

Identification of High-Quality Tactile Requirements for an Instrument Panel through Friction Measurement and Fingertip Surface Visualization

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In recent years, tactile quality has become a key factor influencing the user experience in automotive interiors. However, the physical factors underlying high-quality tactile sensations remain unclear because tactile perception arises from the complex interaction of multiple factors, including friction, surface texture, and fingertip deformation. In this study, sensory evaluation, friction measurement, and visualization of fingertip surface behavior during tactile exploration were integrated to investigate the factors contributing to high-quality tactile impressions of instrument panels.

First, tactile evaluations and friction measurements using a force plate were conducted on actual interior materials with different grain pitches. The results showed that perceived comfort was strongly associated with sensations of moistness and smoothness. In addition, periodic stimulation frequencies were estimated from the finger scanning velocity and representative grain pitch. The results confirmed that differences in grain structure altered the frequency range of stimuli applied to the fingertip surface. In particular, specimens rated as having superior tactile quality showed estimated periodic stimulus frequencies corresponding to the sensitivity ranges of tactile mechanoreceptors.

Furthermore, a visualization system using transparent glass specimens was developed to capture fingertip surface behavior during sliding contact with a high-speed camera. Through image analysis, feature-point tracking and displacement vector field calculations were performed to visualize the displacement and strain distributions of the fingertip surface under sliding contact. The proposed method demonstrated the potential to quantitatively evaluate dynamic fingertip behavior that cannot be sufficiently characterized by the coefficient of friction alone.

These results suggest that periodic spatiotemporal stimuli generated by grain structures play an important role in the formation of high-quality tactile sensations. Moreover, visualization of fingertip surface behavior provides an effective approach for elucidating the mechanical mechanisms of tactile perception. Future work will focus on correlating fingertip deformation metrics with sensory evaluation results to establish design guidelines for high-quality tactile surfaces.

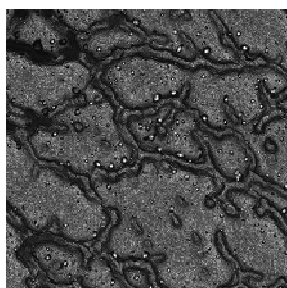


Fig.1 Instrument Panel

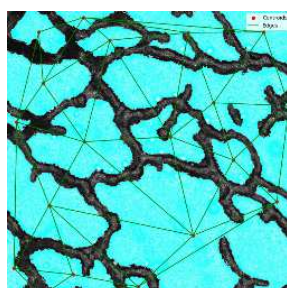


Fig.2 Representative Surface Grain Pitch

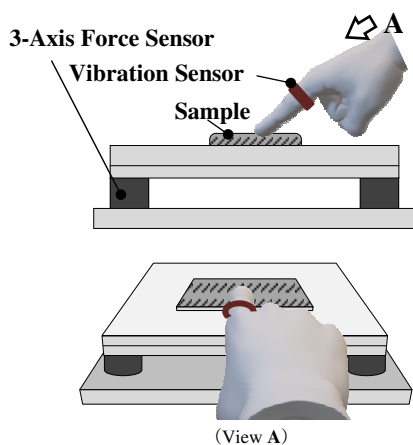


Fig. 3 Force Plate Friction Measurement

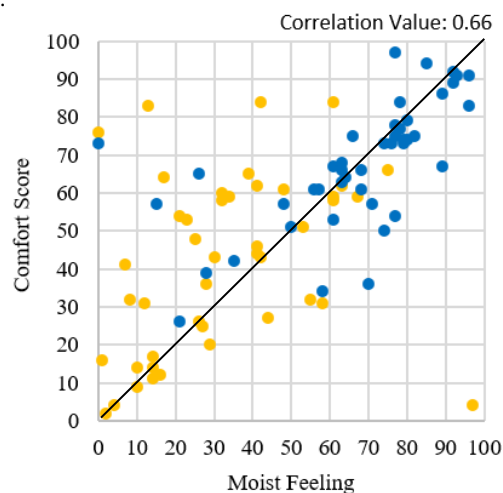


Fig.4 Relationship between Comfort Score and Moist Feeling

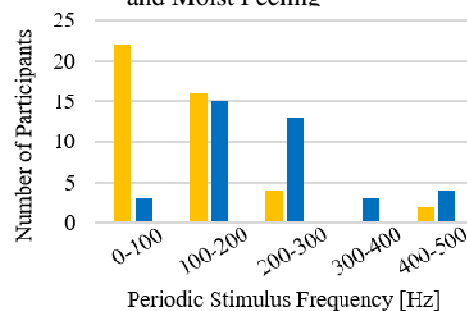


Fig.5 Distribution of Estimated Periodic Stimulus Frequency on the Fingertip Surface