Full-Body Interaction for the Elderly in Trade Fair Environments

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Abstract. In the near future, more and more personalized products will be offered. Presenting physical, customizable products to the customer in all possible variations can be very complicated and space-consuming. Virtual life-size representations of these kinds of products are common and offer an attractive product experience. An interactive product configuration allows customers to explore several variations on their own. The combination with natural interaction technologies, such as gesture input, also allows users, which are mostly unfamiliar with technology, to explore product variety efficiently. The research presented in this paper focuses on motion-based interaction in public spaces. The application field are trade fair environments and the target group are elderly people with specific needs. We present a design methodology for the development of full-body gestures adapted to our application field of configuring large-sized products (specifically caravans) on large displays in trade fair environments using full-body interaction.

Keywords: Gesture, elderly, interaction design, large display, customizable products, public interactive installation.

1 Introduction

Gesture-based interaction technologies are an effective method to interact with information on large displays [4]. Interaction concepts for such innovative technologies should be developed bearing the target group in mind to optimally take into account the users‘ needs. Furthermore, it is important to consider the field of application where the users will interact.

Our application field is the configuration and presentation of products in trade fair environments. In the near future, more and more highly configurable products will be offered, which can be personalized by customers. Presenting physical, customizable products is a huge challenge for exhibitors. Even if the product comprises only a few parameters, the possibilities of configuration are

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enormous. Furthermore, if the product has large dimensions, e.g. vehicles or caravans, a large physical space is required to present several variations. Therefore, virtual life-size representations are used to visualize the product options. Many companies address older people with special products, e.g. caravans, that are considered in our work. They are highly configurable and can be easily presented at fairs in life-size on large displays. We present a configuration system for large-sized customizable products on large displays providing full-body interaction, especially for elderly people. Gesture interfaces can be attractive and make applications more accessible to older users, because they are perceived more natural than interacting via mouse and keyboard [7,3]. Generally, applications and the used gestures should be easy to handle and easy to learn.

In this paper, we present a design approach for an application which can be used by elderly people by utilizing gestural interaction to customize products on large displays. To develop intuitive gestures we employed an user-centered design approach. In the following chapters, we discuss existing research and analyze the requirements of the target group and the application scenario. Moreover, we present an early interaction concept including an early interactive prototype as well as an adapted procedure for full-body gesture development. Finally, we discuss our results and show starting points for future work.

2 Background and Related Work

Full-body interaction that does not use explicit input devices is successfully established in the entertainment industry. Primarily, this technology is used for games, e.g. exergames that support your personal fitness at home [10,16]. The best-known device is the Kinect sensor by Microsoft, which is also used in applications for elderly people [7]. It is low-cost and easy to handle, which is why it is used more and more by designers and developers for elderly people, among many other purposes. But not only in private but also in public spaces, full-body interaction is getting increasingly attractive. There are a number of public installations with the main purpose to advertise, e.g. *Paximadaki*, an advergame installation for promoting the brand and products of a food company at exhibitions [8]. But only a few projects use touchless interaction for productive use, e.g. the touchless user interface by Ruppert et al. for interactive image visualization in urological surgery [18].

In full-body interaction you use your whole body. Most research projects about gesture interaction have focused on hand gestures which may be due to technological progress. Humans naturally use gestures to communicate [15]. By using gestures they do not use exclusively hands [12]. In certain interaction scenarios, it is conceivable that gesture interaction with other body parts or the whole body is more intuitive than hand gestures. A human-based approach is needed to identify those gestures for interacting as intuitively as possible with a system [17].

In current research, gestures are characterized by different properties depending on the viewpoint. McNeill distinguishes gestures from a linguistic view: deictic (pointing), iconic, metaphorical and beats [15]. Wobbrock et al. classified surface gestures to form (static, dynamic), nature (symbolic, physical, metaphorical, abstract), binding (object-/world-dependent, mixed) and flow (discrete, continuous) [21]. Depending on the users, different gesture types are preferred. Stößel and Blessing investigated touch-based gestures on mobile devices for older users and compared their preferred gestures to those of younger users. They found out that preferred gestures differ significantly on characteristics such as basic gesture type, fingers involved, or gesture complexity [19]. Thus, we include especially older users, our target group, in the development process.

Our work focuses on the development of a full-body interaction concept for productive use (configuring products) in public space (trade fairs). We include users (older people) in the design process pursuant to Nielsen et al. and Wobbrock et al. and adapted their method to full-body interaction using a generic, technology-independent definition of gestures.

3 Methodology

General ergonomic findings of Nielsen et al. and Wobbrock et al. suggest an user-centered approach for the development of highly intuitive and ergonomic gestures for tabletop interactions [17,21]. The approach includes four stages: analyzing the using context and finding functions, collecting gestures by involving the potential users, extracting gesture vocabulary and testing resulting vocabulary. The approach is transferable to various fields of interaction, e.g. multitouch and pen gestures [5], mobile phone gestures via integrated sensors [13] and free-hand gestures without explicit input devices [20]. We adapted the user-centered approach for hand gestures to support the development of full-body gestures.

The underlying gesture definition is a decisive factor in the development procedure. Regardless of the used gesture recognition technology, for a highly generic development approach, it is necessary to use a generic gesture definition. Kurtenbach and Hulteen define gestures as a *motion of the body that contains information*, which focuses on a dynamic aspect [14]. Harling and Edwards distinguish between static and dynamic hand gestures [11]. These definitions can be combined to a general definition of full-body gestures: *Gestures are a motion (dynamic) or a position (static) of the body or parts of it that contains information.*

If we use the general approach of the gesture definition, we can develop technology-independent natural gestures. A second benefit is that gestures are probably more natural because there are no restrictions in users' body movements and body parts. For the development of the gesture interface of our configuration system we started with a small survey, which we present in section 5. We followed the user-centered approach according to Nielsen et al. and Wobbrock et al. to design an appropriate gesture vocabulary, but adapted the procedure to technology-independent gestural full-body interaction.

4 Towards Developing an Interaction Concept

A gesture-based interaction concept used by elderly people in the context of public spaces has to meet certain criteria. Therefore we have to answer the following questions: Who are the users? And which parameters of the fair environment influence interacting? After analyzing the requirements, we suggest how to meet these requirements in the system adopted to the application field of configuring large-sized products.

4.1 Requirement Analysis: Target Group and Application Scenario

At first, we analyzed the user group and the context of fairs. The special user group, the elderlies, who are mostly unfamiliar with technology, are subjected to changes due to age in the field of physical, perceptual and cognitive abilities [6]. There are many older people who can use applications designed for younger users, but it is clear that learning those applications is very difficult because of normal aging process [3]. The lack of computer experience requires a user-centered approach for interaction development because elderly users do not have the knowledge of typical gestures.

In addition, trade fairs enhance the probability that the interacting user is a so-called first time user. There is hardly any learning effect because these trade fair visitors use these gestures for the first time and only for a short period of time. Due to the fact that trade fairs are usually noisy, users can be easily distracted from interacting. Therefore the cognitive demand should remain low. That is why we suggest a configuration wizard to customize the product step-by-step in a linear way concerning application navigation. Along with a short interaction time the application should provide just a limited configuring functionality. On the other hand, the physical demand needs to remain low.

All these facts lead to the necessity of an interaction concept, which is easy to use and easy to learn [1]. Embodied interaction with gestures which are as intuitive as possible supports learnability. Thus, a user-centered approach should be applied, e.g. by involving the target group in the development process. Furthermore, the application needs to be easy to handle with a small range of functions. The following sections describe in detail how we meet the requirements as outlined above. Our interaction concept for elderly people using full-body interaction includes simplicity at three levels: *navigation*, *functions* and *gestures*.

4.2 Navigation: Preprocessing the Product Data

We developed a generic approach for preprocessing the product information to configure them step-by-step in a configuration wizard. Product data are typically structured in hierarchies with any level of detail. There are product parts which can be organized in groups (e.g. *bed* and *bedside table* to a *bed arrangement*). Consequently, the result is a product tree. This product structure can be

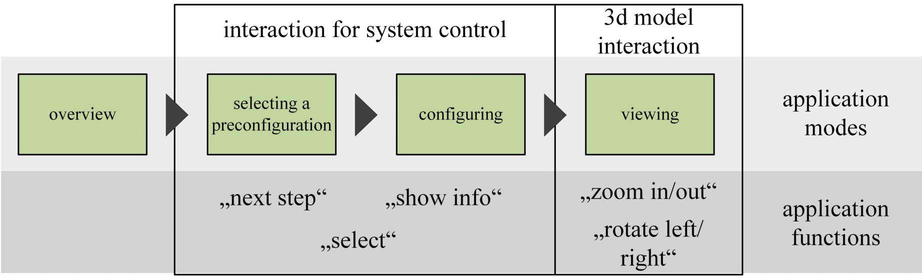


Fig. 1. Structure of interaction sequence within the application

used to sequence the different options for each customizable product part. After sequencing customizable product options there is a simple sequential structure. This structure can be used for implementing a configuration wizard. Complex product structures should be divided into simple constructs. The sequencing forms the basis for a clear and consistent navigation. The total interaction sequence should be kept to a minimum by organizing customizable parts in whole customizable groups (e.g. a *table* and *chairs* can be grouped to a *seat set*). A resulting linear navigation facilitates the interaction in each configuration step because of its reduced range of functions.

4.3 Functions: Configuration Functionality

In order to simplify the customizing of products for the user, it is necessary to provide just a basic but adequate configuration functionality. Therefore, we divided the application into three main stages (see figure 1): preconfiguring, configuring and viewing mode. The first step to simplify interaction sequences in the field of functions is to offer different preconfigurations of the product which can then be customized in a further stage. In general, these stages can be separated by their interaction focus (system control and 3d model interaction). During the configuring stage we mapped the functionality to basic functions for system control, including menu interactions (*next step*, *show info*, *select*). To support the imagination of the customer it is useful to present tangible products as 3d model in real time. While configuring different parts of the product, the application should help to navigate through the 3d scene by focusing relevant scene parts automatically (see figure 4). In the final stage, the viewing mode, the customer can explore their customized product on their own (*zoom in/zoom out* and *rotate left/rotate right*).

4.4 Gestures: Development Procedure

In a next step, we wanted to find those gestures that may trigger the functions. Because of the compact set of functions, the resulting set will comprise only a few number of gestures. The gesture vocabulary is kept at a minimum, so that it

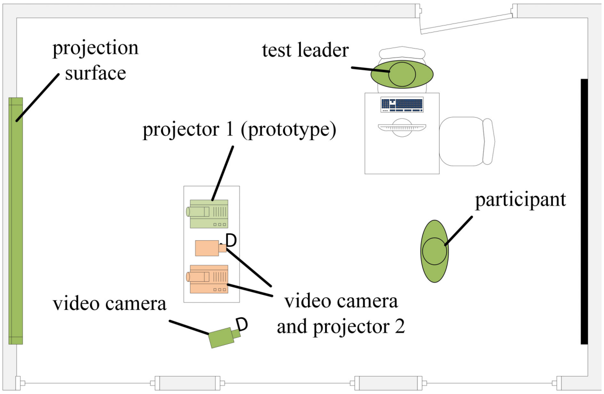


Fig. 2. The setting of the laboratory where the study had been conducted

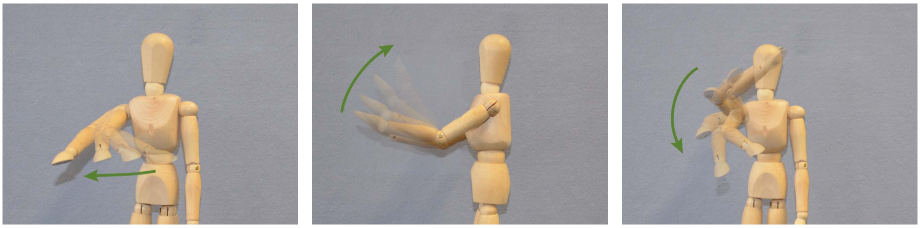
is easy-to-understand and users do not have to learn much. There is a wide gap between the young designer's personal experience and the experiences of older users. To bridge this gap we adopted the user-centered approach and based the development process on a general gesture definition as we presented in section 3.

5 User Study for Developing Gesture Interaction

Participants and Technical Setup. In a first iteration, we conducted a user study with five participants (2 male, 3 female; average age of about 60) to identify first full-body gestures for the configuration system of caravan products. None of the participants had much experience with computer systems or prior experience with gesture interaction.

The technical setup of the user study can be seen in figure 2. The system was simulated by a low-fidelity prototype (slide show) which was displayed with a projector. We implemented two passes: without and with visual feedback. Visual feedback was given by installing a second projector, which overlayed the prototype picture and showed the reflection of the participant. The test leader described a typical interaction scenario step-by-step which the participant should turn into body movements. They were asked to move freely with their whole body to interact with the prototype.

Results. Movements of hands and arms were often performed by participants. One of the participants tended to take a few steps forward to enlarge the presented caravan. All in all, gestures of different categories were shown: physical related to the caravan transformations (e.g. beckoning to enlarge as you see in figure 3(b)), metaphorical (e.g. a sleeping gesture in order to switch to the sleeping area of the caravan by putting both hands beside the head) and deictic to interact with menu options. There was no essential difference between the two passes, but the pass with visual feedback shows interactions with a stronger



(a) *next step* by swiping (b) *zoom in* by beckoning with both arms (c) *rotate left* by moving clock-wise

Fig. 3. Extracted dynamic gestures for interacting with the configuration application

object-dependency. One participant complemented some of his gestures with voice-commands.

The results showed an initial, compact set of five full-body gestures of different categories. In the next step, we sorted out those body movements and gestures, which would not to be used at fairs (e.g. clapping). It was interesting to observe that the participants without any technological background performed very similar movements spontaneously. They differed from the designer's expected gestures, but are well-known from everyday life (e.g. beckoning to zoom in) and are therefore applicable in the specific context of trade fairs.

A standard concept for interacting with systems is point-and-click [2,9]. Besides the gestures showed in figure 3, we could observe this central concept in our study. Participants pointed to something and tried to confirm their selection by tipping in the air. Furthermore, the test persons preferred discrete gestures, which means they repeated e.g. their rotation movement up to the desired position of the caravan.

Interactive Prototype. Based on the interaction concept and study results we implemented a first interactive prototype by using Microsoft's Kinect (figure 4). For the development of the basic functionality we used the Unity3D-Engine[1]. For rapid gesture development we used the Omek Beckon Development Suite[2]. Technology restrictions for gesture recognition imply in this development stage. For a better recognition rate, some of the gestures had to be performed with exaggerated movements, e.g. rotating in a more vertical plane in relation to the Kinect sensor. Thus, the resulting prototype includes the configuration stages and functionality as shown in figure 1.

6 Discussion

Our study has been conducted with a small number of five participants composed by representatives of the user group. On this account, the results are

[1] `http://www.unity3d.com/`
[2] `http://www.omekinteractive.com/`

Fig. 4. Screenshot of an early interactive prototype

only a set of initial thoughts of a final gesture vocabulary and interaction concept. Nevertheless, it has been demonstrated that older users with less computer and gesture experience prefer other gestures than the young designers expected (e.g. zooming - our designers expected a movement similar to the multitouch pinch/spread). Our findings indicates that elderly users prefer certain gesture types (deictic, metaphorical). Stößel and Blessing showed similar results in the field of preferences concerning multitouch gesture types [19]. They also identified that most of preferred gestures were discrete. A comparison of discrete and continuous gestures for shown dynamic gestures with an interactive prototype could show to what extent this results can be transferred to full-body interactions.

Further improvements will focus on refining the extracted gestures using the interactive prototype like presented in section 5 as well as evaluating the interaction concept itself. Resultant gestures have to be tested reverse according to distinctness, memorability and ergonomics as stated in Nielsen et al. and Wobbrock et al. [17,21]. In addition, future work will include refinement and evaluation of the application navigation. For example, an extension, which includes orientation metaphors would be useful for an understandable linear structure. The limited configuration functionality, as a second simplicity factor, is only applicable to products which are less complex. In case of highly configurable products, it might be necessary to adjust configurations in a last step by the seller. It is essential to determine under which conditions a product is too complex for customization with the developed interaction concept.

We have presented an adapted methodology of developing intuitive gestures for full-body interaction originally proposed by Nielsen et al. and Wobbrock et al. for tabletop interaction. Participants were introduced to the general gesture definition with no restrictions concerning their body movements and body parts.

Most participants used mainly specific body parts like arms and hands, but there were also hints that they actually would use their whole body to interact naturally with systems, e.g. take a few steps forward to zoom in. To refine extended methodology we should conduct a user study with more people and of different target groups.

7 Conclusions and Future Work

In this work, we presented a design approach for an interaction concept to customize large-sized products by using full-body interaction especially for elderly people. Beside the requirements of older people, our application field of trade fair environments needs special attention. We concluded based on the requirements to an interaction concept which includes simplicity at navigation, functions and gestures. We implemented a linear navigation, a basic configuration functionality and developed gestures by involving elderly users.

For designing full-body gestures, we adapted the methodology of Nielsen et al. and Wobbrock et al.: on the one hand to the development of full-body interaction, and on the other hand to our application field of configuring products using large-sized products in context of trade fairs. The extracted gesture set might be transferred to other domains, where older people want to interact.

Due to our application field of the public space, collaboration and multi-user interaction scenarios have to be investigated. People rarely visit a trade fair alone, so that there will be scenarios where you could use the configuration system by customizing a product in collaboration with a friend or a partner. In the long run, we have to investigate how the user group of older people accept full-body interaction in a productive interaction scenario like customizing products. The participants of our study were at least excited about the possibilities. Full-body interaction on large displays has a high potential to experience products in a very special way and provides access to computer systems to elderly people.

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