Touch versus In-Air Hand Gestures: Evaluating the Acceptance by Seniors of Human-Robot Interaction

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Abstract. Do elderly people have a preference between performing in-air gestures or pressing screen buttons to interact with an assistive robot? This study attempts to provide answers to this question by measuring the level of acceptance, performance as well as knowledge of both inter-action modalities during a scenario where elderly participants interacted with an assistive robot. Two interaction modalities were compared; in-air gestures and touch. A scenario has been chosen in which the elderly people perform exercises in order to improve lifestyle behavior. The seniors in this scenario stand in front of the assistive robot. The robot displays several exercises on the robot screen. After each successfully performed exercise the senior navigates to the next or previous exercise. No significant differences were found between the interaction modalities on the technology acceptance measures on effort, ease, anxiety, performance and attitude. The results on these measures were very high for both inter-action modalities, indicating that both modalities were accepted by the elderly people. In a final interview participants reacted more positive on the use of in-air gestures.

Keywords: Robot Acceptance, Assistive technologies, Activities of daily Living (ADL's), Human Robot Interaction.

1 Introduction

Both touch modality and in-air gestures are candidates for serving as modality in Human-Robot Interaction (HRI). Recent developments in in-air gestures (Kinect) have made this modality a more likely candidate than before.

This thesis presents the results of an experiment on the technology acceptance of a multimodal interactive social robot. The work in this paper has been done at Novay for the EU FP7 project Florence (http://www.florence-project.eu/) that focuses on personal assistive robots for Ambient Assisted Living (AAL) at home. The research involves an experiment using an assistive robot called *Florence*[1]and

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[1] The project is named after Florence Nightingale, who is seen as the founder of nursing sciences. When she worked as a nurse, she wandered through the hospital during the nights to look after her patients, why she became known also as the lady with the lamp.

the evaluation of this system by seniors in a local care home. The knowledge that has been gained may be applied in the development of automatic gesture recognition systems that fit typical or natural human behavior and capabilities.

The main question which will be answered in this study is: What is the influence of interaction modality in the context of HRI on user acceptance and preferences? Simply said, when an elderly person performs a gesture/tactile command towards a robot screen, does that have influence on the users acceptance? And is there a preferred modality? The research question to some extent was inspired by the preliminary research regarding the acceptance of social robots by seniors [5], but predominantly they were chosen because of the importance to learn more about the perception by seniors of a social robot with multi modal interaction capabilities. The main research has been split in the following subquestions:

1. Does the HRI context afford a certain type of modality e.g. touch or gestures?
2. Which of the two modalities is preferred by the senior participants, or what are the objections for a particular modality against the other?
3. Is there a difference in gesture performance? Does the notion of $'Next'$ or $'Previous'$ lead to different gesture performances?

An experiment has been performed addressing these questions. In the experiment, participants were given the task to perform physical exercises to improve or maintain a healthy lifestyle. In order to move to the next exercise, the participants were asked to either *press a screen button which says next* (in case of the touch interface) or give a 'Next' In-Air gesture. No information was provided *a priori* about how to perform such a $'Next'$ or $'Previous'$. Thus, insight was gathered into human gesture perception of the actions $'Next'$ and $'Previous'$.

2   Design

For this comparative study between interaction modalities, a simple prototype of an assistive robot and an application have been developed. Both the application and the robot will be described in more detail here.

For this application a scenario has been chosen in which the elderly person performs exercises in order to improve lifestyle behavior. The senior in this scenario stands in front of the assistive robot. On the screen of the robot several body postures are presented that have to be copied by the senior. After each successfully performed posture (as recognized by the recognition part of the software) the senior navigates to the next or previous exercise.

HRI may be realized using different modalities such as speech, head pose, gesturing and touch or a combination of these modalities. This study compares two modalities namely touch and gestures. The main concern regarding the design and implementation of the software application was gesture recognition.

Gesture recognition is a very popular research area ([3,2])in which the implementation of various kinds of feature extraction algorithms finally result in the recognition of the points of interest such as a human hand.

Instead of traditional gesture recognition software, a contemporary approach is used in this research: The Microsoft Kinect 3D sensor array. (see figure 1a).

This 3D sensor was originally designed for the game console Xbox 360. But the 3D sensor is also usable when connected with the PC. The Kinect is mounted on a stand. The stand is mounted on top of the mobile platform PeekeeII [4]. A touchscreen, which essentially is a touchscreen enabled laptop is mounted below the Kinect(See figure 1b). By having the depth-of-field camera and the RGB camera a calculated distance apart, the Kinect is able to perform immediate, 3D incorporation of real objects into on-screen images.
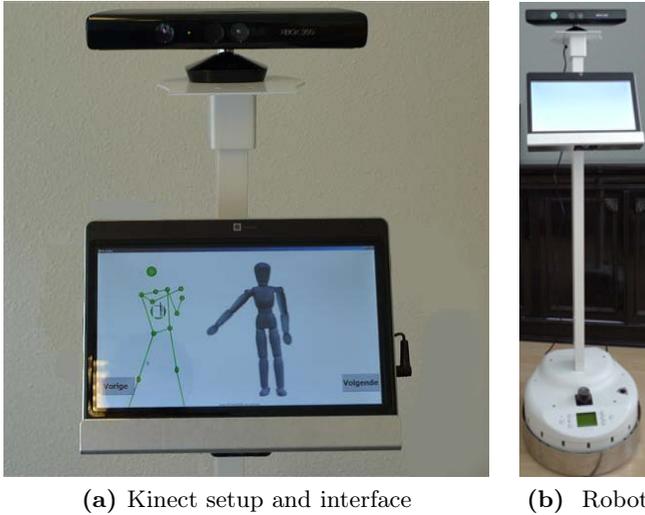

(a) Kinect setup and interface   **(b)**   Robot

Fig. 1. Setup

3   Methodology of the Experwhereiniment

3.1   Subjects

Participants in the experiment were 12 elderly people who participated voluntarily in this study, and signed a consent form. The average age of the participants was $77,17 (\sigma = 7.19)$ with the youngest being 71 and the oldest 96. Of the 12 participants 7 were female. 8 participants had mobility problems. Most of participants reported to never have used a computer before. The most frequent appliances used by the participants were the TV, coffee machine and microwave.

3.2   Experimental Setup

The gesture recognition system is implemented in such a way that it even if the 'Next' or 'Previous' gesture is not performed precisely as suggested it can be recognized correctly. Not only differences between modalities can be measured. Agreements in the way that gestures are performed may become visible as well as the different notions which the participants have towards the notion of *gestures* in general. Each participant was asked whether he or she knows what gestures

are, and how he or she would perform a $'Next'$ or $'Previous'$ gesture before showing how the actual gesture should be performed in order for the system to be recognized.

3.3 Data Acquisition, Procedure and Analysis

The participant is recorded during the experiment. The Technology Acceptance Model(TAM) is used to investigate Effort, Ease & Anxiety (EEA) and Performance & Attitude (PA) [1]. Together with a short interview which is recorded on video, insight in the preferences and acceptance of the interaction modalities is obtained. A within subject design is chosen to measure differences between the modalities gestures and touch. Counterbalancing of the two modalities is a applied to avoid order effects. The participant started with filling in a pre-test with questions regarding their daily use of appliances. A questionnaire including questions regarding a modality was filled in after each modality experiment. A final interview was held in which comparing questions were asked regarding preference, effort, ease and attitude.

4 Results

An item in the gesture questionnaire asked whether the participants found the gestures easy to perform. Using a 7-point Likert scale 12 subjects answered with a mode of 7 (6 out of 12 answered with a 7) and an average of 6.4. The exact same result is discovered after the analysis of the question regarding the touch modality wherein the question was asked whether the participant found it easy to press the screen buttons. Testing these results with a Wilcoxon signed-rank test to a neutral result, yielded $Z = -.587, p = 0.557$. No significant differences were found on the other questions of the questionnaire either.

The interview yielded valuable information concerning alternative gestures by the participants for the concepts 'Next' and 'Previous'. Also interesting behavior was noticed after the preliminary question about the notion of gestures. 4 out of 12 participants knew instantly what gestures and they even gave examples of gestures which they used back in the days during work or sports. Although they had different ideas about the performance of the gestures $'Next'$ and $'Previous'$, they did not have any problems understanding and relating the specified gestures to the concepts $'Next'$ and $'Previous'$.

In the final interview participants reacted more positive towards the use of in-air gestures. 9 out of 12 participants preferred the gesture interface. They also reported that they have little knowledge about assistive robots. They were inquisitive and felt the need to have more information which is expected to result in a overall higher level of robot acceptance. Many participants (7 out of 12) argued that they could express themselves more using in-air gestures as opposed to pressing screen buttons. Physical constraints of the participants was also a cause of the before mentioned preference, as they had to walk towards the robot in order to touch the screen.

5   Conclusion and Future Work

Two interaction modalities were compared; in-air gestures and touch. No significant results were found regarding the variables Effort, Ease & Anxiety (EEA) and Performance & Attitude (PA). The results on these variables were very high for both interaction modalities, indicating that both modalities were accepted by the elderly people.

The results on questions in the final interview where people were asked to compare the use of the two modalities indicate that the participants reacted more positive towards the use of in-air gestures. Most participants had a preference to use in-air gestures for the interaction with the robot because they could express themselves more using gestures as opposed to pressing touch screen buttons. An extra reason to prefer gestures were the physical constraints of many of the participants. In the touch interface they had to walk towards the robot in order to touch the screen. In-air gestures can be further applied in for instance *calling* the robot, as well as *interrupting* the robots activity.

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