
Master project, 2025-2026

— Human-in-the-Loop: Measurements for surface haptic devices —

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Context

Haptic technologies are systems that enable users to physically interact with virtual objects through the sense of *touch*. Beyond enhancing immersion in virtual contexts, these technologies contribute to sustainability by reducing the need for physical prototypes, enabling safe and resource-efficient training, and supporting remote work and teleoperation. By lowering material waste, reducing energy consumption, and improving access to education and healthcare, haptic devices address key environmental challenges while promoting inclusiveness, health, and safety.

Making these technologies adaptable to individual users is essential for improving the interaction experience and broadening their real-world applications. This project follows a *human-in-the-loop* approach, with the objective of developing virtual textures on in-house devices that can adjust to each user's physical and behavioral characteristics.

The device under study is a '*Surface haptic device*' that creates texture illusions through ultrasonic vibrations. The illusions are created because ultrasonic vibration reduces the surface friction. These vibrations are controlled in closed loop, using vector control on piezoelectric actuators. The tactile sensation depends on the vibration amplitude. However, we have observed that individual perception may be variable, because of skin properties or exploration techniques. Each human, therefore, acts as a unique 'load' on the system. We wish to investigate whether real-time measurements of this 'load' can provide insights about the user, offering an essential information for personalizing the experience.

This project offers the possibility to collaborate on an interdisciplinary subject at the intersection of engineering and neuroscience within the context of a PhD project.

Objective

Implement real-time measurement protocol for psychophysical tests for real-time acoustic finger force observation vs. Friction and Perception, using in-house device. Perform tests and provide data analysis and preliminary conclusions



Figure 1. Ultrasonic surface haptic devices and in-house prototype testing

Work steps

1. Bibliographic research / 2. Development of measurement protocol (with the help of PhD. Student) / 3. Programming of testing routines (Microcontroller (c++), user interface (python), serial port control of peripherals) / 4. Test volunteers / 5. Data analysis (Matlab, R, etc...) / 5. Synthesis of results

Key word

Haptic, Ultrasound, Vector Control, Human-in-the-Loop

Reference

Master "Electrical Energy for Sustainable Development"

[1] Diana Angelica Torres, Betty Lemaire-Semail, Christophe Giraud-Audine, Frederic Giraud, Michel Amberg, *Design and control of an ultrasonic surface haptic device for longitudinal and transverse mode comparison*, *Sensors and Actuators A: Physical*, Volume 331, 2021, 113019, ISSN 0924-4247, <https://doi.org/10.1016/j.sna.2021.113019>