Dependence of Texture-Elicited Skin Vibration on Scanning Speed

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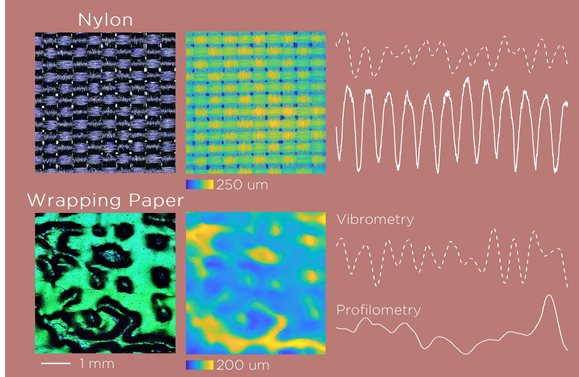
Overview

Introduction:

- When a fingertip moves over a texture, vibrations unique to the microgeometry of the texture are elicited in the skin[1].
- The speed at which the texture is explored modulates the frequency and intensity of the vibrations.

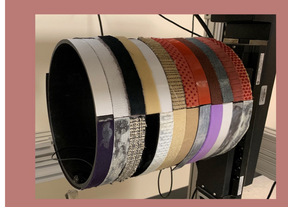


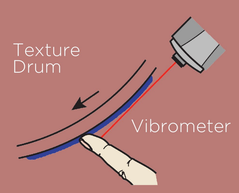
Motivation:

- What is the relationship between speed and intensity?
- Is this relationship consistent across individuals?

Approach:

- We used a robotic texture drum to scan textures across the fingertips of human subjects at many speeds .
- Skin vibrations were recorded with a laser Doppler vibrometer[2].
- We developed a model to predict how vibratory intensity changes with changes in speed.





Conclusions:

- Increases in speed result in more intense texture-elicited vibrations.
- The frequency warping model can predict vibratory intensity at any speed from the vibratory trace measured at a single speed h a high degree of accuracy.

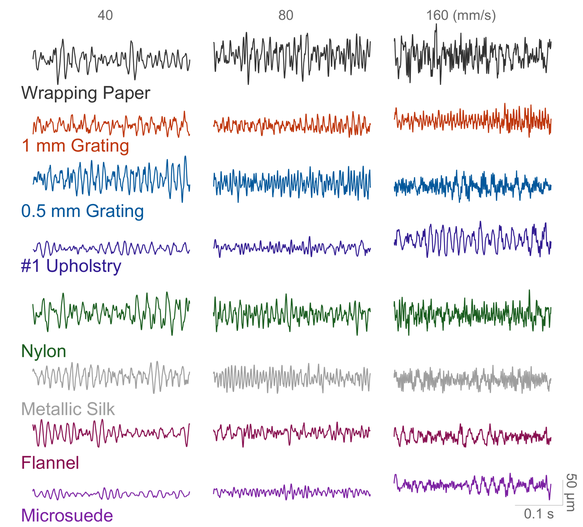
Further reading:

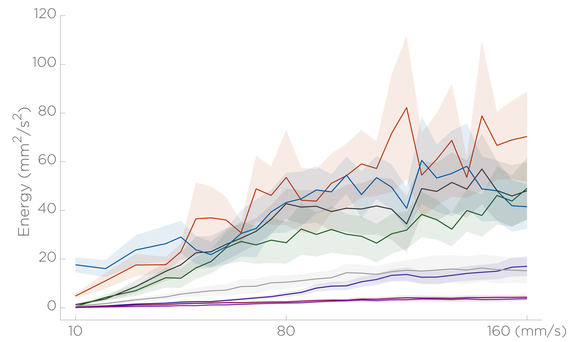
Greenspon et al (2019). Texture-elicited vibrations stretch or contract systematically depending on scanning speed. *bioRxiv*.

1. Manfredi et al (2014). Natural scenes in tactile texture. *Journal of Neurophysiology*.
2. Manfredi et al (2012). The Effect of Surface Wave Propagation on Neural Responses to Vibration in Primate Glabrous Skin. *PLoS ONE*.

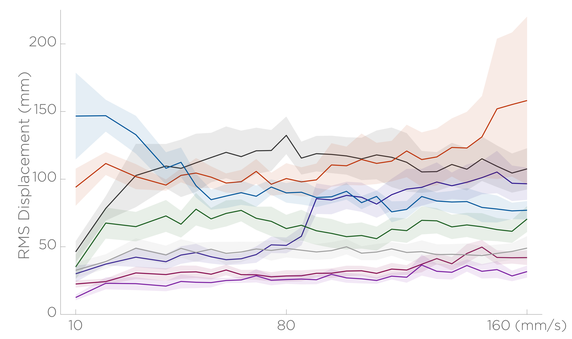
Results

As speed increases, so does the energy of the skin vibrations.

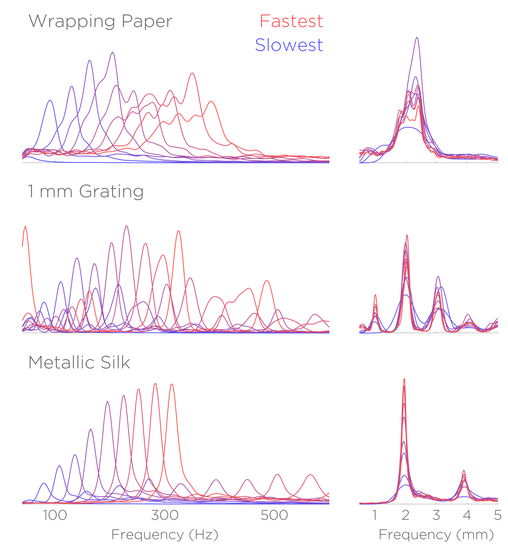




However, the amplitude of the vibrations remains relatively constant.

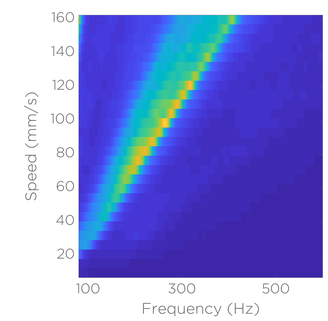


The vibrations stretch or contract systematically with decreases or increases in scanning speed, respectively.

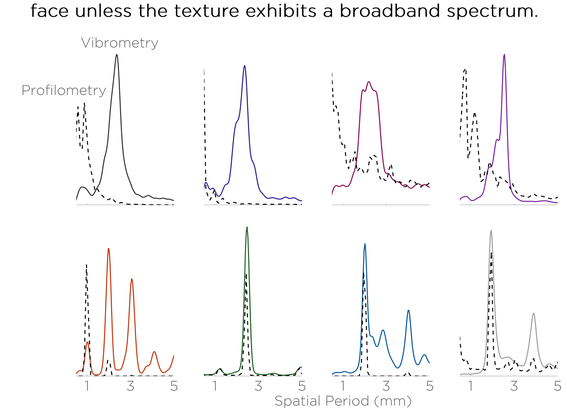


The warping of the vibrations is linearly proportional to the change in speed.

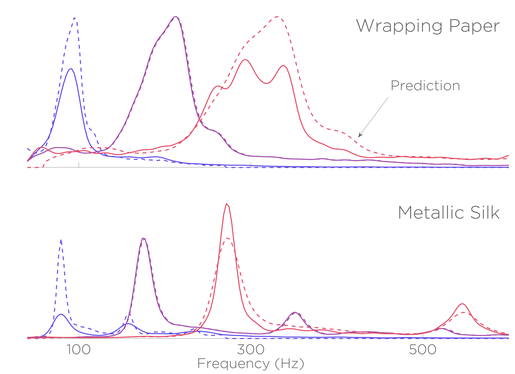
Broadband textures shown.



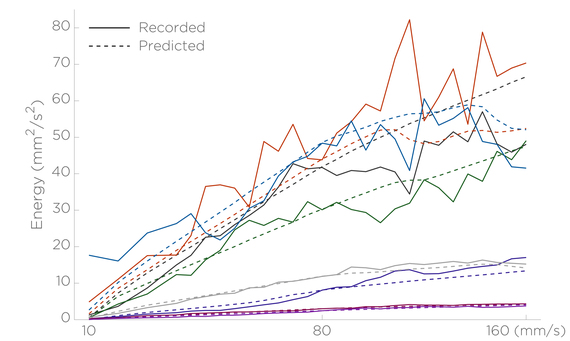
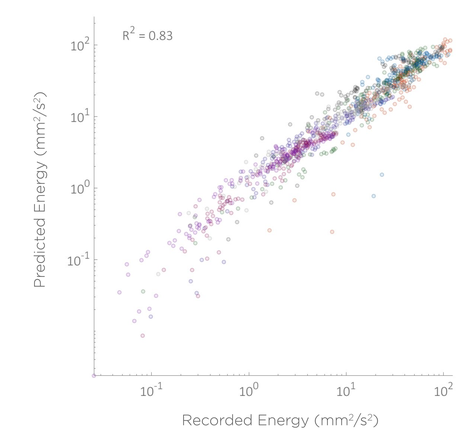
Vibratory spectra reflect the spatial power spectra of the surface unless the texture exhibits a broadband spectrum.



The vibrations at one speed can be warped to resemble those at any other speed. 80 mm/s reference used below.



Predictions of vibratory energy from the warping model match their measured counterparts.



Across all participants and speeds this model captures most of the variance in the energy-speed function.