Reproducing Fine Textures on Touch Displays Using Band-Limited White Noise Vibrations

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Resume of the Author

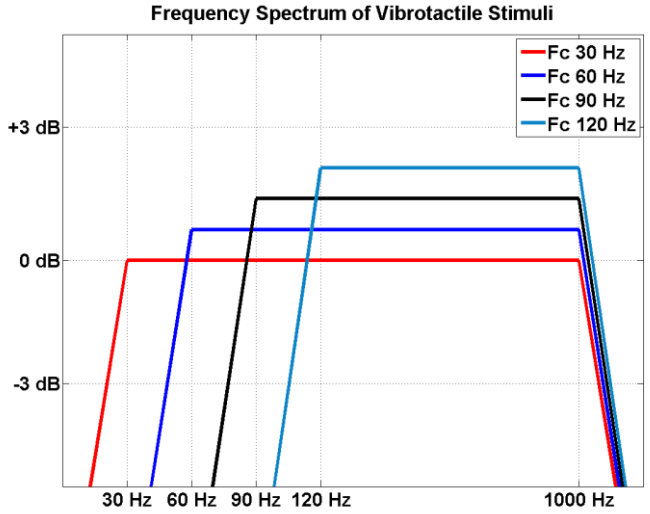
Ugur Alican Alma was born in 1988 in Turkey. He studied manufacturing engineering at the Technical University of Istanbul and completed his master degree at Bogazici University at the chair of mechanical engineering. In 2017, he was accepted to the Insitute of Acoustics and Haptics (Prof. Altinsoy), Technical University of Dresden, Germany as a Ph. D. student. During the Ph. D. studies, he has been working on developing perception-based texture reproduction models on touch displays.

Aims of the Study

The motivation of this work is to improve the perceptual capacity of white noise vibrations by adjusting its character according to the surface roughness of fine textures.

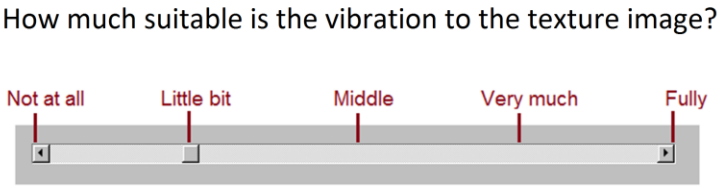
In the previous study, white noise vibrations without a specific cut-off frequency were found suitable while rendering fine textures. In that study, some participants reported that low frequency content of the noise vibrations were not plausible when they were touching the fine textures to rate the similarity of given white noise vibrations.

Vibration models:



Psychophysical Experiment

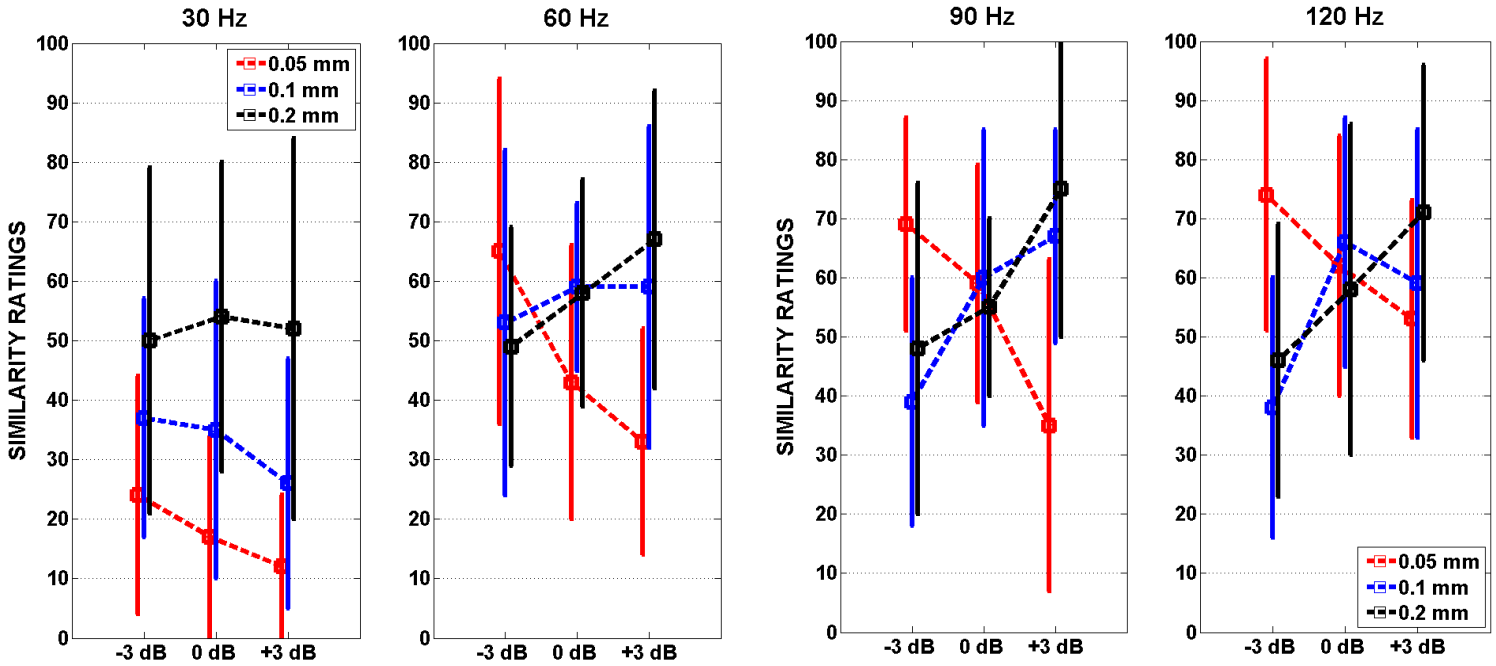
- Similarity estimation based on Rohrmann scale with verbal anchors
- Roughness similarity of reproduced vibrations with respect to the fine textures were measured.
- Textures images were only haptically explored.
- 12 subjects participated in the perceptual evaluation.



Experimental Results

According to 3-way Anova test:

- Cut-off frequency (F(3,431) = 19.351, p = .0001) and the grit sizes of the fine textures (F(3, 431) = 5.268, p = .005) were found to have significant effects on the perceived similarity while intensity was not found as a significant factor.
- Significant interaction effects were found between the factors of cut-off frequency and the textures (F(3, 431) = 5.346, p = .0001), the intensity and the texture (F(3, 431) = 20.079, p = .0001), and all three together (F(3, 431) = 1.691, p = .045).



Conclusion

The goal of this evaluation was to detect the most plausible frequency band and the vibration intensity level according to grit sizes of the fine textures.

1. According to the results, the cut-off frequency was found as a primary factor to create congruent noisy texture vibrations.

2. Vibration intensity could have had more impact on the similarity ratings if the intensity level would be increased or decreased more than 3 dB.

3. 0.05 mm and 0.1 mm textures were found significantly different than the 0.2 mm texture, but they were not found significantly different from each other. Possibly, it shows that different cutaneous perception processing might have occurred for 0.2 mm texture compared to 0.05 mm and 0.1 mm textures. This outcome agrees with the previous studies conducted by Lederman and Johnson.

4. The maximum ratings of the vibrotactile feedback, which are resembling the roughness, were clustered between 70% and 80%. The reason why the ratings did not reach 100% is because the tactile texture perception consists of four main dimensions, and roughness is one of the dimension in texture perception.

END!!!