Towards Co-creative Intelligent Agents for Gesture-based Creativity in Elderly Populations

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Abstract

In this paper we describe Move and Paint, a gesture-based interactive system designed to provide a fun way for the elderly to be physically active, social, and make something creative. Move and Paint uses a Kinect to convert hand and arm gestures to filling in colors on a scene or drawing on a large projected screen. To better understand how elderly populations interact with embodied creativity, we compared the use of Move and Paint in two separate locations: an elderly retirement community and a university library. Our analysis shows that elderly participants were more timid in trying things and exploring the interface, more likely to interact if someone else was already interacting, and wanted instructions on how exactly to interact. The results suggest that co-creative agents may be able to address the needs of the elderly in learning about and engaging in creative technologies. In this paper we discuss design principles for co-creative intelligent agents for gesture-based creativity that takes into account the opportunities and challenges of designing interaction for the elderly.

Introduction

Interactive technology holds the promise of enhancing the quality of life, providing a playful experience, and increasing the independence of older adults. The full benefits of technology may not be realized by the elderly due to the fact that designers have not considered older adults as distinct and active users of technology and thus many interfaces or interactive systems are designed without accommodating the needs of this population. Some of these needs arise from progressive deterioration in both physiological and psychological abilities, and some needs are based in a lack of experience with technology that younger people have. The distinct needs of the elderly are often ignored in the design and development of interactive technology, resulting in low adoption and usage. There is a lack of understanding of the broad range of reasons for why older adults have difficulty in using new technologies. In this paper, we present the results of an empirical study to better understand the differences in the mental models of older adults and the relevant environmental factors that affect the elderly in order to encourage meaningful interactive technology.

Staying physically active, social and having fun is important for older adults. Interactive systems that enable sustainable change in health behavior have become a core component of interaction design and research (Predrag et al., 2011). As fine motor skills deteriorate and energy decreases, it is increasingly hard, but increasingly important to incorporate physical activity into daily tasks. One way to motivate natural physical and social activity is to design embodied interaction that requires full body actions and is compelling enough that users are willing to perform them and also can be the center of an engaging social experience. Embodied interaction is interaction that recognizes and takes advantage of the fact that humans have bodies. It means designing interaction such that the user can use their body in ways in which they are used to using them in the natural physical world. Not only is this an attractive approach for an elderly population since it requires less time to learn how to use the system, it also requires them to move and participate in natural physical activity. We built an embodied interactive system designed to promote natural physical activity for elderly populations. Move and Paint is a public gesture-based art system that motivates users to use hand and arm movements to make large-scale drawings and paintings on a screen. Based on our findings from studying Move and Paint with an elderly and a college-aged population, we discuss the challenges of designing for the elderly and propose principles for a co-creative gesture-based drawing system to address some of these challenges.

Background

Challenges

When compared to the younger generation, older people are less likely to use technology (Czaja et al., 2006). The use of new technology is more complex for the elderly generation than the younger generation, which can be attributed to the fact that the older people were not exposed to technology during their formative years (Peek et al., 2014). The utilization of new technologies by the aged is heavily influenced by stereotypes and expectations which affect their performance and motivation (Peek et al., 2014; Sixsmith, 2013).

Eisma et al. (2004) found that the elderly often attribute their fear to their own perception of complexity as opposed to the technology design. The aged convey negative self-efficacy, thus feeling too old to adopt new technology and less skilled when it comes to operating new technology. Older people lack the basic knowledge and experience to interact with technology effectively. According to Steele et al. (2009), older people's fear of technology is due to their concern that they lack control over activation and de-activation. This may be drawn from prior experiences with technology, which may have been confusing, frustrating or complicated. Therefore, older people exhibit enhanced anxiety about their confidence, effectiveness and ability in utilizing new technology, as compared with their younger counterparts (Czaja et al., 2006; Eisma et al., 2004).

To eliminate negative feelings about technology and encourage confidence, it is necessary for the elderly to receive precise instructions. Besides age and cognitive ability, training also helps in the proper utilization of technology. Learning technology may be a new experience for some older people and they will thus require more time to practice using the technology than younger people (Siek et al., 2006). It is essential to make necessary use of memory aids that can provide the knowledge an elderly user may not have (González et al., 2012; Wang L. et al, 2011). Other ways to motivate them is by letting people within the surrounding area help. Further, older people can benefit greatly from social groups and learning from other people who have successfully learnt how to utilize technology. Such groups should be encouraged to find a suitable mentor to guide the group and motivate them to embrace technological change and as such make things easier for them (Patterson et al., 2011).

The older generation often exhibits unenthusiastic feelings about using technology and the effort needed to learn how to utilize a computer effectively (Steele et al., 2009). It is therefore important for technology designers to develop interactive features that make clear the expectations and objectives of a system, as well as adapting to the mental models and expectations of the elderly. This is in line with the findings of Keyani et al. (2005) that the elderly should have access to technology that is simple and easy to interact with, through provision of suitable feedback. Users are more likely to explore the interactive abilities of a technological device if it provides visual feedback or is consistent with other forms of interactive features that alert and induce the users. Unfortunately, the focus in designing features and affordances of interactive systems is on the expectations and mental models of the typical, younger population of users.

There are many challenges faced by the elderly in the usage of current technology. Further, there is a lack of literature detailing the development of technology designed to enhance interaction among older people. Intelligent co-creative systems have significant potential to enhance the interaction of the older population with technology to improve their quality of life.

Intelligent Co-creation

There are several interactive systems that are designed to facilitate the aging process, such as improving user abilities to make up for physical (Vargheese et al., 2016) and cognitive age-related impairments (McCarthy et al., 2008), entertainment and education (Fiol-Roig, et al., 2009), and improving social interactions (Vardoulakis et al., 2012). There is a growing body of literature supporting the view that technological support can positively impact on older people. New technologies that incorporate intelligent co-creative agents to support older adults help them cope with the changes of aging and meet their needs. Based on the idea of co-creation as an approach to inspire, motivate, and engage creativity through collaboration (Davis et al., 2015), we propose that co-creation is an approach to addressing interaction design for the elderly.

A small but growing number of projects in the co-creative intelligent user interfaces are introduced to collaborate with human users as partners (Davis et al. 2014). There are examples of co-creation that address engagement and training issue. Viewpoints AI (VAI) is a co-creative dance partner that user can dance with a virtual character projected on a large display screen in real time (Jacob et al., 2013). This system analyzes the user's movement and selects a complimentary dance move for the virtual character to perform. In the elderly community, this will help to create new opportunities for social interaction through dance, which is important to promote wellbeing among the elderly community. The Drawing Apprentice is a co-creative agent to draw abstract artworks on a digital canvas in real time (Davis et al. 2014). Once the user draws a line, the system recognize user's drawing, behavior and patterns, then provides real-time feedback to collaborate with user's drawing. This playful interaction will not only bring a fun experience but also serve as a trigger to motivate older adults to engage in the use of technology. Shadow Draw (Lee et al., 2011) and iCanDraw (Dixon et al., 2011) are co-creative systems to provide real-time feedback, active guidance, or personalized training to enhance the accuracy of drawing. Older people unintentionally make errors in some steps of interaction. Such co-creative systems can provide information about kind of errors, consequences and recovering strategies. This helps the elderly overcome fear about the use of technology.

Move and Paint

System Description

Move and Paint is an embodied interactive painting application that uses a Kinect sensor to convert full-body gestures to drawings and color and displays the results on a large screen. Our design was guided by 3 major interaction principles: usability, learnability, and creating an engaging experience.

The Move and Paint installation is shown in Figure 1. The Kinect sensor identifies the hands of multiple users and shows them on the screen as a circle of color. The user changes the color by moving the circle to one of a selection of colors across the top of the screen. Users create a painting either by drawing or filling a section of a coloring book image with the color of the circle. Selecting icons on the screen allows the user to change the background, brush thickness, or color. A line on the floor indicates where the interaction area is.

The user can choose between brushes and colors by hovering their hand over the options on the top and side of the screen. The system has two modes, coloring mode and drawing mode (Figure 2, Figure 3), which the user can choose between via the icons on the side of the screen. Figure 4 shows an example of what the instructions look like.

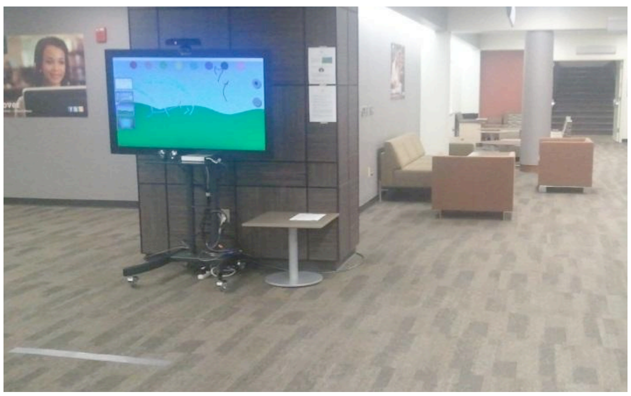


Figure 1. Move and Paint system setup in public area of a college library

Figure 2. Move and Paint in coloring book mode. Users move their hand to fill sections of an image.

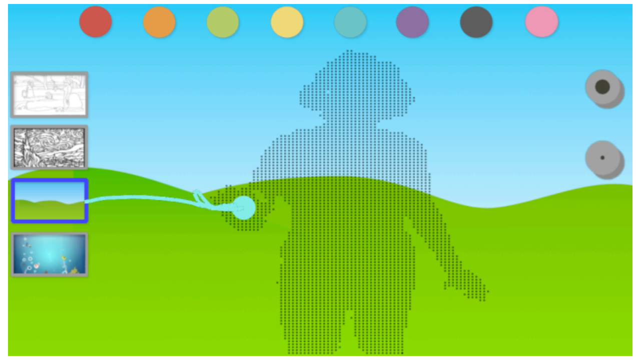


Figure 3. Move and Paint in free draw mode. Users interact with the system by moving their hands and arms to move circular cursors around the screen.

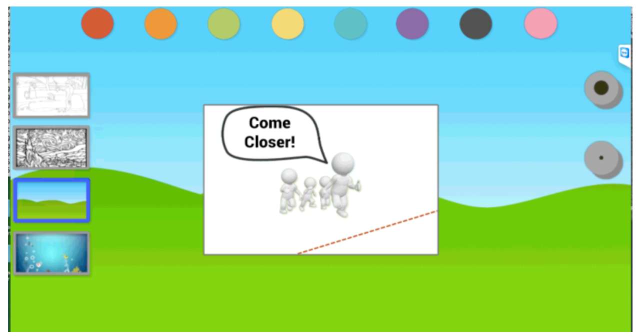


Figure 4. Example of instruction: displayed when no one is interacting or when someone is too far away.

Findings

To study the use of Move and Paint, we left two different versions unattended in two different locations: with and without instructions in both an assisted living retirement community and a college library. Participation was voluntary and was recorded with a video camera. The first 3 days of data for each version of the system in each location was used for analysis. Videos were coded based on actions relevant to the themes discussed below (exploration, learnability, and engagement).

Voluntary exploration

We observed that the elderly participants approached the system with more hesitation than the college students. To investigate the initial engagement with the system, we compared active approaches to passive approaches, and summarize these numbers in Table 1. Active approaches are when people begin by attempting to interact with Move and Paint (column 2) and passive approaches are when people stand by to look at the display or watch someone else interacting without joining in (column 3). There is a minor difference in the instruction condition. However, a greater percentage of elderly participants than college students approached the system passively and did not physically act on the system throughout the length of their engagement with it in no-instruction condition. We performed a Fisher exact test and although the percentages show a decrease in the number of college age students that remained passive, this is not a significant difference.

Population	Condition	Other interaction	Learned Mid-air gesture	Did not interact
Elderly	No instructions	8/26 (30.8%)	10/26 (38.5%)	11/26 (40.3%)
	Instructions	3/8 (37.5%)	6/8 (75%)	1/8 (12.5%)
College	No instructions	27/73 (37.0%)	48/73 (65.8%)	12/73 (16.7%)
	Instructions	34/160 (21.3%)	135/160 (84.4%)	15/160 (9.4%)

Table 1. The number of people who tried certain actions.

***Elderly participants**:* Elderly participants (11/26: 40.3%) were more likely to stand and stare at the system or watch someone else interacting with the system without instructions rather than physically try to figure out how it works (Table 1 in the column labeled "Did not interact"). Interestingly, several elderly participants asked where the mouse was and a pair of elderly participants was so set on finding a mouse that they searched until they found the facilitators' mouse, which was tucked away behind the system. That shows that elderly participants have difficulty identifying what to do if their expectations are not met.

College Students: College students (48/73: 65.8%) were more active in their exploration and tried things (albeit sometimes incorrectly) such as waving their hands and touching the various hardware elements of the system (Table 1 in the column labeled "Learned Mid-air gesture"). As with the elderly the college students' expectations, such as touch interaction, strongly influenced what they tried to do when learning how to interact with Move and Paint.

Both populations: In both populations, many tried different means of interacting, such as touching the screen and picking up or gesturing at the cameras that were gathering video footage. Instructions helped, but did not eliminate these attempts to use a more common interaction modality (Table 1 in the column labeled "Other interaction").

Learnability

Participants in both populations had difficulty figuring out how to interact with the system. Figure 5 shows that elderly participants were less able to figure out the interaction on their own without help from another human or from the instructions.

We performed a Fisher exact test to see if there is a significant difference in Voluntary exploration in the two populations and conditions by focusing on the number of participants that learned to use mid-air gestures to successfully interact with Move and Paint (Table 2).

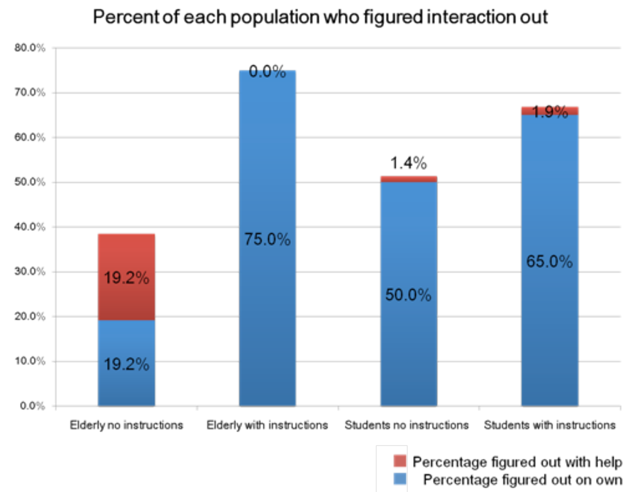


Figure 5. The percent of each population who figured out the interaction with and without help from another human.

Learned mid-air gesture	No instruction	Instruction	
Elderly	38.5%	75%	p=0.109988
College	65.8%	84.4%	P=0.001907
	p=0.020563	P=0.616029	

Table 2. Significance of instruction vs no instruction in the 2 populations.

Engagement

When both elderly and college aged participants figured out how the interaction worked, their engagement time was largely the same. Table 3 summarizes total time of interaction for people who successfully figured out how to interact.

Population	Condition	Average time of interaction (min:sec)
Elderly	No instructions	1:30 (n=13, stdev=00:50)
	Instructions	2:51 (n=6, stdev=2:47)
College	No instructions	1:21 (n=38, stdev=1:38)
	Instructions	1:14 (n=106, stdev=1:12)

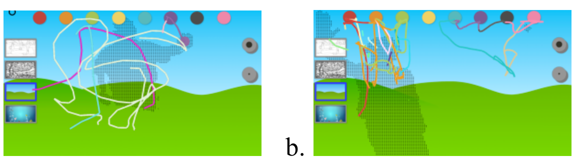
Table 3. Average time of interaction in the 2 populations.

Elderly participants: As a result, it was found that elderly participants show more interest in the instruction conditions than college students (Average time: 2:51 in instruction condition), 4 of 34 (11.7%) showed continued interest in Move and Paint and came back to use it for several days. In elderly participants, even those who just stared at Move and Paint constantly showed interest in this system. The elderly also asked questions of others nearby about the purpose of this system or how to use it. They seemed to hesitate, showing an anxiety that they might incorrectly use or break this system.

College students: Students showed one-off interest, none of the students (0/232; 0%) came back to try the system again. When college-age students showed interest in this system, they started doing many different things with this system right away. College-age spectators stared at Move and Paint a couple of times, but seemed not to have any interest. Instead, they were observed to make phone calls or wait for users who were actually using this system. Particularly, the embodied interaction system attracted interest at first, but exposed a limitation by failing to have their interest maintained.

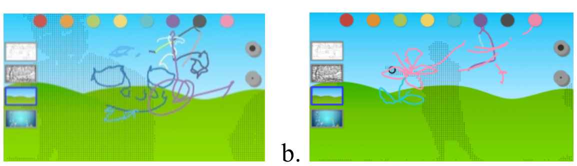
Students found the shadow most interesting in this system. Some of them took pictures or videotaped it, while playing with the shadow in various ways, like dancing or making funny motions. In addition, when making attempts with the concept of coloring book drawing, most of the users moved their arms up and down vigorously to fill in the blanks.

While the time of engagement was largely the same between elderly and college students, the nature of engagement was different. Elderly participants tended to perform repetitive or meandering gestures with little evidence of recognizable shapes or forms (Figure 5). College students were more likely to explore different hand and body gestures such as jumping or dancing and more likely to try to draw pictures that were creative or intentional (Figure 6).



a. b.

Figure 5. Drawings from elderly users that are representative of the usage from the elderly population.



a. b.

Figure 6. Evidence of creative intentions in the college population (a and b were drawn by the same person).

Design Principles: Co-creation for the Elderly

Based on our results, we suggest the following principles for the design of a co-creative intelligent agent for gesture-based drawing for the elderly.

Sensitive design. Elderly participants remain very focused on what they are doing and often do not notice cues on the screen or pay attention to what other people were drawing. A co-creative agent needs to be sensitive to the timing of an intervention and select opportunities to intervene.

Engaging design. Elderly participants were more likely to interact if another human was present or someone encouraged them to try. A co-creative agent can engage the user by indicating presence and creating content with the user.

Instructing. Elderly participants are unlikely to explore new features of the interface. A co-creative agent can gradually introduce the user to new features and gestures.

Encouraging. Elderly residents were hesitant to try any initial actions with the system and were hesitant to step outside of drawing lines or circles once they did begin to interact. This could be because they have low confidence in their abilities or they are shy about making a mistake. A co-creative agent could encourage them to explore new things and help them build confidence.

Ownership. Elderly participants are more engaged with the interaction than the drawing itself. It may be the case that they do not feel as much of a sense of ownership over what they are creating. A co-creative agent can make it clear that the agent produces some content and the user produces other content.

Conclusion

The Move and Paint interactive display was designed to engage elderly residents in a community to engage in creative activity that leads to more physical activity. The results of our comparison of elderly vs college-age participants in voluntary interaction with Move and Paint shows that the elderly have distinct interaction design needs from the elderly. We present opportunities for co-creative agents to address these needs with 5 principles for the design of co-creative agents for elderly interaction: sensitive design, engaging design, instructing, encouraging, and ownership.

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