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Surface texture discrimination by reproduced Friction-Induced Vibration stimuli on a dynamic actuator

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Friction-Induced Vibrations, generated when sliding the finger on isotropic surface textures, have been measured and analyzed. The same mechanical stimuli have been then simulated by a dynamic actuator and discrimination campaigns have been performed on volunteers, both with the real surfaces and those reproduced by a dynamic actuator. The results highlight the possibility to discriminate the tested surface textures based on the sole Friction-Induced Vibration stimuli.

Keywords: tactile perception, friction-induced vibrations, discrimination of textures, tactile stimuli

1. Introduction

Among the five senses through which the human beings perceive the external world, the sense of touch is the less comprehended one. The touch is mediated by the mechanoreceptors, that react to quasi-static and dynamical mechanical stimuli. In particular, the Rapidly Adapting receptors are specialized to detect the transient mechanical stimuli, such as the vibration generated during the sliding contact between the finger and the explored surface (Friction-Induced Vibrations, FIVs). From recent researches in the field of biotribology, FIVs seem to be the most meaningful mechanical stimuli allowing the discrimination of the surface textures [1]. Then, the present work aims to evaluate the possibility to discriminate the surface textures by only FIVs.

2. Methods

In order to evaluate the capability to discriminate the surface textures by means of the sole Friction-Induced Vibrations, the FIVs have been measured, when sliding the finger on the surfaces of isotropic samples, and then reproduced by the dynamic actuator, used as tactile simulator. Discrimination campaigns have been then performed, involving both the real surfaces and the simulated ones. For the real surfaces, it was asked to the subjects to touch and acquire familiarity with the samples, that have been then presented in a random order to the subjects, who had to discriminate the samples, entrusting to the tactile sense. Then, the subjects were asked to discriminate the simulated surfaces by the dynamic actuator by associating the reproduced FIVs stimuli with the corresponding real surfaces. The results have been analyzed by means of correlation matrices.

3. Discussion

The discrimination campaign resulted in a really good performance in the discrimination of both the real and the simulated surfaces. High percentages of correct associations of the samples have been recovered (matrix diagonal in Figure 1). Moreover, simulated surfaces were confused when the corresponding real surfaces were confused too, or resulted difficult to discriminate.

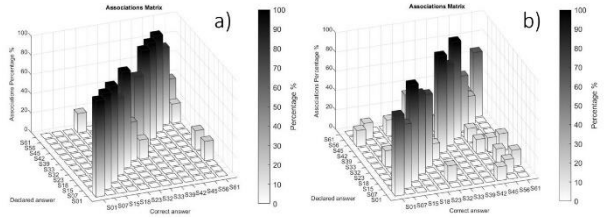

Figure 1: Results of the discrimination tests on a volunteer by correlation matrices: a) discrimination of real surfaces; b) discrimination of simulated surfaces.

By analyzing the spectra of the corresponding FIVs, it turned out that samples characterized by similar spectra were more easily confused than surfaces characterized by very different spectra. Figure 2 reports an example.

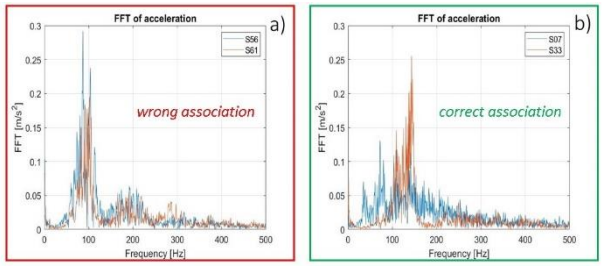

Figure 2: Examples of spectra of induced vibrations in case of wrong(a) and correct (b) discrimination.

The results highlight once more the role of the Friction-Induced Vibrations in the discrimination of surface textures. The sole FIVs, reproduced by the tactile simulator, have been sufficient to correctly discriminate the samples with a reduced number of association errors.

4. References

[1] Massimiani, V. et al., "The role of mechanical stimuli on hedonistic and topographical discrimination of textures", *Trib. Int.*, 143 (2020).

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