Rendering and comprehending texture perception by a vibrational tactile device

Livia Felicetti*†[1,2], Eric Chatelet[2], and Francesco Massi[1]

[1]Università degli Studi di Roma "La Sapienza" = Sapienza University [Rome] – Italy
[2]Laboratoire de Mécanique des Contacts et des Structures [Villeurbanne] – INSA Lyon, France – France

Abstract

The sense of touch is one of the channels that allows humans to perceive the external environment. Unlike sight and hearing, where stimuli are detected from a distance, touch requires contact between the skin and the explored object. This contact generates various mechanical stimuli, such as forces, vibrations and heating flows which are detected by the mechanoreceptors present in the skin. These stimuli are converted into electrical signals and transmitted to the brain for processing and interpretation. Discovering the complex processes occurring at the contact between the skin and a surface is crucial to understand touch mechanisms. In particular, when skin moves across a surface, Friction-Induced Vibrations (FIV) are generated; these vibrations come into play to determine how different textures are perceived and differentiated. Recent findings suggest that humans rely on specific characteristics of FIV to identify and distinguish between various type of surface textures. As an example, the frequency distribution of FIV appeared to be fundamental to discriminate periodic textures, while FIV amplitude is the key FIV feature to discriminate isotropic textures. This work focuses on a better understanding of the role of FIV features in touch sense, by exploiting a vibrotactile rendering device, named PIEZOTACT, to simulate vibrational stimuli and alter specific FIV features, in order to investigate their specific role in the perception of different textures. Using a piezoelectric actuator, the device simulates the vibrations produced when the finger moves across a surface, allowing users to experience tactile sensations without direct physical contact with the real surface. By altering specific characteristics of the FIV stimuli, "fake" textures have been generated to better understand how changes in FIV features affect texture discrimination. Campaigns have been conducted with panels of volunteers, evaluating if the introduced signal modifications could mislead participants in discriminating between surfaces. The results of these experiments confirmed that participants' perception of the textures was consistently influenced with the FIV modifications. The ability to replicate tactile sensations without direct contact opens new outlines for a range of applications, in virtual environments, remote surgery, online commerce and beyond. The presented approach highlights the potential of tactile devices in simulating or even creating new tactile textures for technological purposes.

*Speaker
†Corresponding author: livia.felicetti@uniroma1.it