Designing Feedback for Haptic and Shape Changing Interfaces with Feelix

Designing Force Feedback and Shape Change

A tutorial on the design of force feedback and shape change in custom user interfaces

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Force feedback and shape change introduce unique qualities in interaction design that can be favorable for the design of more intelligent physical user interfaces and robotics, as communication revolves to a large extent around body language and gestures. Research in HCI and industry has a strong focus on voice interfaces, while modalities as force feedback seem to receive most interest in contexts where inherent haptic feedback is absent, such as VR and robotics. There is a dearth of design tools and support to explore the haptic design space given the challenges associated with the haptic modality. The haptic authoring tool Feelix aims to address some of these challenges that the designers are facing to make these modalities more accessible as a design material in HCI. Attendees will learn about possibilities and challenges associated with the design of force feedback and shape change for custom user interfaces and engage in hands-on exploration with different methods and techniques to develop haptic experiences for deformable interfaces with Feelix.

CCS CONCEPTS • **Software and its engineering~Software creation and management~Designing software** • Hardware~Communication hardware, interfaces and storage~Tactile and hand-based interfaces~Haptic devices

Additional Keywords and Phrases: Haptic interaction design, tools and toolkits, physical user interfaces, force feedback

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1 INTRODUCTION

As an ongoing trend, the focus of design is shifting more and more towards user experience. Yet, haptic interaction design is still at an early stage of development [9]. Despite the important role of haptics in user experience design and the possibilities that have emerged in recent years for active haptic technology in user interfaces, designers still face many challenges that can turn the design process into a slow and painful experience [5,9]. Therefore, designers need better tools and design guidelines that enable them to focus on the actual design of the haptic and multimodal experience

and provide sufficient freedom to explore and integrate haptics in novel and surprising ways [7]. Recent efforts in the field have contributed software tools for the design of multi-dimensional force feedback experiences for simulations and VR (e.g. CHAI3D [1], H3D [3], OpenHaptics [6] and vibrotactile feedback for mobile devices, game controllers, and the like (e.g. [8,10,12]). However, there is a dearth of tools that enable designers to explore with force feedback (e.g. [2,11]) and integrate it into their designs in a flexible manner, despite the potential that force feedback provides in terms of information, control, and experience [4]. Examples of everyday interfaces that utilize this potential remain scarce. The purpose of this tutorial is to address challenges and opportunities associated with force feedback design and shape change in HCI and discuss tools and methods developed to make these more accessible as design material.

2 TUTORIAL SUMMARY

2.1 Theme and goals

The design of force feedback and shape change for custom user interfaces will be the theme of the tutorial. The goal is to highlight challenges associated with the design and implementation of force feedback that obstruct exploration and adaptation of force feedback in a wider variety of contexts. Additionally, attendees will be introduced to methods that have been explored and studied in recent activities with the haptic authoring tool, Feelix [7], which was developed to make the design of force feedback and shape change more accessible for designers. These methods will be demonstrated through hands-on explorations with Feelix.

2.2 Benefits and Learning Outcomes

The tutorial will be beneficial to HCI researchers and practitioners who have an interest in haptics, as the tutorial will introduce them to a design perspective on the haptic design process, and application areas of force feedback and shape change. Different topics will be addressed from the design of custom haptic user interfaces with diverse interaction possibilities towards the usage of machine learning (ML) in combination with physical user interfaces. Hands-on activities will form a major part of the tutorial to enable attendees to experience the process of designing feedback for diverse user interfaces firsthand and explore different methods that are supported in Feelix in the process.

2.3 Duration

The duration of the tutorial will be 3 hours, including scheduled breaks.

2.4 Hybrid or Physical

The tutorial is planned to be held in person since a major part of the tutorial is devoted to hands-on explorations. Remote participation is considered an exception since this requires access to specific hardware. Please, contact the main author for more information regarding the possibilities for remote participation.

2.5 Intended Audience, Prerequisites, and Preparation

The tutorial can be attended by anyone who has an interest in haptics, regardless of their background or expertise. The tutorial is accessible for novices and experts, experience with the haptic interaction design is not required. Attendees should bring a Windows or MacOS laptop with a USB-socket to connect with the device. A computer mouse is optional but recommended. Working in teams is possible in case attendees cannot bring a laptop. To prepare for the tutorial, attendees should watch the introduction video on the tutorial website.

2.6 Planned Activities

(1) Introduction to the workshop and outline of plans and goals.
(2) **Presentation**: Challenges with force feedback design and shape change in custom haptic interfaces.
(3) **Introduction to Feelix**: methods and features in Feelix will be explained in more detail to guide attendees in the design process and prepare them for the hands-on exploration exercises.
(4) **Hands-on design exercises with Feelix**: Attendees will receive the required hardware to follow the exercises, attendees might need to work in groups depending on the number of attendees.
    1. Basic design exercises to get familiar with the tool and illustrate the difference in graphical notation methods.
    2. Design exercise with custom shape changing interfaces with multiple degrees-of-freedom.
    3. Exercise in which the usage of Machine Learning for interaction with physical user interfaces is explored.

    Instructors will walk around to answer questions and to provide feedback and support.
(5) **Discussion on haptic interaction design process and tools, and directions for future research**: The tutorial concludes with a structured group discussion on explored methods, personal experience with haptic interaction design, and future for directions for haptic interaction design. Here, attendees have the opportunity to ask questions, exchange experiences, best practices, ideas, and make contacts for potential collaborations.

2.7 Tutorial Website

For more information regarding the tutorial and Feelix please visit https://feelix.xyz.

2.8 Technical Requirements

Power sockets will need to be available close to where participants will be seated and power adapters (12V – 20V).

3 TUTORIAL HISTORY

This is the first edition of this tutorial at a conference. Prior editions have been presented as part of the Master course 'Multimodal Interaction' at Aarhus University, the Master course 'Interactive Materiality' at TU Eindhoven, and an informal workshop with Industrial Design students working on projects that involve Machine Learning.

4 INSTRUCTOR BIOGRAPHY

Anke van Oosterhout is a postdoctoral fellow at TU Eindhoven. Her research focuses on force feedback and shape change. She is interested in the design of intelligent user interfaces that facilitate interaction mediated through force feedback and shape change. To make the design of such interfaces more accessible, she developed a haptic authoring tool named Feelix, which simplifies the design of force feedback and shape change using a graphical editor with tools and features familiar to designers. The tool has been validated at different stages of the design process by students from two different universities who have been working on a variety of projects.

Eve Hoggan is an associate professor at the Computer Science department at Aarhus University. Her research focuses on the design of novel interaction techniques and non-visual multimodal feedback.

Miguel Bruns is an associate professor at the Industrial Design department at TU Eindhoven. His research focuses on aesthetic and emotional expressivity of haptic and shape changing interfaces with programmable material qualities.

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