Robotic Interfaces Design

Avatar and GUI Competing for Older User's Attention

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Abstract. In the Human Robot Interaction field, developers choose among different solutions to portray a face, ranging for mechanical solutions, or avatars displayed on screens attached to the robot's body. Those designs are commonly displayed separately, being a mechanical head and a tablet size screen, or a screen with the avatar's face and a different one for the Graphical User Interface. The user interactions with the avatar and the GUI are noticeably divided by screen, and interaction designers can make use of design guidelines for computer systems during their design process. However, when the Avatar and Graphical User Interface are displayed together in the same screen, visual and interactive features compete for user's attention, increasing the complexity and affecting users' impression of the robotics system.

It is known that prior knowledge affects older user's interactions, and navigation structures for can be applied trying to elicit that prior knowledge. However, when it comes to robots and elderly people, interaction designers should consider a robot's embodiment as a variable in the interaction equation, whether they are making decisions for the avatar or the GUI.

Designers have little empirical research to guide them in creating such combined models for robotics interfaces and older adults. The fashion in which the visual interfaces of a robot are designed could make the difference in how often and ease individuals use that technology. The true challenge in designing a robotic interface for a system that displays an avatar and a Graphical User Interface in the same screen is representing a GUI Interaction structure without affecting the state of the embodied agent or avatar.

The present research approaches this issue. Different Robotic Interfaces designs for Avatar + GUI with older adults as users are analyzed. The study reported in this paper, implements a robotic female Avatar and Graphical User Interface of our own design. Both designs share the same screen on Homemate, a consumer robot developed to assist the elderly with errand services, communication, entertainment capabilities, and that employs a screen instead of head, allowing us to explore whether these design considerations of Avatar + GUI produce any effect in older adults impressions of an assistant robot.

Keywords: Robotics · Interface · Design · Avatar · Elderly · User experience · Interaction · GUI · UX · Older adults

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1 Introduction

There have been numerous studies about how the interfaces should be designed for older adults. A good portion of those studies are oriented to web based applications or operative systems.

The ageing population is a global concern that affects all the aspects of the technological development [1, 2], and in the robotics field, increase the demand for new and improved robotics systems and applications designed to support older adult's needs.

Robots that are developed to be used for regular consumers, Consumer-robots, alternate from mechanical heads to animated visual elements displayed on screens to portray a face. Those visual elements that animated represent facial expressions and information, are commonly known as conversational agents and avatars [3].

Since those agents or avatars, could play a very important role in how people interact with technology, require to be designed in a proper way.

In the design field, while avatars and customized images are a common terminology as on-screen representations of social presence in mobile technology or Internet. The problematic related to the older adults' technological use of graphical user interfaces is a core theme to be investigated [4, 5].

Nowadays, the vast majority of the available Interaction design guidelines for Graphical User interfaces are for web based and mobile applications, which results in interfaces that bring interaction challenges to designers developing for robotic systems.

This discovery motivate us to research into the conception of Interaction design considerations for robotics interfaces in which two different design solutions, avatar design and GUI design conciliate in the same display portrayal. In the interface design for a robotic system, design decisions represent the state of embodied agents or avatars and the Graphical User interface that allows the user to command and interact with the robot itself.

2 Literature Review

Several researchers have conducted studies regarding the use of new technological interfaces by the older adults [6–8]. In our research, we focus on the design of a structure that integrates the display of an avatar and a GUI in the same screen for a robotic interface, the possible design structures, and the resultant perceptions of the elderly towards the robotics system.

Prior to the study, researchers demonstrated that embodied agents and avatars are interpreted to have social presence for users [9]. Furthermore they also have investigated about the effects of graphic representation level.

Avatars can be designed in a wide range of possibilities; however, in the case of a humanlike avatar to mediate the human-computer interaction, the social aspects of interaction become more explicit. The entire visual design of the avatars (form features, clothing, facial expression, and gestures), express information and reflect contents in the same way as human–human social interaction [10, 11].

HCI studies have examined how new technology can be integrated in older user lives. From Internet searching [12], game play in tablets [13], smart TVs [14] to Social networking, a set of guidelines were provided to build applications aimed to help older adults interaction experience [15–17]. However, in Human Robot Interaction, designers lack sufficient guidelines to ensure that avatars and GUI design decisions will play an efficient role in the user experience and the general impression of the robot. And the designs of those interfaces bring even more complicated interaction challenges to users aged 65 and above.

Very interesting things were found while reviewing previous research, but many questions are still there. For instance, although different design considerations for the elderly have been explored in HCI, none of these studies have explored the applicability of those considerations for robotics interfaces and, more specifically, the possible resultant interactions of a Graphical User Interface integrated with an avatar as the robots face.

The advents of interaction with robotics systems express the need to specify effective, reliable and consistent design guidelines for robotics interfaces. There is little research to guide the creation of avatars and robotics graphical user interfaces for interaction designers. In our case, the findings of the following research contribute into the interaction design guidelines for "Homemate", an assistant robot developed for the Korus Tech project in the Intelligent Systems Research Institute.

2.1 Research Question and Hypothesis

The primary purpose of this study is to demonstrate that interaction decisions, in terms of how an avatar and a graphical user interface are displayed in the same screen, affect user's positive or negative impressions towards the robotics system. In our case, being the users, older adults.

Hence our main research question can me summarized as follows: For older adults, controlled by the type of interface design, what is the relationship between the avatar + GUI design and the level of engagement, learnability of the interface and avatar recognition as a robotic agent.

Therefore, we hypothesize:

- H1: Interface Design with visual dominance of the avatar will allow the users to perceive the robot as an agent and not merely as a user interface.
- H2: Interface Design with visual dominance of the GUI, displaying the totality of the system of icons, will allow older users to identify an icon task with more efficiency.
- H3: Since icons offer strong visual and spatial cues and it is much easier to learn them and to remember their location in the interface structure, and older users have age–related vision complications, the no inclusion of textual elements will allow us to create a less complex visual interface helping from visual attention to icons recognition.

- H4: Interface Design with categorization of robot' tasks, will allow a visual dominance of the avatar and a simultaneous display of GUI with animated menus.

3 Method

A number of methodologies can be used when involving the elderly in the Interaction design process. For instance, focus groups, surveys, interviews, observational studies, and controlled experiments have all been used to study older users experience with new technologies. Many of those methodologies are applied into the participatory Design (PD) approach, which facilitates interaction evaluation to collect and to analyze feedback from intended users, and makes possible their integration through all the interaction design and development process, rather than finishing an interface design and conducing a posterior user testing on it.

Four interface structures were applied to the design of Homemate robot interface during the time of approximately eighteen months. Focus groups of older adults from the Jogno Senior Welfare Service Center interacted with the first stages of the robotic interface design in a controlled scenario.

Asking older adults what they prefer as part of a usability test may offer important information about their subjective response to a given design. However assigning simple interaction tasks, allow us to do a much better job of collecting missing information and helping to achieve consensus on design decisions.

In our prior experience, older adults were in some way reluctant to participate in paper and pencil questionnaires, and to recruit participants for more elaborated experimental designs could be a time-consuming task without a meaningful difference in the outcome given the characteristics of the study. Therefore we decided to implement a reaction card method [18] during the testing of the last two versions of the robotic interface, followed by a series of interviews to the participants and video recordings for a posterior observation and analysis.

Since the participants have no English fluency, the cards were previously translated to Korean language by a Korean native speaker.

3.1 Reaction Card Method

Developed by Microsoft, the Reaction Card method was originally designed to collect the information related to the emotional response and desirability of a design or product. This method is commonly used in the field of software design.

The older adults are asked to describe the robotic interface using any number of 118 words, targeted in a 60 % positive and 40 % negative/neutral balance. Below is an example of these cards "Fig. 1".

Each word is placed on a separate card. After viewing a design or product the participant is asked to pick out the words they feel are relevant. The moderator would then ask the participant to describe their rationale for their selection in a short interview.

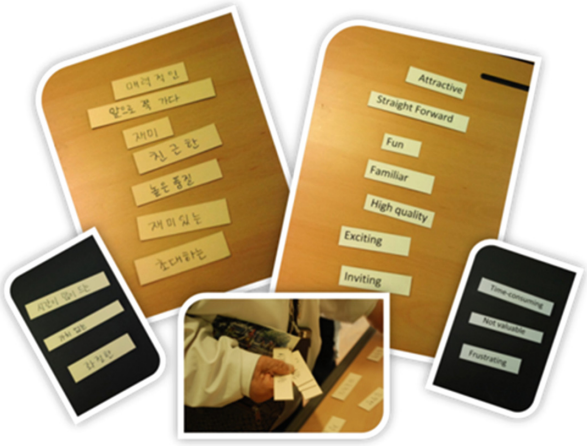

Fig. 1. Example of reaction cards

3.2 Participants and Stimulus Materials

Twenty four participants from the Jongno Senior Welfare Service Center in Seoul, South Korea were recruited to participate in the Reaction Card Desirability test. N = 24 (8 Males, 16 Females).

Since the robot for this study has a small screen size, the two elements of the avatar + GUI were designed to fit screen dimensions and a good legibility on distance. We should keep in consideration that most of the Korean older adults tend to get very close to the screen regardless the use of eye glasses (Fig. 2).

Fig. 2. Homemate robot from inteligent systems research institute (Left) and Robotic interface evaluated (Right).

For a better understanding, we can describe the Robotic Interface designs layout for visual dominances “Fig. 3”.

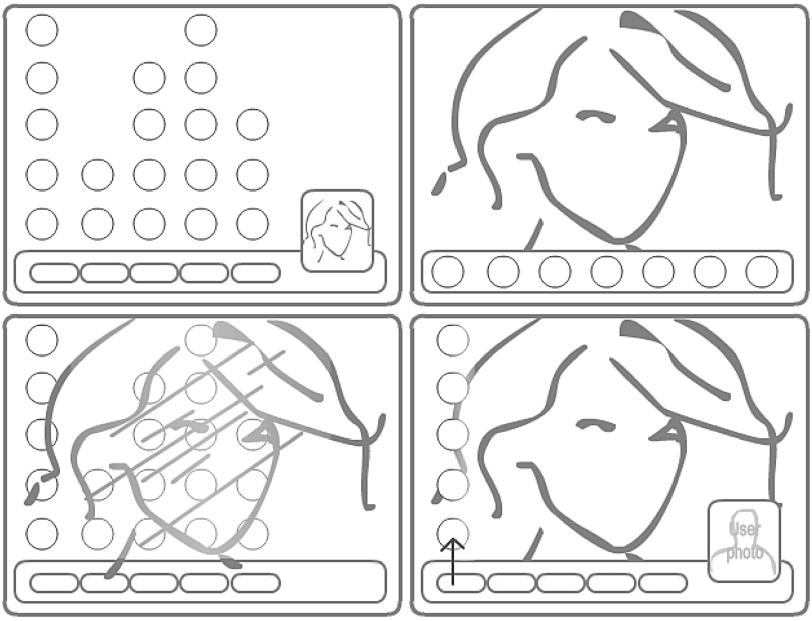

Fig. 3. Robotic interface design structure types

3.3 Manipulation/Independent Variables

Type of Interaction Design:

- GUI dominance on avatar. (full system of icons at once)
- Avatar dominance on GUI
- Intercalating Avatar/GUI
- Avatar dominance and GUI displayed in categories

3.4 Measurements/Dependent Variables

- Perceived Efficiency of the interface
- Perceived Complexity of the Interface
- How intuitive is the interface (Icons recognition, Interface ease of use and learning)
- Recognition of the embodied agent (avatar)
- Desirability

3.5 Procedures

A controlled scenario was prepared in one of the coffee areas in the elderly center. Context was designed to reduce distractions and allow free interaction with the robot and the interface.

The participants for each condition were introduced with Homemate robot avatar. The robot approaches the participant and the experimenter briefly explains the capabilities of Homemate: Delivery service, entertainment, video chatting, etc. Experimenter used the same short discourse in both conditions for each older adult that participates in the experiment. Each participant had 1 min to explore the interface. After the initial exposure to the interface, the researcher gives the following instructions to the participant:

- Please touch the online services icon
- Please select the icon that you think is for watching pictures
- How can I do if I want to watch more pictures?
- Do you know how to exit?
- Please touch the entertainment icon in the interface.

Then the participants were invited to give an interview about their impressions of the robot. We included questions such as: Do you find it easy or complicated? How old do you think the robot is?; Robot's gender; Do you know what is this ___ icon for?…

4 Results

4.1 Based on Interviews and Observational Analysis of the Interaction

Information of great value was collected during the interviews and the observation of the interaction videos. How the participants referred to the robot, whether as a machine, computer or robot. Depending on the applied interface they change their behavior towards the robot having a friendlier attitude with the avatar dominance or stressed attitude with the GUI dominance.

Participants were willing to interact with the robot for longer periods of time when the robot was displaying the Avatar and the categorized GUI structure. Older adults were enthusiastic about trying it again but found complicated to learn and remember what each icon was for. It could be solved by adding task-descriptive text, but then it will bring more elements to the screen that can make complicated the visualization of the avatar.

Auditory feedback was also included for each interaction, but we found it not relevant for the recognition of the icons.

However we found that the inclusion of fading textual information during the touching gesture could help in the recognition and recalling of the icons tasks. This was a very important finding for our design process, allowing us to take advantage of textual aids without keeping them present during all the time of the interaction.

4.2 Based on the Reaction Cards Method

Positive Card Selections:

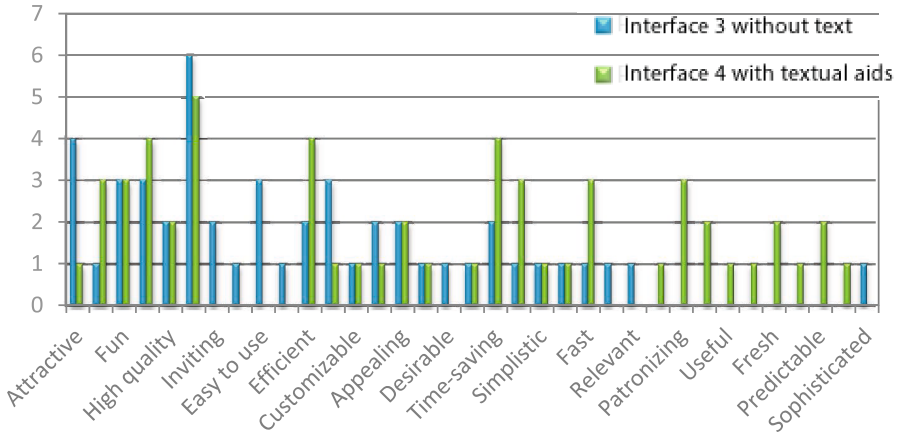

Fig. 4. Avatar dominance on GUI with categories and No textual aids compared with Avatar dominance on GUI with categories and with textual aids.

In general, participants expressed very positive opinions about the two last versions of the robotic interface designs. Selections such as Attractive, Exciting, Usable, Fun, were very popular Avatar dominance on GUI with categories "Fig. 4". However, while the inclusion of textual fading elements help into making more valuable, fast, time saving and efficient the interface, negative impressions for complexity and confusing interface also increase "Fig. 5".

Negative Card selections:

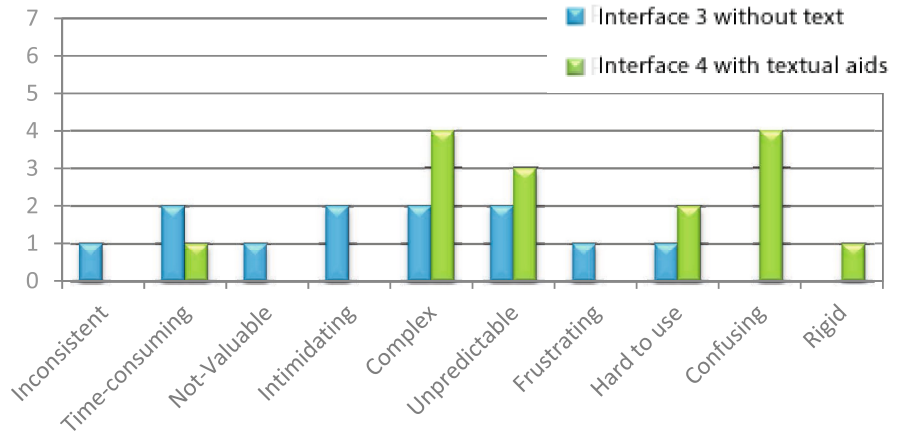

Fig. 5. Avatar dominance on GUI with categories and No textual aids compared with Avatar dominance on GUI with categories and with textual aids.

4.3 Hypotheses Testing

The results from our observations indicated that interaction structures for robotics interfaces are judged to inherently affect the positive impressions of older adults towards the robots. Those interaction designs, combining Avatars and Graphical User Interfaces, can have an important effect on the user's perceptions of robot's capabilities or the complexity of the robotic system.

- H1: Interface Design with visual dominance of the avatar will allow the users to perceive the robot as an agent and not merely as a user interface. This hypothesis was greatly supported by our analysis of the interactions and interviews. Participants assigned a gender and age to the robot and several gestures interacting with the robotic systems were possible like touching and talking to the robot.
- H2: This hypothesis was not supported, based on the participants reactions. They found the interface to be too complex and almost overwhelming. This interface was graphically displayed in a similar fashion of a smartphone interface. The participants needed more time to see each icon and understand how to interact with the interface.
- H3: This hypothesis was not totally supported by our analysis of interviews and the reaction cards information. Although a more simple and clean interface was designed by no including textual information. The participants faced complications to identify and remember some of the icons that represented complicated robot capabilities or services. This could be due to that level of affordance required for those icons representations is difficult to achieve.
- H4: This hypothesis was supported by our analysis of interviews and Reaction Cards information. By keeping the avatar full screen but presenting a GUI in categories, we found a more intuitive way for the elderlies to interact with the interface without losing the robotic agent sense.

5 Discussion

5.1 Theoretical Implications

In Human Robot Interaction field, interaction designers of robotics interfaces should be aware of the user's impressions toward the interface designed for the selection of appropriate representations, affordances, icons size, feedback, sounds, behaviors and visual cues. These interfaces structure adoptions might have a crucial effect on the user's judgment of the robotic system complexity and the perception of the embodied agent.

In this study, the way how a user interface structure is designed to allow the coexistence of an avatar and a GUI, represent valuable information about the behaviors and expectations of the elderly in the human robot interaction scenario.

5.2 Practical Implications

Interaction Design studies for Robotics Interfaces, offer tremendous valuable information for designers of interfaces for the elderly. How a scenario in which an avatar

and a GUI share the same screen can be structured for the better performance of the system and an intuitive interaction experience. Considerations such as the use of fading elements to reduce the visual load on the learner in reading text can guide interaction designers in the process. These quick exposures of fading text can help ensure that needed material that may otherwise get excluded from an overtaxed visual modality is processed. Similar considerations are equally important as occurs with less complex interfaces in terms of amount of icons shown in the interface.

The present study contributed in the development and interaction design for a cognitive consumer robot "Homemate" from the Korus Tech Project in the Intelligent Systems Research Institute In Sungkyunkwan University. Homemate tobot displays an Avatar + Interface in a screen instead of head. This robot has a female voice and gives assistance to the elderly for different scenarios such as Errand service for water, beverages, etc. facilitates communication through video chatting, entertainment such as games and karaoke, health assistance and online services such as Facebook photo albums.

Additionally, while in HCI Interaction Guidelines concerning interface design for the elderly, there is not a deep understanding whether the same principles can be applied for HRI and interfaces involving Avatars and Graphical User Interfaces.

Furthermore, with the aging of our society, older adults have been becoming in one of the one of main targets for the robotic industry, therefore investigate which is the more reliable way to achieve user expectations about robots, from the interaction design to the technical and engineering implications that it conceives is strongly needed.

5.3 Limitations and Future Research

The findings in this current study could provide a set of design considerations to help guide interaction designers in creating effective robotic interfaces for older adults, but still are there some concepts to be tested regarding affordances and user learning avatar or GUI assistance.

In robotics systems, task analysis plays a very important role for early input into the design process designing for older adults. Such analysis can help into identify information needs and expectations, visual and auditory requirements, focused attention elements and aids for retaining information. This information provides a starting point for identifying problems that older users could face during the interaction with the robotic interface.

In addition, we can consider a comparative study with American older adults, customization of the system of icons and perhaps conduct a future experiment considering senior adults with cognitive disabilities and applying a similar reaction card methodology.

Few limitations of the study should be acknowledged in order to interpret its findings effectively. First, while there are several assistant robots for older adults, our focus in this study was on Homemate Consumer Robot that has only one screen which plays the role of robot's head. Second, the subjects were Korean older adults without including individuals with serious physical or psychological disabilities.

References

1. Lutz, W., Sanderson, W., Scherbov, S.: The coming acceleration of global population ageing. Nature **451**(7179), 716–719 (2008)
2. Goldstein, J.R.: How population age. In: Uhlenberg, P. (ed.) International Handbook of Population Aging, pp. 7–18. Springer, New York (2009)
3. Breazeal, C.: Designing Sociable Machines. The MIT press, Cambridge (2001)
4. Gregor, P., Newell, A.F., Zajicek, M.: Designing for dynamic diversity: interfaces for older people. In: Proceedings of the Fifth International ACM Conference on Assistive Technologies. ACM (2002)
5. Shyam Sundar, S., Behr, R.A., Oeldorf-Hirsch, A., Nussbaum, J.F.: Retirees on facebook: can online social networking enhance their health and wellness? In: Proceedings of the 29th Annual CHI Conference on Human Factors in Computing Systems (CHI 2011), pp. 2287–2292. ACM, May 2011
6. Ellis, R.D., Allaire, J.: Modeling computer interest in older adults: the role of age, education, computer knowledge, and computer anxiety. Hum. Factors: J. Hum. Ergon. Soc. **41**(3), 345–355 (1999)
7. Redish, J., Chisnell, D.: Designing web sites for older adults: A review of recent literature. Prepared for AARP December (2004)
8. Hawthorn, D.: Cognitive aging and human computer interface design. In: 1998 Australasian Computer Human Interaction Conference, Proceedings. IEEE (1998)
9. King, W.J., Ohya, J.: The representation of agents: anthropomorphism, agency, and in-telligence. In: Proceedings of CHI, pp. 289–290 (1996)
10. Oren, T.: Guides: characterizing the interface. In: Laurel, B. (ed.) The Art of Human-Computer Interface Design. Addison-Wesley Publishing Company, Reading (1990)
11. Don, A.: Anthropomorphism: from eliza to terminator 2. In: Proceedings of CHI, pp. 67–70 (1992)
12. Jayroe, T.J., Wolfram, D.: Internet searching, tablet technology and older adults. Proc. Am. Soc. Inf. Sci. Technol. **49**(1), 1–3 (2012)
13. Pedell, S., Beh, J., Mozuna, K., Duong, S.: Engaging older adults in activity group settings playing games on touch tablets. In: Proceedings of the 25th Australian Computer-Human Interaction Conference: Augmentation, Application, Innovation, Collaboration, pp. 477–480. ACM (2013)
14. Coelho, J., Guerreiro, T., Duarte, C.: Designing tv interaction for the elderly-a case study of the design for all approach. In: Biswas, P., Duarte, C., Langdon, P., Almeida, L., Jung, C. (eds.) A Multimodal End-2-End Approach to Accessible Computing, pp. 49–69. Springer, New York (2013)
15. Gomes, G., Duarte, C., Coelho, J., Matos, E.: Designing a facebook interface for senior users. Sci. World J. **2014**, 8 (2014)
16. Hawthorn, D.: Designing Effective Interfaces for Older Users. The University of Waikato (2006)
17. Reddy, G.R., et al.: Intuitive use of complex interface structure, anxiety and older users. Lecture Notes in Computer Science (LNCS), IFIP and Springer (2013)
18. Mertens, A., Koch-Körfges, D., Schlick, C.M.: Designing a user study to evaluate the feasibility of icons for the elderly In: Mensch & Computer 2011, Oldenbourg Wissenschaftsverlag GmbH, pp. 79–90 (2011)
19. Benedek, J., Miner, T.: Measuring desirability: new methods for evaluating desirability in a usability lab setting. In: Proceedings of Usability Professionals Association (2003)