Study of the interaction between human fingerpad and isotropic rough surfaces for tactile stimulators improvement

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KEYWORDS

Tactile stimulators, Fingerpad, Friction induced vibrations, *in-vivo* measurements, Tactile perception.

ABSTRACT

Significant efforts have been made over the past few years for the development of tactile stimulators. These electro-mechanical systems aim at enhancing tactile devices functionalities by giving the feeling to touch various surface textures when user's finger explores smart devices screen. Although different technologies are exploited, the common thread of every stimulators is their ability to modulate the fingerpad/screen mechanical interaction against time. Nevertheless, the touch sensation offers by these devices remains coarse and depends on individuals. Hence, the improvement of tactile stimulators requires a better understanding of the interaction between human fingerpad and real surface textures.

The study presented herein makes a contribution to the development of tactile stimulators for the perception of rough surfaces. To this end, *in vivo* measurements of friction forces and friction induced vibrations (measured with a light accelerometer located on the finger nail) stemming from the rubbing of 12 volunteers' forefinger on 10 isotropic rough surfaces were carried out. Tested surfaces had Ra ranging from 3.3 to 42.6 µm and mean spatial period between asperities (SP) ranging from 20.9 to 141.7 µm. Friction tests were performed using a dedicated apparatus, and a 0.7 N mean normal load was applied and controlled by volunteers themselves. In parallel, topography and hydration of each volunteers' fingerprints have been characterized. In addition, psychophysical methods were employed in order to evaluate the subjective perception of roughness for each volunteer and surface.

Measurements show significant differences of macroscopic friction coefficient value and various increasing of friction coefficient versus Ra between individuals. The acceleration power spectral density (PSD) has a broadband spectrum shape concentrated in the band [0-800 Hz] leading in good agreement with skin's mechanoreceptors frequency response. Moreover, a shift of the PSD towards higher frequencies when Ra decreases occurs (see Fig. 1). This shifting is correlated with the subjective perception of roughness but is more or less pronounced between individuals. These singularities are then discussed and correlated with fingerprints properties.

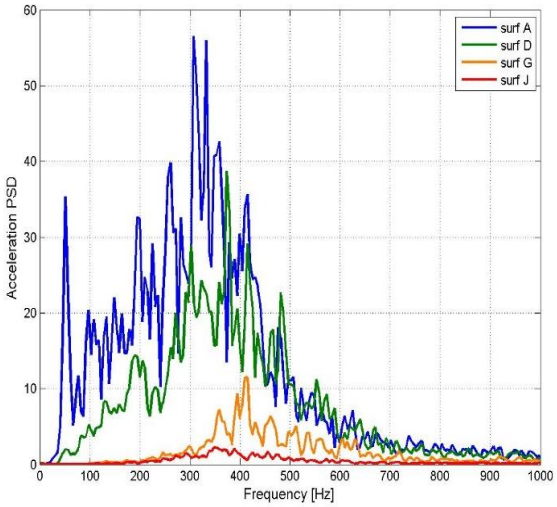

Fig. 1: Power spectral densities of the acceleration measured on the finger nail when rubbing 4 rough textures having Ra increasingly smaller.

Main results highlight the necessity of taking into account of fingerpad properties in the definition of the signal supplied by a tactile stimulator.

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