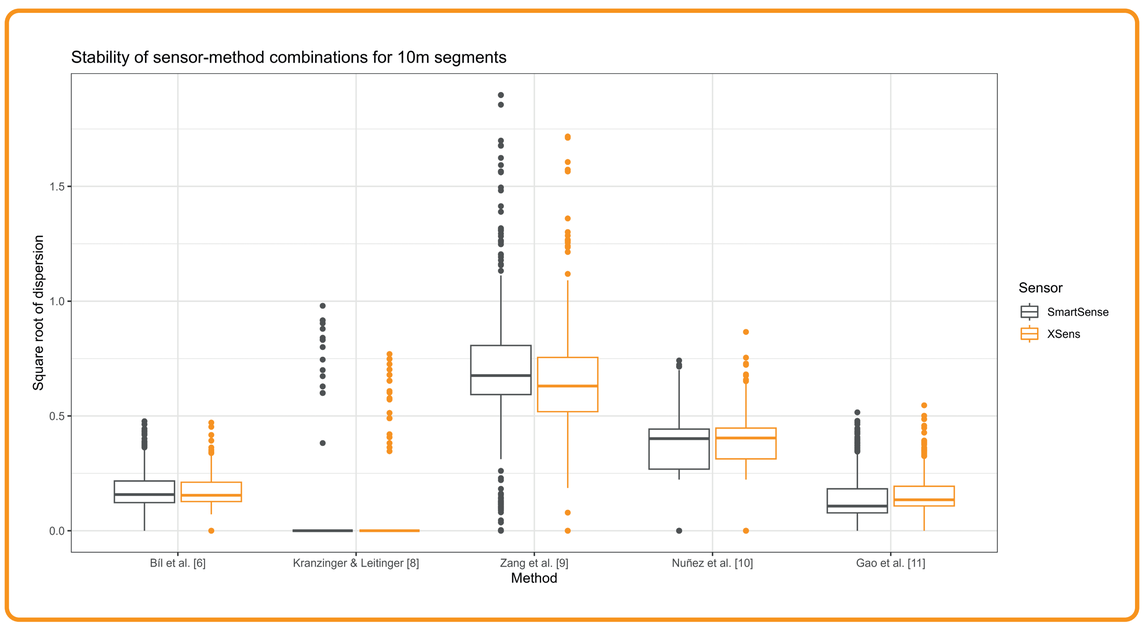


The surface roughness of bicycle infrastructure is a well-established component of bicycle comfort [1]. Most works on measuring it use acceleration data [2] collected with dedicated devices [3, 4] or smartphones [5-7]. The aim of this work is to provide insights on the properties of different combinations of acceleration sensors and calculation methods for roughness and comfort. To achieve this, test data from both types of sensor was collected during the same test rides. Subsequently, simplified versions of five well-established methods [2-6] to assess roughness or comfort were applied to the collected data. For each combination of sensor and calculation method, the stability and reliability of the resulting assessments were evaluated. Based on these two metrics, a recommendation of which combinations to use under which circumstances could be provided.





Experiment Design

- A Xiaomi Mi 9X smartphone and an industry-grade IMU built into the XSens MTI-680G device were used for data collection
- Following previous works, surface roughness was calculated for segments of 5 [5], 10 [6], 20 [7] and 100 [3] meters
- Three of the considered methods to derive roughness yielded numerical assessments [3, 4, 7], while the other two yielded 4 [6] and 6 [5] ordinal classes respectively
- As stability measure, the dispersion of derived roughness or comfort measures on the same segment is considered
- As reliability measure, Spearman's rank correlation coefficient ρ [8, pp. 140-148] is considered, as it provides comparability of numerical and ordinal assessments

Results

- Stability depends predominantly on the used calculation method, the used sensor only plays a minor role
- Implementation of methods proved difficult due to imprecise and sometimes incomplete descriptions
- Spearman's rank correlation showed promising results, but further analysis is needed to assess the significance
- Longer segments lead to less dispersion while average ratings remained the same. However, spatial accuracy obviously decreases
- The effect of different sensors and segment lengths on reliability varied between methods

References: https://srfg.at/smooth-ride

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The research leading to these results has received funding from the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK)

Bundesministerium
Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie