IAAA – Interaction Analysis for Automated Adaptation

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ABSTRACT:
There is a sustainable spread of interactive software systems in a large portion of our everyday lives. An aging society and the near omnipresence of computer-based systems make it ever more important to personalize software systems and by doing so prevent usage errors and create a good user experience. A major drawback of personalization, however, is that it is a very time and resource consuming process. Therefore, the IAAA project aims to provide automated adaptation after a user's interaction capabilities with several input modalities have been assessed. Yet, the mere selection of input modalities can be a critical factor for the success of such endeavors which is why we also focus on the careful selection of input devices. Thus, an extensive task-based user observation involving the actual target group was conducted during the project's initial phase. Later on, first functional prototypes were evaluated within the same target group. The subjects of this paper cover the general objectives of the IAAA project, the process and methodology of, and aims behind the user observation and outlines the most important results.

1   INTRODUCTION

An ever expanding role of personalization in computer-based systems can be expected due to increased and changing requirements for these systems caused by rapid and lasting demographic change, prospectively aging employees or the focus on intelligent production processes, which are all topics dealt with through the European and national Strategy 2020. Furthermore, the portion of people with disabilities in the workforce can be increased through personalized hard- and software. However, the personalized configuration of interactive systems implies an enormous amount of time and effort if it is not done automatically respectively semi-automatically. Consequently, the demand for interactive systems which can automatically adapt to special needs of individual types of users will rise.

People with disabilities were chosen as the initial target group because the diversity of their needs is best suited for personalization. However, the Interaction Analysis for Automated Adaptation (IAAA) project does not exclusively deal with the personalization of interactive systems, but also analyzes and provides means to choose among different input modalities. Therefore, an analysis tool capable of automated and systematic analyses of input behavior is developed. The tool's output can in a next step become the basis for making the chosen software adaptive (reducing configuration complexity).

2   METHODOLOGY

A general overview of the course of action followed in the IAAA project can be seen in **Figure 1** and is described subsequently.

We initially intend to find out which forms of interaction are potentially beneficial for people with disabilities. Therefore we *analyze* typical *interactions* by designing some interaction scenarios, e.g., combination of a smartwatch with a touchless interaction device, or stylus pen interaction on or next to a tablet PC. Then we create test cases mostly in the form of tasks to evaluate the interaction capabilities of the target group. Some of the tasks were supported by small software applications that record usage data. Next after having identified a set of interaction scenar-

ios relevant to the target group, e.g., i) gesture-based, ii) haptic or iii) traditional (e.g., via mouse and keyboard) interaction and combinations of these, we develop several functional *prototypes* which aim at measuring users' interaction abilities regarding different aspects. The analysis of the user's interaction is based on some key indicators (e.g. accuracy). To test the abilities of the users we develop interaction tests for each interaction scenario. One interaction test affects several key indicators. With the definition of a number of key indicators that cover the whole interaction, e.g., reaction speed, or time to achieve a task, it becomes increasingly possible to predict if a user will be able to achieve his or her interaction goals using a particular input device. Next in an individual evaluation (user level) we aim to analyze the execution of the interaction tests inside the user group. In this step the key indicators for an individual based on the interaction scenario are computed and stored in the *user model*. The user model which contains a comprehensive number of indicators provides the basis for predicting a user's ability to interact with a system.

In general the user model will comprise information about different kinds of input devices and related configurations. In addition to a user's ability to operate a particular device properly, the user model should also account for the user's prospective individual preferences as they are likely to influence motivation and therefore the overall performance.

Finally the user model becomes the basis for the *automated adaptation* of further applications.
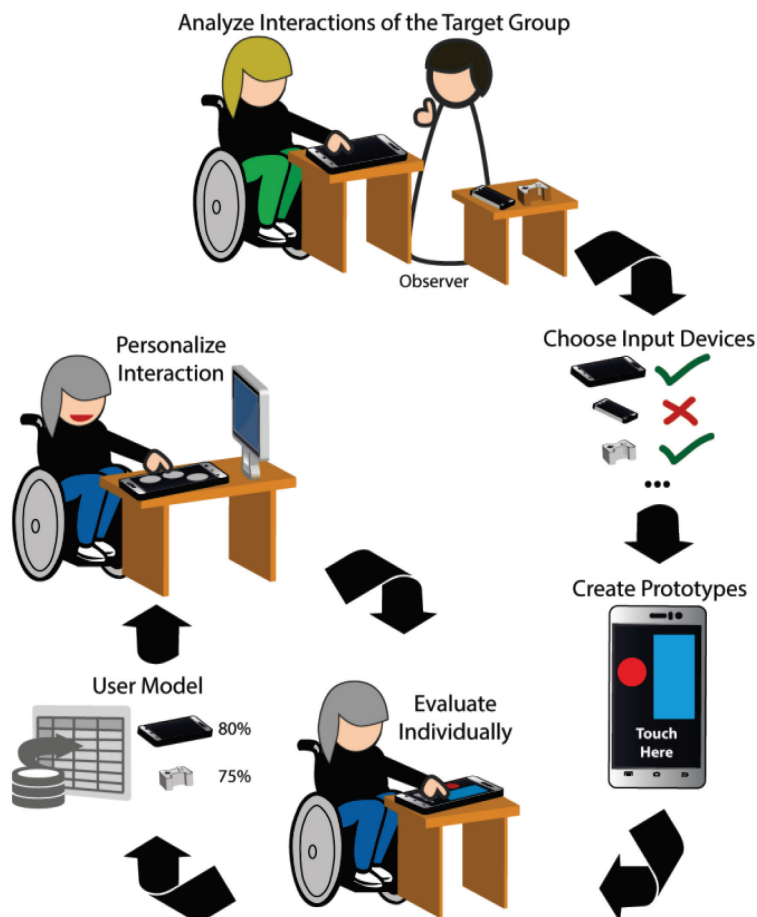

Figure 1. General iterative user-centered course of action followed within the IAAA project.

3 RESULTS & DISCUSSION

Results presented in this paper comprise the results of an initial observation that took place in early November 2014 at an IT workshop for people with disabilities. We worked with four participants who suffer from different disabilities ranging from cognitive through motor to visual impairments who had to solve about 50 tasks the instructions of which were given by the project team members. However, if it was clear beforehand that a participant would not be able to perform a set of tasks, e.g. because he or she could not move an arm, we omitted those tasks. While performing the tasks, the participants have been observed by the project team and notes have been taken in an especially prepared observation guide. The tasks contained activities concerning different input modalities (the related work to these methods is referenced alongside), namely smart watch as an output device of haptic feedback, smartwatch as a source of additional sensor data, smart watch as additional explicit input device (for smart watch related interaction modalities and possibilities please see [1]), the measurement of physical pressure (see [2]), magnetic field manipulation (see [3]), special touch gestures (see [4]), and touch-less gestures (see [5] for our earlier work). Yet, for this initial evaluation we used low-fidelity prototypes only with the aim of finding out how well participants could potentially work with the input modalities. Exemplarily, we used a common wrist watch instead of a smart watch, and circular stickers to depict target touch areas that would otherwise be visible on a touch screen. Results of the more promising interaction scenarios are described below.

The first set of tasks involved simulation of a smart watch as an output device of haptic feedback. This situation is of relevance to us as it has been shown in previous research that when working with touchless input devices (like Leap Motion) it is oftentimes problematic when users leave the area recognizable by the device without their knowledge (see [6]). We simulated this behavior by cutting a box open on one side and letting participants touch each side/edge of the box, receiving direct haptic feedback of the hand touching the borders of the recognizable area. Additionally, the findings showed that with few exceptions, all participants managed to reach all sides of the box.

The second set of tasks dealt with a smart watch as source of additional sensor data with the background of allowing for a greater number of interactions through a combination with other devices, e.g. smartphones. It involved (among others) holding a smartphone in one hand, reverse it to its back side, and then perform a touch. The results showed that half of the participants had no major problems with their arm's rotation movements (which is one important aspect of using a smart watch to send additional sensor data) whereas one person had serious problems with the rotation motion.

Thirdly, in order to find out if it is reasonable to pursue the method of using a smart watch as an additional explicit input device, we created tasks like touching a smart watch on one arm with the fingers of the hand of the other arm and hold the touch for a short time period. Two participants had no problems with this task, one had problems to hold the touch for several seconds and the remaining participant could not move his arms sufficiently to fulfil this task (so this task was omitted for this person).

Because we observed rather good vertical motor capabilities inside our target group (the limitations seemed to be more related to horizontal movements) we decided to also create tasks concerning the application of physical pressure to a surface. Participants therefore were asked to apply physical pressure onto a smartphone with their hand and vary the amount of pressure applied. This aspect looked very promising because three out of four participants could perform this movement "very well" and for the remaining it was at least acceptable. Connected to this field of vertical movements is magnetic field manipulation (see [3]) whereas this generally also aims at horizontal movements in addition to vertical ones. Participants had to draw different shapes with the stylus pen but the results showed that it was too difficult and required a lot of effort for almost all of them to draw recognizable shapes. However, most of them were able to hold the pen quite stable (i.e., keeping it at a certain position). To declare possible later applications of this method, users could by adjusting the physical pressure applied to the stylus pen

exemplarily adjust the position of scroll bars or navigate through menus and select an item by applying more pressure.

Finally, we outline how the observation results influence our future work. For example, it was decided which input modalities should be focused on following the findings of the observation, namely the measurement of physical pressure was the first segment we stepped into, whereas the other methods have been prioritized comparably lower. Additionally we could establish some first parameters that will be considered for inclusion to the user model, e.g. the maximum physical pressure a user is able to apply, or the number of different pressure levels he or she can sustain reliably for some period of time.

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