Human-centered Evaluation of Localized Surface Roughness in Terms of Biosignals

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ABSTRACT

The International Roughness Index (IRI) has been applied to the roughness evaluation of pavement surfaces in Japan. In case of expressways, the IRI is applied with the following two specific criteria: a fixed interval of 200 meters and a fixed interval of 10 meters. However, the gap between the maintenance criteria in terms of the IRI and the road users rating has been reported for the ride quality for expressways which is due mainly to the localized surface distress. This study conducted field surveys on in-service expressways where the complaints regarding ride quality were reported by road users even though the surface conditions were less than the maintenance threshold. At the locations, the longitudinal surface profiles as well as the distress types were acquired in the survey. After that, the data were virtually reproduced and examined by a motion base driving simulator involving road users as participants. The simulator experiment introduced two measurers of biosignals, the electrocardiogram (ECG) and the electrodermal activity (EDA), to comprehend unconscious mental stress of the participants toward vehicle vibrations induced by the surface roughness. This study examines the relationship between road surface characteristics in terms of the profile wavelength and the mental stress quantified by the biosignals. As a result, the mental stress increases with increasing amplitudes of wavelength ranging from 4 to 8 meters of a profile. Consequently, the IRI brings underestimation of ride quality because it less responds to this waveband. In contrast, the Ride Number which emphasizes these wavelengths well corresponds to the mental stress. This study describes how the localized surface roughness corresponds to the mental stress of road users in terms of the biosignals. The outcomes of this study contribute to the development of sustainable road transportation on the basis of human-centered design concept.

Keywords: *Road Surface Roughness, IRI, Heart Rate Variability, Skin Conductance Response, Human-centered Design.*