Persuading older adults to socialize and exercise through ambient games

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***Abstract*—Families are increasingly using Social Networking Sites (SNS) to keep in touch. Building upon our prior work and using the results from 6 participatory design sessions, we present the design of two ubiquitous exergames: GuessMyCaption and TakeAPhoto. These games use family memoirs available in SNS and natural interfaces to encourage older adults to exercise. We further describe the implementation of GuessMyCaption and the results of a 5-weeks deployment study with one older adult and 12 relatives. The system maintained the older adult engaged with her exercises while offering new opportunities for online and offline social encounters. We close discussing that the use of natural interfaces and family memorabilia facilitated the adoption of the game and catalyzed family social encounters.**

Keywords-; videogame, older adults, social ties, Kinect, exergame

I. Introduction

Social ties and social integration are beneficial in maintaining the physical and psychological well-being of older adults [1, 2]. Paradoxically, as an individual ages his/her social network is reduced [3] and individuals concentrate their social ties upon family interactions [4]. Videogames have been shown to become "meeting places" where older adults can initiate social interaction [5]. Recent research has analyzed the increasing popularity of exergames among the elderly [5, 6] for improving physical health and assist during rehabilitation [7]. Motion sensing controllers (e.g. WiiMote[1], Kinect sensor[2]) provide to the elderly with natural means to manipulate items in games while they follow semi-structured routine of exercises attempting to maintain the elderly engaged with the games through virtual rewards (e.g. scores, robot speech motivation). Although exergames use these means to maintain engaged the older adult in her exercises, they do not include means for socialization or family-related factors that help engage the older adult in the game.

In this paper we study the use of ubiquitous exergames that take advantage of the social capital available in Social Networking Sites (SNSs), to persuade older adults to socialize and exercise. We describe the formative design of two ubiquitous exergames prototypes and the results of a 3-week deployment with an older adult and her social network.

II. Design Methods

Following a user-centered design process we used multiple design methods to inform the design of ubiquitous exergames for older adults. We conducted 6 participatory design sessions with potential users, a geriatric nurse and experts in HCI, Ubicomp and computer vision.

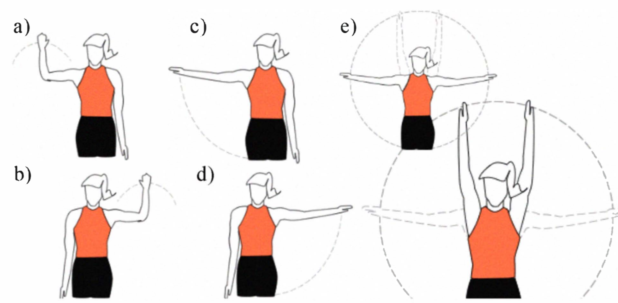

Figure 1 Upper limb exercises: a)Right hello, b) Left hello, c) Right arm raise, d) Left arm raise, and e) Circular arms raise

A. *Establishing appropriate physical activities for older adults*

To define appropriate physical activities for older adults, we conducted 2 participatory design sessions involving an 86 year-old woman who lives alone, a geriatric nurse and HCI/Ubicomp experts. Before our design sessions the geriatric nurse assessed the health of the older adult. During the design sessions we discussed several physical activities that were appropriate alternatives for the targeted older adult, while being general enough to be beneficial for other older adults. From those alternatives we selected three physical activities (see Fig. 1) aimed at preventing the loss of arm muscle strength, a common problem among the elderly.

B. *Co-designing the prototypes*

To supplement our understanding on the role of social media in improving family social ties [8], we conducted 3 participatory design sessions: two involving HCI/Ubicomp

1 http://www.nintendo.com/wii
2 http://www.xbox.com/es-MX/Kinect

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experts, a geriatric nurse and a computer vision expert and another one which also involved the older adult's grandson and a granddaughter in-law (see Fig. 2). We also conducted 1 semi-structured interview with the older adult to gather insights for designing for an engaging experience. The results of these meetings led to the design of two prototypes. Both prototypes were discussed in a final meeting to obtain feedback from all stakeholders. This feedback was used to re-design the prototypes.

III. UBIQUITOUS EXERGAMES PROTOTYPES

The requirements obtained during our participatory design sessions were used to design the following prototypes.

A. *TakeAPhoto*

The objective of the game is to ask relatives to take artistic photographs, or photographs portraying the context of their everyday life or memoirs, based on the older adult's submitted "mission". A "mission" might demand relatives to take a photograph of the context of their everyday life (*e.g.*, when they are at work), an artistic photograph (*e.g.*, a sunset), a photo of their activities based on their location or time of the day (*e.g.*, take a photo at 10 o'clock) or from a memoir (*e.g.*, take a photo of your childhood). Relatives will compete from the best photograph rated by the older adult. To avoid cognitive load to older adults for submitting "missions" the system might automatically submit "mission" if no new requests are detected.

The system has two interfaces: a digital portrait the older adult uses to submit "missions" and consult photographs (Fig. 2), and a capture tool that is synchronized with Facebook to post "missions" for relatives and to upload the photographs resulted from a "mission". To initiate the game, the older adult has to use either "left hello" (see Fig. 1a) or "right hello" (see Fig. 1b). Once in the game, the older adult sends the "mission" to all her relatives who have 48 hours to upload their photo into the SNS. Relatives receive the "mission" in their Facebook account as a post in their timeline.

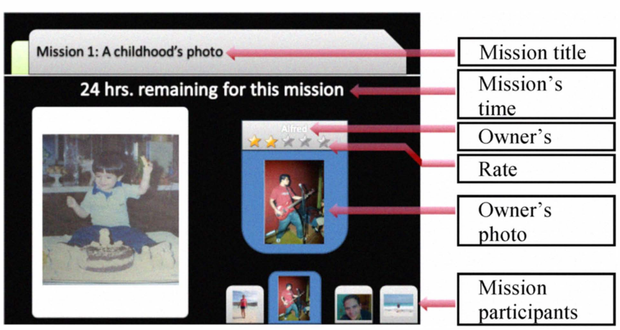

Figure 2. The TakeAPhoto game. A screenshot of the older adult digital portrait for consulting and submitting "missions"

Once the 48-hours period expires, the older adult will consult the photographs in her digital portrait (see Fig. 2). The older adult uses either "left arm raise" (see Fig. 1c) or "right arm raise" body action (see Fig. 1d) to navigate through the uploaded photographs. To rate the photographs, the older adult uses the "circular arms raise" body action (see Fig. 1e) to add a star rate for up to five stars. So for a family of around 10 members, the older adult will execute a minimum of 20 exercises for around 30 minutes, three times a week. The older adult will be rewarded with a printout of the top rated photograph of the previous "mission". The top three rated photographs are published on the older adults' SNS timeline as feedback for relatives.

B. *GuessMyCaption*

The other exergame employs the same approach to initiate the game and uses the content available in the Facebook's family account to feed the content of the game. The objective of this game is to guess the photograph that better matches a description. Three photographs are randomly retrieved from the relatives' accounts on Facebook, and are displayed to the user (Fig. 3). From this set of photos one is randomly selected and the description displayed at the bottom is retrieved from the photograph's caption or associated comment in Facebook.

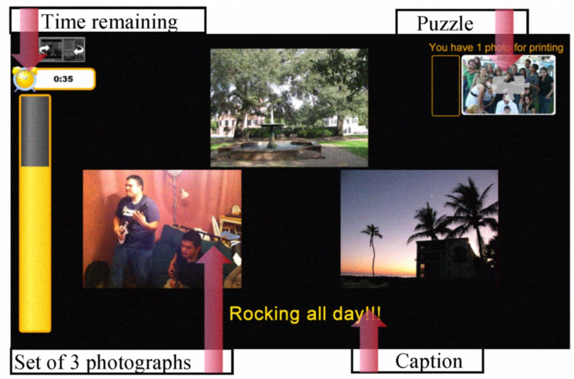

Figure 3. Matching game

The player has 45 seconds and two attempts to select the correct answer. He uses the body actions to select the desired photo; "left arm raise" (see Fig. 1c) to select the displayed photograph on the left of the screen, "right arm raise" (see Fig. 1d) to select the displayed photograph on the right of the screen and "circular arms raise" (see Fig. 1e) to select the photograph displayed at the top of the screen.

The exergame provides visual (*e.g.*, glowing green rectangle around the correct photo) and audio feedback (*e.g.*, cheers sound) when the older adult selects the correct answer. A puzzle of a family photograph on the top right corner of the screen is assembled based on the number of attempts that the user requires to get the correct answer. If the user deduces the correct photo on her first attempt, then the game assembles 2 pieces of the puzzle; if it's the second attempt, then the game assembles 1 piece of the puzzle. Once the puzzle is complete, the older adult receives one virtual credit that can be exchanged for a printout of a photograph of her choice. A post is published on her SNS showing the photograph the older adult chose to print and the owner of this photograph.

IV. IMPLEMENTING THE GUESSMYCAPTION GAME

We implemented the GuessMyCaption prototype as it proved to be more appealing during our participatory design sessions and few relatives had Internet in their mobile phones to use TakeAPhoto.

A. *Pose detection through a depth perception vision system*

We selected the Microsoft Kinect sensor to detect the pose of the user. The scene depth information is processed with a decision forest in order to find up to two users interacting with the game. This information is also used to track the user skeleton determined in a three dimensional position of 20 human body joints (*i.e.,* head, neck, shoulders, elbows, wrists, hips, knees, ankles, hands and feet) [9]. The game's perception component tracks the upper limbs of the skeleton to identify the five body actions, previously described in Section II, for manipulating the game.

B. Body actions for GuessMyCaption

Left and Right Hello. This body action corresponds to a natural waving of the hand when saying "hello". The system detects the gestures when the left or right hand is located near the head. The system uses vertical and horizontal thresholds (xThresh and yThresh) to delimitate a small rectangular region where it expects to find the hand. This region is defined by the rules in (1), where α is a small adjust related to the distance between the user and the sensor; and Xdist and Ydist are the horizontal and vertical distance from the hand to the head respectively. Another necessary condition is that the hand must be placed above the shoulder, that is, handYpos – shoulderYpos > 0; next, the hand must be horizontally found between the elbow and the head defined by, handXpos ϵ [headXpos, elbowXpos]; and finally the elbow is found below the shoulder elbowYpos < shoulderYpos.

$$\text{If } Xdist \in [30\text{-}xThresh - \alpha, 30 + xThresh - \alpha] \text{ and } Ydist \in [15\text{-}yThresh - \alpha, 15 + yThresh - \alpha] \quad (1)$$

Left and Right arm raise. The events for these body actions are triggered when the user has his arm fully extended to the side with the hand at the same level as the shoulder; meaning that the Euclidean distance from the shoulder position and the wrist position should be approximately the distance from the shoulder to the elbow plus the distance from the elbow to the wrist. The pose is detected when the hand is found within the rectangular threshold region defined by (2) and (3):

$$dist(shoulderPos, wristPos) - (dist(shoulderPos, elbowPos) + dist(elbowPos, wristPos)) < distThresh - \alpha \quad (2)$$

$$|handYpos - shoulderYpos| < yThresh - \alpha. \quad (3)$$

Circular arms rise. The system detects this pose when the user completely stretches both arms above the head, see (4):

$$handYpos > shoulderYpos, elbowYpos > shoulderYpos \quad (4)$$

The hands and elbows must be directly above the shoulders, $|elbowXpos - shoulderXpos| < xThresh - \alpha$, $|wristXpos - shoulderXpos| < xThresh - \alpha$; and finally, the hands must be close to each other, $|leftwristXpos - rightwristXpos| < xThresh - \alpha$. It is through these conditions that the system establishes a rectangular threshold region for pose detection.

Fig. 4 shows the detection system in use. The top images show the input captured by the depth perception camera; with this information the system determines the position of the user. The bottom images show the results of the skeletal tracking algorithm used to detect the current pose or gesture.

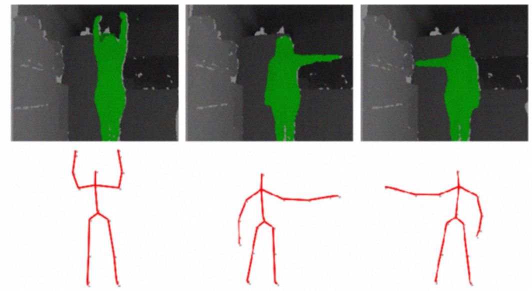

Figure 4 Images from the detection system

V. Evaluation Methods

For a period of 3 weeks we deployed GuessMyCaption at the home of the older adult who participated in our participatory design sessions. Participants (n=12) included a 87-years old woman, 3 of her female-children, 6 of her grandchildren (3 female), 1 grandniece and 1 nephew, all of them were scattered throughout several locations, with almost half of the participants living in the same city as the older adult. Data collection included weekly measurements of arm strength with a dynamometer and weekly semi-structured interviews with participants and logs of computer usage. Interviews were conducted across the three study phases: pre-deployment (1 week), during the deployment (3 weeks), and post-deployment (1 week). Interviews were individual and semi-structured and were conducted face to face or through instant messaging, video calls, or telephone. During the pre-deployment, the older adult was interviewed by the geriatric nurse to determine her health status and the older adult's own perception of her health and received a training session on how to play the game. The interviews were transcribed and we used open coding to reveal evidence in relation to the use and adoption of the game, older adult's perception of the game, health and social support.

VI. Experiences using GuessMyCaption

A. Use and adoption

During the first week of deployment the older adult was enthusiastic with the game. The use of body actions to manipulate GuessMyCaption ease its adoption, helping the older adult to incorporate the game as a usual routine in her life:

OA[3]: "... sometimes around five o'clock [I play GuessMyCaption], it's the time when I am in the bedroom, so I have some time to play"[4]

The affordances provided by the natural user interface made the system easy to learn. Playing GuessMyCaption with natural and known body actions induced a feeling of certainty on how the game reacts to her arm movements, making clear to her how to perform the actions on the game (see Fig. 5), even easier than using current electro-domestics available in her home.

OA: "No, no, no, it is not difficult at all. Maybe the challenge is whether or not I remember the context

[3] *OA = Older adult*

[4] *Participants' quotes were translated from Spanish to English, and some were adjusted to fit English grammar conventions.*

[refereeing to the photograph's captions] of the displayed photograph so I can solve the game. The one I cannot understand [how to use], is my T.V. device [referring to the cable receiver] that is difficult"

Figure 5. Older adult playing the matching game

The photographs displayed by GuessMyCaption triggered joyful moments to the older adult while playing the game by herself but also catalyzed group gatherings to play the game in a "group mode". Indeed the game was designed for the older adult; however its deployment generated new opportunities for social interaction with her younger relatives. Having the common interest of video games helped the older adult to initiate conversations with younger relatives and invite them to play the GuessMyCaption with her.

OA: "Just yesterday I turned on the game and invited my grandson to play the game with me. And one day before, I invited Anita (her granddaughter). Hahaha also my son came to play, but he is not that good hahaha"

The use of rewards promoted older adult's engagement with GuessMyCaption thus promoting the exercise. The older adult kept playing consistently to earn the printed copy of the digital photographs available in the game.

B. Perceived well-being

During the clinical interview in the pre-deployment phase it was determined that the participant presented minor yet perceptible difficulties raising her arms. Also, she perceived her health to be relatively good for her age.

The regular playing time ensured that the older adult perform the arm exercises in a consistent manner which directly influenced her perception about her health. Even though the game presented some false negatives while the older adult performed the circular raise arms gesture, the older adult was aware of the health benefits of repeating the exercise and kept performing the movement until the game reacted properly towards this gesture.

OA: "The front [gesture], well sometimes I have to repeat it several times to select the photograph in the middle but that's ok I know it's good for my health. It is like the exercises once my personal doctor prescribed to me a long time ago"

While the measures with the dynamometer do not reflect a significant change in gained strength, the perceived benefit by the older adult was noticeable from the first week of our study. The older adult observed an improvement with her left arm and attributed this change to the exercises performed while playing.

OA: "I'm feeling really well, my arms feel good. Do you remember that some time ago I told you I had arms-ache? Well something happened, I am sure it was for playing [referring to the use of GuessMyCaption], they do not hurt anymore, especially my left arm".

Furthermore, while the design was intended to require minimum cognitive effort, the older adult observed cognitive challenges in GuessMyCaption. In some occasions the older adult had to be thoughtful while selecting her answer since some of the shared photographs are quite old. Therefore the older adult had to remember the context of the displayed photographs so she could deduct the correct answer. Despite some errors while playing, this thoughtful process alleviated her worries about memory loss and reinforced her certainty of having good memory for her age.

OA: "The game has taught me that I still have good memory. I need to have good memory to remember past photos that I have seen and remember who was in the photo or what were they doing so I can select the correct answer."

VII. CONCLUSION AND FUTURE WORK

In this paper we present two prototypes designed to combine the benefits of exergames and resources for socialization. Our preliminary results suggest positive benefits in user self-perception of her health, evidence of in-person social interactions and the importance of inclusion of social/family components on exergames to maintain the older adult engaged with routine exercises. Further analysis is required to investigate the impact of the intervention on the whole family. Also, false positives with the vision algorithm were detected through the study; therefore we leave open for future work the improvement of a computer vision algorithm capable of self-adjusting to the older adult's environment.

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