Material Properties Affecting Ultrasonic Lubrication

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- 1. Perceptual difference between flat materials
- 2. Impact of Interfacial material on ultrasonic vibration
- 3. Human perception of 3D contact force

Tactile perception of flat materials

The tactile perception of materials with identical topography and coefficient of dynamic friction but different molecular properties



Which sample is different from the other two?

Psychophysical results



Skin humidity matters



Moisture had a very clear impact on perception

Underlying contact mechanics



Better correlation with performance at the onset of touch

Gueorguiev, D., Bochereau, S., Mouraux, A., Hayward, V., & Thonnard, J. L. (2016). Touch uses frictional cues to discriminate flat materials. Scientific reports, 6, 25553.

Take-home message

- Humans can discriminate whether a material is hydrophilic or hydrophobic
- Skin humidity strongly impacts discrimination
- The onset of touch seems to mediate perception

Ultrasonic friction modulation

STIMTAC



Ultrasonic vibration on different materials



Gueorguiev, D., Vezzoli, E., Mouraux, A., Lemaire-Semail, B., & Thonnard, J. L. (2017). The tactile perception of transient changes in friction. Journal of The Royal Society Interface

Ultrasonic vibration on different materials



Ultrasonic vibration on different materials



Video of a typical trial



Psychophysical results US



Psychophysical results Force



Tangential force reduction



Cornuault et al. 2015



Weber fraction (sensory thresholds)



Take-home message

- Aluminum requires a lower ultrasonic amplitude to render a perceivable signal
- Materials did not influence the perception of a given amount of tangential force reduction
- Individual coefficients of dynamic friction influence the % of tangential force reduction but not its perception.

Independently modulating normal and tangential force



Which metric better captures participants' answers?



3D contact force amplitude best matches participants' responses

Conclusion

- Humans can feel the hydric properties of materials
- Interfacial materials impact the amount of ultrasonic lubrication... but not its perception
- The 3D contact force vector seems a more relevant metric than the coefficient of dynamic friction
- Future work should study materials with more various surface properties

Acknowledgements

