Prospects of User Elicited Gestural Interaction Techniques

Jens Heydekorn
University of Magdeburg
Faculty of Computer Science
User Interface & Software
Engineering Group
39106 Magdeburg, Germany
jheyde@isg.cs.uni-magdeburg.de

Mathias Frisch
University of Magdeburg
Faculty of Computer Science
UI & Software Engineering Group
39106 Magdeburg, Germany
mfrisch@isg.cs.uni-magdeburg.de

Raimund Dachselt
University of Magdeburg
Faculty of Computer Science
UI & Software Engineering Group
39106 Magdeburg, Germany
dachselt@acm.org

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Abstract
One way of a user-centered approach to define interactive gestures is to study users' proposed gestures for a given task or application. The result is a vocabulary of gestures, which is called a *user-defined gesture set*. However, this approach is a twofold method, which offers great opportunities but also risks for the gestural interaction design, because users cannot be seen as interaction designers. Furthermore, this approach was only incompletely described in the literature, e.g. with regard to study preparation or gesture classification. As a consequence, important aspects of the process, e.g. criteria for selecting elicited gestures, were not sufficiently discussed yet. We propose an enhanced process to work out a conflict free gestural interface. This proposal is based on own work [2]. The twofold character of this method is indicated in every step of the process by naming important artifacts, analysis methods and decisions within the process. It starts with the study design and ends with the evaluation of an implemented interface. With this paper we provide an overview and outlook in the research field of user elicited gestures. Thereby, a comprehensible basis is offered for discussing open questions.

Keywords
Gesture, user-elicited gestures, user-centered approach

Introduction

Through the technical advances in detecting and using gestures for interaction, there is a rising demand for appropriate gestures and a process to define a gestural vocabulary respectively. A description of a procedure to gather gestures and gestural interaction techniques can be found in Nielsen [4]. This work was the inspiration for following work, e.g. by Wobrock et al. [5], Epps et al. [1] and Micire et al. [6]. They all applied the theoretical process, whereby Micire used it for the particular domain of robot control. The approach has been extended in the work of Frisch et al. [2] by taking expert concepts and mental models into consideration. Every work enhanced the procedure by their own insights and solutions, which allows us to get a refined understanding of benefits and hazards within the process.

1 Analyzing the application domain

If the gesture set should be used in a specific domain, an analysis of the domain is required, which was only rarely incorporated up to now. An elaborated application scenario examines basic requirements out of the natural environment, such as functions and objects, organization and grouping, devices and tools, workflow and communication resources. Based on this analysis, required functions are identified and utilized physical devices or tools are determined. Especially in computer usage, prevailing workflows and metaphors used in the interface are of interest. Furthermore, cultural and social observations and inquiries are useful to prevent undesirable gestures. The goal is to get a picture of the natural workspace including technical systems, which shapes the mental model of the users. The prevailing mental models are essential for the gestures a potential participant in the study will propose as well as for nomination in the composition phase.

2 Collecting and studying elicited gestures

The results of phase one are the basis for the design of a user study. Basically, the environment, offered devices and functions are to be defined for the study. Techniques such as paper prototyping or wizard-of-oz can be used to emulate a work environment. It should be decided by experts which functions of the domain can be expressed by gestures. We think that the creativity of participants can be encouraged through the environment. This includes all ineligible tools and devices, e.g. pens and other tangibles. In that way it is more likely to get unforeseen gestures and usages of devices. It is predictable that only already known interaction techniques are elicited if the offered environment and the presented content are too stereotypically designed. However, for every task experts can define an initial gesture set, based on determined and selected metaphors, mental models and identified types of users. This gesture set can be over-determined. This can help to support various mental models, as we have observed in [2]. Every design decision is valuable for the composition of the gesture set, because a comparison between proposed and elicited gestures becomes possible.

During a user study, observations and logs are used, for example video and audio recording, notes of experts and logs of technical/digital devices. This material is used to identify gestures for every task, function or operation. Every observed acting of a gesture must be identified as precisely as possible. To analyze even small parts of the acting, like moving one finger up, can improve the decision provided there are two similar gestures. In [2] and [4] a vocabulary of symbols or short descriptions is used to identify gestures, and to enable a decomposed description of the movements. A

peer review of the analysis by two or more experts may raise the quality of the result. After that, the frequency of gesture occurrence can be calculated. Further values can be determined to find prominent gestures, for example values for agreement [5] and guessability [6].

3 Classification by taxonomy

To get a deeper understanding of elicited and identified gestures, a classification could be conducted. The classification by taxonomy is not fully required for the composition of a gesture set. Nevertheless, the result contains valuable insights of prevailing mental models, the perceived nature of a task and applicability of bimanual gestures. This information can be used to resolve conflicts within the gesture set. One approach of a taxonomy for gestures on interactive surfaces was suggested by Wobbrock [6], whereby Nielsen [4] indicates other classes and categories. For example Giuard [3] names valuable details for bimanual gestures, which are not sufficiently considered in current research. Furthermore the elements and semantics of a gesture should be defined more precisely. For example this would help to overcome problems in distinguishing bimanual gestures in combined gestures (composition of two unimanual gestures) and unique gestures (unique bimanual gesture).

4 Composing the gesture set

The goal of this step is to find appropriate gesture candidates for every task or function. In addition, conflicts of competing gestures are to be solved, e.g. ambiguities or over-determined tasks. The decision to include or to discard a gesture depends on defined design goals. A design goal can be based on or refer to derived information or values of the study's analysis. Examples are a high occurrence frequency of a gesture in the study or a prevailing mental model after the classification. Furthermore, grounded decisions of experts are to be considered, because derived values do not necessarily represent the whole possible design space. Another design goal can be that the number of distinguished gestures should be minimized to increase the learnability of the whole gesture set. The decomposition of a gesture within the analysis of elicited gestures can identify partial movements, which are carried out for multiple tasks. This indicates conscious or unconscious identification, rearrangement and reuse of (sub-) functions or corresponding gestures. Overall, the composition of the gesture set points to the discussion about the quality of a gesture set. A heuristic of criteria would dramatically increase the external validity of the study results and elicited interaction techniques.

5 Evaluating the gesture set

After the theoretical design an evaluation verifies the gesture set within practical usage. Nielsen [4] proposes a benchmark which is divided in three parts: guessing the function after presenting a gesture, reminding the gesture for a given function and physical stress while acting the gesture set. Wobbrock [6] suggests the same with exception of the stress-test. In addition, they indicate the usage of an implemented gesture set, which allows us to measure recognition rates by the system. These three parts of the evaluation can be quantified to become comparable. Within domains with existing and productive applications, the comparison between two interaction techniques becomes valuable. At least the criteria of effectiveness and efficiency must be additionally evaluated.

Implications

However the heuristics and criteria for integration and usage of gestural interaction must be focused with more effort. This demand becomes especially obvious in domains with mostly abstract information, where natural or physical mimics are difficult to apply in form of a metaphor. As a result it is often noticeable, that gestural interaction has been combined with common techniques such as WIMP. The process and the analysis in particular must better include requirements for an over-determined gesture set, which considers for example more than one prevailing mental model.

Studies on elicited gestures are able to proof and to discover gestural interaction techniques by a carefully designed study setup. The environment basically inspires the participants. It builds bridges from the laboratory situation to the domain dependent work. The selection and analysis of participants delivers information with regard to already known gestures or existing expertise in software usage for example. That serves as a solid basis to interpret study results regarding expected and unexpected gestures. However, a gesture can imply further aspects such as social or comfort aspects, which are not sufficiently considered.

More than in other interaction techniques there is a dependency between inherent semantics of a gesture and the perceived usability. Because of this, we propose to discuss further characteristics of gestures, such as bimanual usage and modeling mimics for example. Furthermore analyzing and clustering of a successfully classified gesture set may identify prevailing characteristics and qualities of the whole gesture-set as well as a subset of gestures. In case of a subset this analysis method may identify gesture techniques, e.g. natural mimics, application of abstract symbols or bimanual expression. The inherent qualities of the whole gesture set could be characterized. For example, a gesture set could be generalized or transferred to content- or domain-dependent applications. Furthermore a gesture set can be distinguished and classified as an abstract, natural, complex or minimalistic gesture set.

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