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# User Experience Challenges of Virtual Buttons with Mid-Air Haptics

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**Abstract**

Recently, imec has built up an extensive portfolio on ultrasound devices, and is now developing a thin-film, glass based platform for haptic mid-air feedback. During the preparation phase of a research project on the development of this technology, several companies expressed their interest in this technology, and joined the user committee. One of the returning concerns was the user experience (UX) of the haptic feedback: what does a user feel, how does this differ from user to user, what interactions can you realize, ... A dedicated project to study these interactions was set-up: the SHAKE project, which will run from May 2018 to May 2020. The main goal of SHAKE is to study the user experience of haptic mid-air systems for virtual buttons in human-machine interaction. Two use cases will be investigated: home appliance buttons and virtual buttons for augmented reality.

**Introduction**

Haptic feedback is an emerging human-machine interface, in which a machine can 'touch' its operator by triggering the mechanoreceptor in the human skin. A commercial example is the use of vibrations in a mobile phone or a game controller, in which there is a direct contact between human and machine. Novel approaches focus on non-contact technologies to generate a feedback in mid-air, in free space. One of

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these technologies is the use of focused ultrasonic waves to generate a local pressure field, enabling a sensation on the human skin. Although the basic concept is already demonstrated, it is not yet fully understood what a user experiences and will accept when subjected to focused ultrasound.

SHAKE will study the possible application domains and interaction patterns for mid-air haptics, both in qualitative as well as in quantitative ways. At the start of the project, commercial hardware components will be assembled in a generic platform, in order to start the user experience studies at an early phase. After one year, novel haptic feedback hardware will be injected. This hardware is, in contrary to more bulky commercial components, based on thin-films processed on glass sheets, and compatible with standard flat panel display industry. The new components will enable seamless integration in future products, and broadens up the possible acoustic patterns by going for a smaller (mm size) focal point. Feedback from user experience studies to the design and processing of this novel technology is crucial at this early research phase, in order to prune the almost endless possible acoustic patterns and to focus on the user friendly ones.

The final demonstrator is the realization of haptic and visual feedback in order to convey a convincing virtual button to the user. Two use cases will be studied: interaction with home appliances and the creation of a virtual button in an augmented reality environment.

### **User Experience Challenges**

There are three main UX challenges that SHAKE will address. First, while there are many ideas on potential products and applications using mid-air haptic

feedback, few of them are actually validated by end-users. SHAKE will fill this gap by exploring potential products and applications. Secondly, there is little knowledge on how to interact with virtual buttons or objects that provide mid-air haptic feedback. Most research to date has focused on which emotions are elicited by specific patterns, but not on how to design the interaction with objects of various sizes and shapes. SHAKE will generate new knowledge on how to design visual and haptic interaction patterns for virtual buttons. Thirdly, there are many open questions on how users experience mid-air haptic feedback. In contrast to emotions, other aspects of the user experience such as effectiveness, learnability, perceived safety, trust, or competence are rarely studied, or not at all. These aspects will also be addressed.

### **Case: Virtual button in augmented reality**

Each user has a mental model of a mechanical button that depicts a similar sequence of events and when moving to AR or VR, one will need to take this mental model into account in order to create a convincing experience. Seeing a virtual button infers the expectation of receiving haptic feedback that resembles previous experiences. In one of the cases in this project, we will explore the interplay between haptic, auditory and visual feedback in order to convey a convincing virtual button in AR to the user.

### **Presenting authors**

Both authors will be attending the workshop at CHI2018. David Geerts is specialized in user experience design and evaluation, while David Cheyns is specialized in hardware design of thin-film mid-air haptics. They will both be involved in the SHAKE project.