Is gesture-based interaction a way to make interfaces more intuitive and accessible?

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ABSTRACT
Especially older user generations are struggling to use everyday technology. Two major reasons for this observation are the lack of technology familiarity among older adults, and an age-related decline of sensory, cognitive or motor function. This entails difficulties in the interaction with products that are not designed to meet the older users’ capabilities. Striving to design more inclusive products, we should turn to technology which requires less technology familiarity and domain knowledge and at the same time puts a minimum strain on the sensory, cognitive and motor abilities of the user. Gesture-based interaction might be a tool to increase accessibility of a product and foster intuitive interaction. This can be achieved by employing gestures that rely on rather general sensorimotor levels of knowledge instead of specific expertise with the electronic device. The success of products which pioneered gesture-based interaction (e.g. Apple iPhone or Nintendo Wii) proves their adequacy already for a wide range of user types, from kids to business people. Whether gesture technology could allow for intuitive interaction with products also for the elderly users will be discussed in this paper. In particular, gesture technology can yield new perspectives on the debate whether prior experience equals intuitive use: even though people have usually no prior experience with the particular device (e.g. doing a “pinch” gestures on the iPhone, or operating the Wiimote), they would generally qualify the interaction as feeling “natural” and “intuitive”.

1. GESTURE-BASED INTERACTION
By “gesture-based interaction” we refer to technological systems which can be operated by means of gestures. As a gesture, in the context of HCI, we define a coordinated and intended movement of body parts to achieve communication. The information which it contains is specified by the configuration of body parts, the speed and direction of the movement and must be meaningful to its receptor. By this working definition, we separate gesture input from simple key presses or mouse clicks where the button press itself carries no information. However, the boundaries between direct object manipulation (e.g. dragging an object across the screen) and manipulative gestures (e.g. clockwise circular motion to fast forward a media track) are still fluent. Gestural interfaces are implemented on a wide range of technical systems and classified roughly into 2D gestures, operating through finger or hand movements on touchscreens or interactive surfaces, and 3D gestures, operating through free-form movements in space [13]. Since gesture-based interaction has been introduced to the mass consumer market through products such as the iPhone or the Wii (which have since then dominated their respective markets), the technology has been brought to a wide range of products, ranging from mobile phones, over PDAs, digital cameras, portable music and video players, gaming systems, navigation systems to laptop and desktop computers. The marketing language makes excessive use of the word “intuitive” whenever a product features gesture-based interaction elements. Furthermore, even though standardized patterns of gesture input are only beginning to emerge [13], first-time users usually report relatively few interaction problems, despite a lack of prior experience with this technology. These observations give reason to include gesture-based technology in the discussion on the role of intuition and prior experience to achieve inclusive design.

2. FRAMING INTUITIVE INTERACTION
Different research groups have attempted to scientifically grasp the buzzword “intuitive use” of products and evaluate its value as a scientific term (e.g. [2, 9]). Two definitions identify the generally unconscious application of prior
knowledge as the key feature of intuitive interaction. While Blackler et al. additionally stress the fast nature of intuitive interaction, Mohs et al. add the requirement for the interaction to be effective [1]. A central point in these definitions is that intuitiveness of use is not a characteristic inherent in the product specifications, but emerges from interaction and is largely dependent on the user. Both groups further agree that intuitive interaction can best be described as a continuum that stretches along the dimensions of product novelty and cognitive effort [3] or the type of prior knowledge employed [11]. The knowledge continuum assumes innate knowledge as the most basic and prevalent type of knowledge, followed by sensorimotor knowledge, culture specific knowledge and lastly expertise in a specific domain. While intuitive interaction can be found on each level of the knowledge continuum, Hurtienne and Blessing [6] argue that knowledge from the lower levels of the continuum is more likely to be applied subconsciously. Hence, user interfaces that tap on lower knowledge levels are more intuitive to use. In addition, these interfaces would reach a larger number of users, so this claim could be extended in that they also would ensure a more inclusive interface. Gestural interfaces bear the potential to make excessive reference to the cultural and sensorimotor levels or prior knowledge, and thus, in theory, could be a means of making interfaces more intuitive and more inclusive at the same time.

This point is exemplified in Figure 1: Three different implementations of the shuffle function (on different iPod devices) are shown. The first implementation (iPod shuffle, 3rd generation) is operated by an unlabeled switch which can only be mastered through knowledge of this particular product. The second implementation (iPod shuffle, 2nd generation) also relies on a hardware button to switch into shuffle mode but additionally relies on symbols which are known from other hardware and software media players. Thus, people that are familiar with similar systems might be able to use it intuitively. The last implementation (iPod nano, 4th generation) switches into shuffle mode by shaking the device. It taps into the basic sensorimotor knowledge that shaking a container with (previously aligned) objects mixes them up.

3. INTUITION VS. PRIOR EXPERIENCE

Prior experience has been shown to be an important predictor of successful product use [5, 8]. However, this concept has not yet been defined as clearly as "intuitive use". It is usually equated with technology familiarity and assessed through questionnaires which yield a technology familiarity score. This score could be based on the frequency of exposure and branding familiarity [8], or level of exposure and depth of knowledge [2]. If one tries to link the concepts of prior experience to intuitive use, the crucial point seems to be how much prior knowledge is generated through prior experience, and whether this knowledge can be activated subconsciously in order to allow for true intuitive use of products (Figure 2). The amount of prior knowledge about an object or process is thought to be determined by the quantity (e.g. frequency) and quality (e.g. intensity) of previous exposure to this object or process. Thus, while prior experience is surely a common constituent of intuitive use, it is neither a necessary prerequisite, nor is intuitive use the mandatory result of it:

- First, prior experience as measured by technology familiarity is usually contextualized with the specific product or product class. Intuitive use of products, however, can also result from a successful application of prior knowledge of cultural, sensorimotor or innate levels (Naumann et al., 2007).
- Second, especially in complex scenarios or changing
contexts, even high levels of prior experience might not generate knowledge that can be tapped subconsciously and effortlessly.

4. TOWARDS INCLUSIVE DESIGN

The definition of inclusive design is based on the idea of excluding only a minimum number of users, necessitated by the product requirements, but to refrain from introducing further exclusion factors by the specific design of the product [7]. For example, an inclusively designed kettle would presuppose certain cognitive, sensory and physical abilities of the user (e.g. the users must be able to handle a cup of hot water safely, or manipulate a cup-sized container of liquid - the product requirements), but no further restriction (e.g. through weight, contrast, visibility etc.) should be introduced by a specific product design [7]. However, a design approach which is solely based on user capabilities [12] might exclude at the same time a substantial number of users if the product is aesthetically unpleasing, is too expensive, lacks compatibility with other products and services, or has a stigmatizing connotation. As Keates and Clarkson note ([7], p. 69), "a strategic decision is therefore required regarding the balance between the marketability of the product and the level of population exclusion”.

The use of gesture technology, in our view, could be a means of achieving this balance, as the marketability of such devices has already been demonstrated, and by developing intuitive gestures, a wider range of people, also older people and people with disabilities could be reached. At a first glance, this idea might seem surprising, because especially elderly people lack prior experience and thus familiarity with this new kind of interactive devices. However, as was pointed out before, an intuitive interaction with these devices could still be established, if the gestures make reference to lower levels of the knowledge continuum. For example, while the process of deleting or confirming an item on a traditionally operated cell phone involves opening a hierarchical menu with help of soft keys and selecting the appropriate command through the navigation keys, a gesture-based approach could simply involve performing a "crossing out" or "ticking off" gesture on the item in question. The traditional approach will only be intuitive to people who have some computer literacy and experience with similar systems, while the gesture-based approach will be intuitive even to people with no prior domain knowledge. However, while certain gestures could lead to a more intuitive interaction, there is no automatism behind this relation, and different gestures could also impede intuitive interaction. If the gesture command does not bear any semantic relation to the function it should trigger (e.g. moving the mouse in an L-shape (down, then right) in a common mouse gesture extension for the Firefox web browser results in closing the current tab), prior knowledge cannot be appropriately applied, thus the gesture does not qualify for intuitive use.

In our research, we focus on healthy older adults (60+), who could benefit from technology that helps them to compensate age-related cognitive, sensory and physical deficits, that enables them to communicate, navigate and meets their needs of independence and security. In particular, we investigate whether gesture technology on mobile devices could be a means to achieve inclusive design, resulting in a more intuitive interaction. Potential benefits of this technology are:

1. **Indirect size advantage**: by replacing hardware buttons by touch or movement gestures as input method, more screen space is available (on an equally sized device). This way, visual information can be displayed bigger, thus facilitating readability for the vision impaired.

2. **Adaptable screens**: As software buttons replace hardware buttons on multi-touch interfaces, it becomes possible to load different profiles on a device, which could feature differently labelled, sized and positioned buttons, reflecting the needs and capabilities of the target user.

3. **Direct interaction**: Direct interaction has been shown to be beneficial to elderly users and in particular the advantage of touch panel use has already been demonstrated [10].

4. **Intuitive gestures**: By using familiar symbols or movement patterns as gestures, interaction knowledge could tap deeply rooted cultural or sensorimotor knowledge resources, increasing the chance of effortless interaction. Hence, less domain or product expertise is required.

5. **Balance of marketability and capabilities**: Making use of this new technology could present a good solution to the trade-off between senior-specific (yet stigmatizing) and universally designed (yet not meeting older users’ capabilities) devices.

Potential limiting factors of gesture technology for older adults could be:

1. **Lack of feedback**: By getting rid of hardware buttons, one also loses immediate tactile feedback on whether...
button press has been successful. To satisfy older people’s needs for feedback and desire for control, alternative feedback mechanisms (visual feedback, vibratory touchscreens etc.) might compensate.

2. **Loss of cues and affordance.** While a hardware button affords to be pressed (e.g. to cancel a phone call), and menu items provide cues on their functionality, nothing hints at which gesture could be employed in which context.

3. **Complex motion.** Bearing in mind some age-related constraints on motor performance (e.g. reduced wrist flexibility [4], suitable gesture patterns for elderly users have to be chosen appropriately.

4. **Acceptance.** Elderly users are generally more reluctant to adopt unfamiliar technologies. As gesture input presents a radically new interface concept, they might be reluctant to make use of it, even if they score better on usability metrics with gesture input.

The aim of this contribution is to introduce gesture-based interaction to the field of inclusive design. The benefit of gesture technology is pointed out on the background of common concepts of intuitive use and prior knowledge. Strengths and weaknesses of this technology with regard to older users in particular are being discussed. In our research, the advantages and disadvantages of gesture input are empirically investigated. Results from studies investigating the feasibility of gesture patterns and addressing the understanding of gesture patterns among older users will be presented to back up the claim that elderly users could effectively use gesture-based technology and point out boundary conditions.

5. **ACKNOWLEDGMENTS**

This research is supported by the German Research Foundation, (DFG-1013 'Prospective Design of Human-Technology Interaction') and by the National Research Fund Luxembourg, FNR (AFR grant).

6. **REFERENCES**


