Learning Special Input Methods with Personalized Game Applications

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Abstract

Personalization in interactive systems can take a variety of appearances, e.g., in the form of individually tailored content presentation, adaptive navigation concepts or layouts. It has been discussed in a number of domains such as e-learning, search or information retrieval and has become an important aspect also in the general context of human-computer interaction. The presented project focuses on the personalization of the interaction process itself. It provides a user modelling framework with emphasis on users' interaction abilities and an infrastructure for i) the personalized and automated selection and configuration of input devices as well as ii) the individually tailored process of interaction with the applications using the framework. This short paper outlines the process of and relations among interaction modeling, further individual training of interaction abilities and personalized application configuration using the example of two simple games that make use of the framework.

1 Introduction

Serious games have been successfully employed in many therapy settings but can also be used as a motivating means to learn new interactions that help people who usually have problems dealing with standard input modalities. In the IAAA project, we developed a user modelling framework for assisting (disabled) people while they are working with interactive systems. So far, we introduced a number of promising modalities the target group could use in their daily work with computers. Initial observations showed that in our target group, vertical movements of a hand/arm seem to be advantageous while horizontal movements are oftentimes limited as most of them suffer from some form of spasticity or paralysis. Thus, we decided to introduce pressure sensing interactions (e.g., applying pressure to the top of a device) and such based on hand shaking. In our user modelling framework, we initially analyze individual interaction capabilities by conducting so called interaction tests with users. Such a test could involve applying maximum pressure or holding a certain pressure level. Next, values (called features) are computed and stored in our user model. Later, these features can be used to tailor an interaction to individual needs. Our user tests showed that it might be beneficial for some applications to use the proposed input methods. Recently, we decided to introduce gaming applications for two reasons: firstly, it is a motivating way to learn the somewhat uncommon interaction methods, and secondly it is a well-defined sandbox environment in which we can test our personalization techniques, since the games adapt to individual users based on the user model features.

2 Related Work

The use of (serious) games as a motivating means to learn and improve repetitive tasks has been successfully employed and described before. (Oosterdorp et al. 2014) analyzed a serious learning game that adapts its presentation with the hypothesis, that an adaptive game is more engaging and more efficient. However, while they found no difference in the engaging ratings, they were able to confirm their hypothesis regarding efficiency, because participants learned significantly more in the adaptive game. We also planned to enable our users to learn the interaction methods more efficiently using adaptive games. (Wobbrock et al. 2011) criticize that current approaches are focusing too much on making technology accessible to users with disabilities, which tends to make the disability the focus of the research. To overcome this limitation, they propose the ability-based design approach, which shifts the focus back to the user and is divided into three categories: i) stance, ii) interface, and iii) system. While stance covers ability and accountability, the interface contains topics like adaptation and transparency. Finally, the system category comprises performance, context and commodity. A similar ability-based approach can also be identified in the IAAA project, where features representing individual abilities lead to adaptations of the system. (Akiki et al. 2014) made a comprehensive literature review on adaptive model-driven UI and grouped their findings along the following three categories: i) end users, ii) user interface designers, and iii) technical characteristics. For i), they suggest engaging end users to increase their affiliation, and reduce the time needed to define the adaptive behavior. For ii), they suggest, that UI designers might want to keep some UI characteristics intact even after the adaption occurs. For iii), they observed, that most existing systems focus on adapting WIMP-style UIs whereas other types are not supported. Our framework provides a means to overcome this limitation as it can readily be extended to be used for all types of UIs.

3 Analysis Application

The analysis application is part of the software framework developed in the IAAA project. It involves several so-called interaction tests that aim at measuring and formalizing a user's interaction capabilities which are then stored in the user model. On the basis of these insights, the system is later able to recommend and configure the interaction device setting (IDS) (i.e., a combination of one or more input devices with an input method) that fits the

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individual user's needs best in an automated way. An IDS related to the pressure-based interaction modality is e.g., a combination of a certain smart phone with one specific way of applying and measuring pressure. The software framework further involves smaller game-like applications (see Section 4) that allow a user to train interaction with the selected IDS as well as real-world scenarios each associated with one of the games. These real-world scenarios require the interaction skills measured in the interaction tests and further trained by the games. Each interaction test pertains to a specific user model feature. The games described later can be played with three different IDSs at the moment: i) a smart phone interacted with via physical pressure measured by a vibration-based approach, ii) a smart phone interacted with via physical pressure applied to a third device measured by a magnetic-field-based approach, and iii) a smart phone interacted with via shaking the arm (movement measured via a wearable device with an acceleration sensor). The interaction tests related to these IDSs measure and model i) the maximum level of pressure or arm shaking intensity a user can apply, and ii) the number of different pressure levels or arm shaking intensities a user can reliably distinguish and apply. For the tests related to maximum pressure or shaking intensity, a user is asked to apply the maximum possible pressure (either to the smart phone or the third device) resulting in the computation of the feature *MaxP* or shake the arm at the maximum possible intensity (feature *MaxS).* The system then stores the individual maximum in the user model. For the test related to pressure/shaking levels, the system repeatedly asks the user to apply pressure or shake the arm within a certain range (features *LevP* and *LevS).* For more details concerning the user model features see (Neumayr et al. 2015). The analysis application's output after all tests with the available IDSs have been finished is an ordered list of recommended IDSs (based on the user's performance in the tests) that could be selected for interaction with the games.

4 Game Applications

The first game, *Traffic,* is about controlling the speed of a car according to a given velocity. Through different pressure or shaking levels the user can control the speed of the car; higher pressure or harder shaking results in an increasing acceleration of the car while lower or no pressure respectively softer or no shaking results in a decreasing acceleration. The goal is to reach a given set of velocities as exact as possible and hold each for ten seconds. To personalize the interaction, the game uses either the feature *MaxP,* or *MaxS* depending on the IDS. The feature value is mapped to the acceleration in a way that the user's maximum pressure on or maximum shaking of the interaction device results in maximum acceleration of the car within the application. Attached to the *Traffic* game is a real-world application scenario, where the user can scroll through a PDF file. The scrolling speed depends on the pressure or shaking intensity exercised by the user whereas the maximum of both is dependent on the corresponding feature values. This means that each user can vary the scrolling speed, but the maximum speed is part of individual adaptivity. In the second game, *BarHero,* the user pilots a plane. Through different pressure or shaking levels the plane's altitude can be controlled while its speed stays constant. The plane has a default altitude that can be increased by either applying higher pressure on the interaction device or by shaking harder, depending on the IDS. The overall goal is to fly through as many so-called "non-cloudy areas" as possible while keeping the plane centered inside these areas. The size of those "non-cloudy areas" is symbolized by blue rectangles and typically varies for each user. Depending on how many different pressure or shaking levels a user can reliably hold (*LevP* or *LevS)* a user might get rectangles with different heights resulting in different pressure or shaking levels that need to be reached and held. As a real-world application scenario for the *BarHero* game, we introduced operation of the Windows start menu. Here also, depending on the different levels achieved in the two relevant features, the user can perform different interactions, e.g., low pressure advances one item whereas high pressure opens the currently selected one. If only one level can be held reliably, the advancement from one item to another is done automatically and the user can only open the currently selected one. In order to account for the increasing capability to interact with our devices which results from training by playing the games, each user's gameplay gets tracked and evaluated. Specifically, the average time a user needs to get to the next goal, the average deviation from the actual target, and the ratio of missed vs. reached targets are used to adapt the game in later runs.

5 Discussion and Conclusion

User tests with the games and real-world applications which have been conducted in the course of a layered evaluation process as suggested by (Paramythis et al. 2010) showed that the unconventional input methods we created for the special domain can be trained in a motivating way. The knowledge users gained from this assisted them to perform exemplary real world scenarios afterwards with similar ease as the games themselves which tends to show an intact knowledge transfer. E.g., for the PDF scrolling scenario we received feedback from a caregiver that our input methods are beneficial because scrolling speed can be easily varied and otherwise it is oftentimes difficult for people with disabilities to successfully target scrollbars. A thorough analysis of the gathered data is currently in progress.

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