The Name of the Title is Hope

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ABSTRACT

Previous work on smart home focuses on implementing efficient and effortless interaction modalities to assist users, focusing on the best way one can meet each possible type of task. We asked the users for their perspective and how they want to interact with a smart home. Meeting this approach, we conducted a study to analyse and compare the interaction modalities, voice control, display control and mid-air gestures, for smart homes. Participants face different smart home tasks and suggest their own voice command, display interaction and mid-air gesture to fulfil the different tasks. This was later analysed to determine significant differences between the interaction modalities and explore the best possible solution for each type of smart home tasks.

KEYWORDS

smart home, voice control, display control, mid-air gestures

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1 INTRODUCTION

While Smart Homes are widely known, they are not widely used. Possible reasons might be high costs, lack of understanding, worries about privacy, the lack of additional value, premature technologies and complicated installation [2]. Solving these problems to further spread the use of smart homes can be done with two different approaches - either remove all the existing obstacles or develop smart home systems so desirable for its users they are not bothered by these obstacles any more, as developed by Hagensby Jensen et al. [7]. Instead of using interaction modalities for smart homes, that are as simple and efficient as possible, the study's intend is to catch potential users attention to own a smart home, by featuring desirable and enjoyable traits.

Our goal is to gain a set of voice commands, display interactions and mid-air gestures, to find out what users want and prefer to do, to solve different smart home tasks.

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2 APPROACH AND METHODOLOGY

We followed a similar approach as Dingler et al. [5] by showing and explaining different smart home tasks to the participants and subsequently asking them to propose a voice command, a display interaction and a mid-air gesture, to fulfil the specific tasks in their preferred way. All eleven tasks are listed in section 'Tasks'. A within-subject design was chosen, so every participant gave suggestions for every modality and task. We used a latin-square on the order of the interaction modalities to reduce sequence effects [4] and fatigue. The tasks were shown to the participants in random order. We took video recordings of all sessions. We also collected feedback from participants through questionnaires, on preferences of interaction modalities for a specific task and on goodness, ease, enjoyment and social acceptance of their suggestions.

Interaction Modalities

We compared three different types of interaction modalities. The already used voice and display control as well as the existing but not enough developed technique of mid-air gestures. Therefore, we were able to collect new opinions on the existing techniques and gain a new set of mid-air gestures.

Tasks

The smart home market can be divided into six different categories [3]. Those are *home entertainment, smart household appliances, energy management, networking and control, comfort and light* and *building security*. We excluded the category *networking and control* for developing the tasks, because it does not include devices that can be controlled, but is rather the infrastructure of a smart home and would be responsible for the detection of performed commands. For all other categories we selected two common tasks [1] each, except

for *building security* three because of its bigger market share. All categories with their assigned tasks are listed in table 1.

Participants

A total of 9 participants (5 female) took part in the study with an average age of 30.6 (SD = 13.2). We recruited the participants through social networks and personal contacts. The participants were mostly students from different departments of the University of Regensburg and OTH Regensburg. All of them at least heard about smart homes and are familiar with interaction with a display. According to the pre-questionnaire seven participants already used voice control, but only one performed mid-air gestures for interaction yet. Four participants own smart home devices like Google Home, Amazon Alexa and smart TVs and use them in several situations.

Apparatus

The study was carried out in a quiet room. The different tasks were illustrated through pictures, which showed the state before and after issuing the command. Mid-air gestures, voice commands and comments of the participants were recorded by a mounted camera. Display interaction was documented through a sketch on paper. None of the interaction modalities were actually implemented.

Procedure

Before starting the session, the participants were asked to fill out a consent form and a demographic questionnaire. Then they had to fill out a questionnaire in terms of their previous knowledge and usage of smart home devices and the three interaction modalities. After that the tasks were presented to the participants in a random order. At first all tasks had to be fulfilled with a single interaction modality, then with the second and after that with the remaining modality. Additionally to the illustration through pictures, the tasks were explained verbally. The participants were allowed to talk, move and interact with a display in any way they wanted and were encouraged to explain their choices in a thinking-aloud approach. After each task the participants rated their specific suggestion on goodness, ease, enjoyment and social acceptance on four 7-point Likert scales. When all tasks were finished with each interaction modality the participants rated the three interaction modalities for each on 7-point Likert scales, on how good each modality is to perform the specific task. They were asked to do this independently of their own suggestions. At the end a semi-structured interview was conducted to explore the motivation of the participants for each choice and allow them to rate the different interaction modalities under the aspects of efficiency, simplicity, naturality, desirability and enjoyment. this is based on a similar approach in the elicitation study on foot gestures by Felberbaum et al. [6]. The study took about an hour, for which the participants were compensated with sweets.

3 RESULTS

With nine participants and eleven tasks, we collected for each of the three interaction modalities 99 suggestions and in total $9 * 11 * 3 = 297$. Our results include the video recording, taxonomies for each interaction modality, user-defined sets of voice commands, display interactions and gestures, subjective ratings of the sets, qualitative observations and an assessment on the modalities for each task.

Classification of Voice Commands

Classification of Display Interaction

Classification of Mid-Air Gestures

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A RESEARCH METHODS

Part One

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Part Two

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Table 1: Categories with their assigned tasks

Category	Tasks
Home Entertainment	• Increase the volume of the music. • Turn on the next TV channel.
Smart household appliances	• Start multi-colored wash at 60 degree. • Turn off the oven.
Energy Management	• Increase the room temperature. • Open the shutters.
Comfort and light	• Turn on the light. • Dim the light.
Building security	• Close the window. • Lock the front door. • Turn on the security camera.

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B ONLINE RESOURCES

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