Microinteractions to augment manual tasks*

Katrin Wolf

Deutsche Telekom Laboratories, TU Berlin, Ernst-Reuter-Platz 7
10587 Berlin, Germany
katrin.wolf@acm.org

Abstract. This paper summarizes the first nine months of progress on my Ph.D. project. The research focus of the project is on investigating microinteractions. a sub-topic of HCI and gesture research. The project will develop a framework for applications that use microgestures to support everyday tasks through invisible and context-aware appearing interface layers underneath object-grasping hands. In an expert study that has been accepted as a full paper at INTERACT 2011, I explore the motor limitations and opportunities of microgestures while grasping objects and valued manual dual-task scenarios by walking through three tasks that involve grasping objects. The outcome of the study is a generic microgesture set for different grasp types and a collection of parameters that have a relevant effect on the choice of the grasping tasks. A further user study in progress is investigating the effect of grasped objects, such as handheld devices, on the feasibility of performing microgestures. Users are asked to perform finger-tip and drags on the front and/or back of a handheld device. The device is two-sided and touch-sensitive, it is made by stacking 2 pads together in a sandwich-like prototype. This allows tracking users' finger gestures through a camera as well as through front and touch screens. The outcome of the two mentioned studies will describe a design space for out-of-a-grasp microgestures. At the INTERACT doctoral consortium I aim to present this design space and discuss how this can serve as a basis for developing a framework of out-of-grasp microinteractions that are subtasks of grasping tasks. The microinteractions will be developed to support the grasp tasks with regard to their perceived ergonomic and hedonic qualities.

Keywords: microinteraction, gestures, dual-task, multitask, interaction style.

1 Research focus

Human actions in the real world are usually a set of tasks solved in parallel and people have the ability to multi-task with respect to motor and cognitive resource handling in many everyday situations. Normally, human-computer interactions are designed as separate tasks and synchronous tasks are understood as multitasking situations with two competing tasks when considering their motor and cognitive

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resource requirements. Microinteractions are a promising technique that can be done in parallel to manual actions with less competitive motor resource effort.

Ashbrook defines microinteractions as short-time interruptions of primary tasks for controlling mobile devices [1]. These interaction techniques have the beneficial potential of allowing mobile application control in parallel with ongoing everyday tasks. This could significantly enrich the quality of tasks that we could perform on-the-go and fundamentally alter the way we view ubiquitous computing [6]. In this context a microinteraction can be designed as a support or subtask of an everyday task or contextual independent, like mobile communications.

I aim to investigate the potential of microinteractions that are a subtask of a primary interaction. In this field several research projects have recently been conducted to develop tracking interfaces [1, 2, 5, 6] and a few projects have been conducted that are driven by the human side of interaction [3, 4, 11]. I see a research gap on the human-centric side of microinteractions, my motivation is to investigate the design space of these interactions; mainly their affordances and constraints regarding usability aspects, such as ergonomic and hedonic qualities. This work will guide the next step of my research, developing a framework for sub-tasking microinteractions that support grasp tasks. Subtasks in this context could include automotive control interactions such as stopping a turn signal or opening the window while driving. Realizing these subtasks through microgestures allows for performing them in parallel to steering a car while keeping the steering wheel fully grasped.

I believe that synchronous microinteractions allow for the possibility of supporting every-day tasking in an ergonomic and hedonic manner. Therefore my hypothesis is: Microinteractions have the potential to increase the perceived ergonomic and hedonic qualities of contextually related tasks that are performed in parallel.

2 Understanding microinteractions

To help understand microinteractions, I did an expert evaluation [10]. I asked sports therapists and physiotherapists to use props (as shown in figure 1) while performing given microgestures, but also they could use any new gestures that they created spontaneously. The gestures should be easily performable without interrupting the primary task, without needing high cognitive effort, and without taking any risk of being mixed up with natural movements.

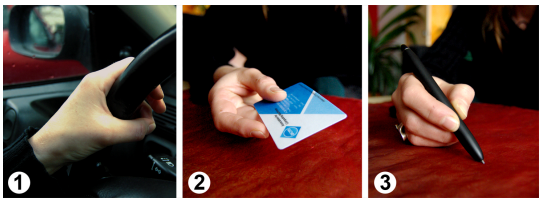

Fig. 1. The participants are testing the feasibility of finger gestures while (1) holding a steering wheel (2) targeting a cash card, and (3) drawing with a pen.

From the expert interview results I developed a taxonomy (see figure 2) for classifying these gestures according to their use cases and assessed their ergonomic

and cognitive attributes, focusing on their primary task compatibility. I defined 21 gestures, which allow for microinteractions within manual dual task scenarios. In expert interviews I evaluated the gesture's level of required motor or cognitive resources under the constraint of stable primary task performance.

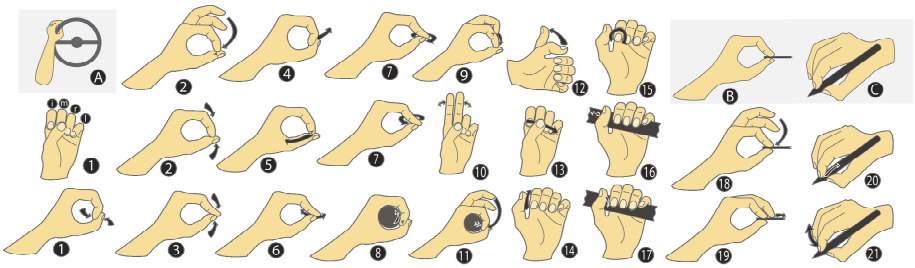

Fig. 2. The expert-defined and evaluated gesture set. The experts found 17 gesture types for the driving scenario (A). The card targeting scenario (B) and the stylus scenario (C) just contain 2 gesture types each. Most gesture types have several sub-types by performing them with different fingers (index, middle, ring, and little finger). Moreover the same gesture results in a different sub-type (e.g. touch, tab, or press), if it is performed with different acceleration or duration.

This study was supervised by three researchers (one psychologist and two computer scientists) of the research group I am associated with at the Quality and Usability Laboratories of TU Berlin and that are named as co-authors.

3 Research plan and status quo

My Ph.D project is planned to consist of three parts and I am currently working on the first one. This part investigates the fundamental understanding of microinteractions. Within the second part, I will – based on the expertise of part 1 – develop novel microinteraction techniques and evaluate them regarding their usability, such as ergonomic and hedonic qualities. The third part will be dedicated to develop a framework for microinteractions that will serve as seamless sub-tasks to support in parallel continued grasp-based tasks.

My first experiment [10] serves as an initial analysis basis for understanding microinteractions and will be continued to generate a fundamental description of the design space for out-of-grasp microgestures. In this initial study, attributes that have a relevant effect on the gesture performance are defined. These are the grasp type, the grasped objects, ergonomic and bio-mechanic aspects, as well as the cognitive effort that is required for the pure gesture performance. The benefit of microinteractions on the usability of the grasp tasks was valued by experts as useful augmentation for many grasp-based tasks but they also brought up the fact that the degree of benefit might be influenced by pragmatic aspects, such as the task length and by ergonomic parameters of the grasped object.

Guided by the conclusion of the expert study, I currently plan a user study to investigate how users grasp an object like a pad and the effect of physical object attributes (use, size, and shape) on the way users grasp it and on their finger gesture

feasibility. The expected outcome of this study is a deeper understanding about users' naturally chosen grasp for holding a pad (e.g. iPad) while performing certain device interactions as well as an evaluation of users' ergonomic skills of performing gestures while grasping the device. To measure the limitations of the grasp performance I will choose certain tasks that have to be done under different conditions (with one or two hands / with or without releasing other fingers). A generic set of finger gestures that are performable by a grasping hand are given by the Taxonomy of Microinteractions [10]. To measure the specific gesture limitations while grasping an object, we ask users to perform guided gestures while holding an iPad sandwich.

4 Contribution and expected benefit of the doctoral consortium

Within the student consortium I will present my previous research [8], [9] and the results of my first study [10] shortly for explaining my current work in greater detail.

In my actual project I measure objective and perceives pragmatic qualities as well as perceived hedonic qualities of microinteractions using SMEQ, NASA TXL, and AttrakDiff. In the student consortium I would appreciate to discuss this approach.

Because I aim to develop a framework for microinteractions, another question to ponder would be how to get valid measurements that are scalable for various grasp-based task types and for grasped objects with different parameters.

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