When Hand and Device Melt into a Unit. Microgestures on Grasped Objects

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Abstract
I am motivated by the idea to capitalize the hand's abilities for becoming a natural input device. This can be achieved through finger-worn sensors that track their movements. I am particular interested in finger gestures that are feasible while grasping devices. Executing gestures on a steering wheel while driving, such as those seen in Fig. 1, are just some examples of interactions, which would not require any device-release. The resulting question is: To what extent can users interact with grasped objects through tiny microgestures that are performed while grasping? This extended abstract shows the progress of my research and presents the design of a study that is in preparation. Around this study design I formulated research questions. My approach aims to apply motor and mental models for designing interactions and interfaces regarding human motor abilities, interaction favors, and the mental model of themselves within their environment.

CHI 2012, May 5-10, 2012, Austin, Texas, USA.
ACM 978-1-4503-1016-1/12/05.

Keywords
Microinteraction; surface-gesture; guidance feedback; back-of-device; grasp.

ACM Classification Keywords
H.5.2 [Information Interfaces and Presentation]: User Interfaces - Interaction styles;

General Terms
Design; human factors; performance

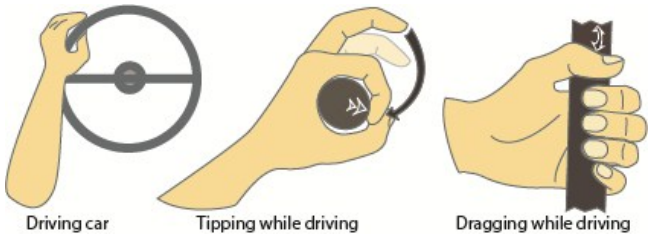

Figure 1 illustrates microgestures that would allow automotive control without releasing the steering wheel.

Research Situation

My background is in Media and Communication Design. After working as an interaction designer in an EU research project that developed a mobile guide for the Jewish Museum Berlin, I turned back to academia. I am fascinated to explore why interaction design succeeds or fails, especially when having less convenient interaction conditions, such as walking with a small device or having competitive information with high priority, which you have while walking through an exhibition. Now I am in the second of the three year Integrated Graduate Program Human-Centric Communication at TU Berlin. There I am affiliated with Deutsche Telekom Laboratories (T-Labs) and work in the Mobile and Physical Interaction Group. My supervisors are Michael Rohs (LMU Munich), Sebastian Möller, and Robert Schleicher (T-Labs).

Context and Motivation

Gestural interfaces let I/O devices disappear and open a design space for imaginary interfaces. Nowadays, miniature sensors can be attached to our hands and almost melt the distinguishable difference between our body and the input device. Interacting through free movements (and not through modifying input devices) supports the illusion of disappearing interfaces. This idea breaks down with explicit input devices like the mouse and Wii mote. The input device, for example a phone, could become invisible with novel technologies, which opens up new design opportunities. Holding a phone can easily be replaced with on-body worn sensors, (pico-) projectors, speakers, and microphones.

I aim to investigate the possibility of the human hand to be a magical tool through fusing it with the technical side of the interface. Attaching sensors to fingers allows not just free spatial gestures but also (because of the incredible motor and sensory abilities of our hand) performing tiny finger movements while grasping daily objects. However, the further the latest interaction with computers moves away from the traditional desktop; the less common concepts tend to succeed, which were designed for static usage situations. For interacting with everyday objects, these concepts have to be re-understood, re-thought, and re-designed. An important characteristic is that the interaction is established when grasping an object. Sensors are attached to the fingers, but the semantics of the finger gestures are established only in the moment of grasping the object. This is similar to Beaudouin-Lafon's [2] notion of "instrumental interaction", in which the mouse is generic and its concrete semantics only gets established temporarily, while "grasping" a virtual object, such as an icon on the screen. My approach aims to apply mental models for designing microinteractions (microgestures, feedback, and applications) while grasping. Here I will focus on humans' motor abilities, interaction favors, and the mental model of themselves within their environment.

Background and Related Work

Research focusing on feedback for around and back-of-device interactions for hand-held devices is important as this interaction space addresses competitive parameters of hardware design and usability. This is the main conflict between the desire for avoiding or reducing physical buttons, the fact that on-screen touches are limiting the visibility of the content underneath, and ergonomic aspects defined by the physiology of our eyes, hands and fingers. The related work covers a variety of disciplines: novel gesture-based interfaces [1, 3, 4, 5, 7, 11, 13] and the understanding of ergonomics in performing gestures

[13] and touch [6] define how around and back-of-device interactions are achieved from a technical and design point of views. Also mental models [8, 10] that explain how humans move and which receptor modalities monitor this action, are presented. This provides an understanding for the relation between receptor modalities that are limited by the physical object (device occludes view) and those that are provided by the interface design (system or guidance feedback). Moreover the models describe how users might cognitively weigh these modalities depending on their situation. A novel approach in HCI [9] argues for investigating how to apply embodied situated cognition to the design for interaction.

Statement of Thesis or Problem

The sensory resolution and the feasibility in 6 degrees of freedom of our hand and each single finger (more or less) define our hand to be a rich and high precision tool. Augmenting the fingers with sensors offers the possibility to interact with grasped everyday in-use devices. Sensing tiny finger movements is a current topic of the related work. Other problems, such as the question, which objects or tasks benefit from microinteractions, how should microgestures be designed, and how can this interaction be supported (through affordances, constraints, guidance, and feedback) are challenging, so far not answered, and guide my dissertation.

Research Goals and Methods

My dissertation project is asking: To what extent can users interact with in-use grasped objects through tiny microgestures that are performed while grasping? This interaction idea is novel and neither familiar to users nor built in available devices. For answering my research question, I therefore will build prototypes and test them within user studies. But designing both the prototypes and the user studies needs some fundamental understanding about how in-use objects are actually held and which gestures are feasible at the same time. Having an idea about the type of gestures that is promising for microinteractions rules the interface design in terms of which sensors should be used and where should they be places? These two steps define the atomic interface on the human and on the computer side. The next step is to investigate interaction techniques. The questions about the feedback representation for microinteractions will be very central and be investigated through performance and perceived task load under different feedback conditions, such as avoiding versus providing feedback of different modalities. The outcome of each of my experiences will iteratively extend a design model for microinteractions. In experiments of the second half of my dissertation, more advanced prototypes will be tested and refer to actual user scenarios. The interaction aspects, which I investigate over the time of my Ph.D. will therefore be very abstract in the beginning and become more applied in the end.

Dissertation Status

For developing a fundamental understanding of microinteracting while grasping, I explored in three user studies ergonomic and feasibility constraints [14], but investigated also feedback requirements and pointing performance for finger movements that are hidden behind a grasped device. Currently work on developing a prototype in cooperation with Michael Rohs (LMU Munich), Sven Kratz (LMU Munich), and Mathias Wilhelm (TU Berlin), which allows real-time finger gesture classification. Moreover I work on an

experiment that investigates microinteractions in multi-dimensional design spaces through developing exemplary applications. In a future user study I plan to explore, which everyday objects people would like to augment with microinteractions. Therefore I plan an in-the-wild experiment in the environment that people are familiar with and where a lot of their devices and objects are located.

Expected Contributions

The expected outcome of my dissertation project will provide findings about how people interact with tangible objects of different form factors and which not necessarily provide rich visual feedback. These findings will describe the opportunity to interact with everyday objects while using them for their original function. I want to help understanding humans' skills and support requirements when interacting with a new generation of traditionally "offline" products, imagining a day when every object that surrounds us could be controlled through microgestures and connected to its environment and our smartphone.

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