Using the Kinect to Encourage Older Adults to Exercise: A Prototype

Samyukta Ganesan
University of Maryland, Baltimore County (UMBC)
1000 Hilltop Circle
Baltimore, MD 21250 USA
samyu1@umbc.edu

Lisa Anthony
University of Maryland, Baltimore County (UMBC)
1000 Hilltop Circle
Baltimore, MD 21250 USA
lanthony@umbc.edu

CHI'12, May 5–10, 2012, Austin, Texas, USA.
ACM 978-1-4503-1016-1/12/05.

Abstract
This paper reports current progress on a project that aims to find the factors that play an important role in motivating older adults to maintain a physical exercise routine, a habit recommended by doctors but difficult to sustain. Our initial data gathering includes an interview with an expert in aging and physical therapy, and a focus group with older adults on the topics of exercise and technology. Based on these data, an early prototype game has been implemented for the Microsoft Kinect that aims to help encourage older adults to exercise. The Kinect application has been tested for basic usability and found to be promising. Next steps include play-tests with older adults, iterative development of the game to add motivational features, and evaluation of the game's success in encouraging older adults to maintain an exercise regimen.

Author Keywords
Microsoft Kinect; game; older adults; exercise; physical activity; focus group.

ACM Classification Keywords
H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous.

General Terms
Design, Human Factors.

Introduction

Physical activity, or exercise, is important for every individual. A regular amount of exercise helps individuals remain healthy and fit. It is difficult to maintain a strict exercise regimen for any person, and for older adults it becomes even more challenging. The World Health Organization (WHO) recommends at least 150 minutes of moderate-intensity aerobic physical activity in a week, or at least 75 minutes of vigorous-intensity physical activity done in bouts of at least 10 minutes [8]. The WHO also highlights the positive outcomes of exercise such as fewer cases of stroke, reduced rates of coronary heart disease, reduced mortality rates, and an overall health enhancement [8].

In spite of these benefits, it is particularly difficult for individuals above 65 to maintain this physical activity due to their health problems [8]. Dishman [4] states that though older adults are *willing* to exercise, they fear injury, which is a hindrance. They would prefer exercising at their convenience in the safety of their homes and to use methods that are cost-effective and convenient to them [4]. Dishman also describes the positive effects that peers and doctors have on improving one's motivation to exercise, suggesting an advantage of having social interaction [4]. This relationship was also explored by Consolvo et al. [3], who developed an interactive system using an everyday technology, i.e. the mobile phone, which counts the number of steps taken while exercising, walking, etc. and shares it with peers. This sharing acts as a motivational factor among friends and peers and motivates one to compete with their friends and walk more than they do [3]. Note that this study was conducted over a period of only 3 weeks, which is much less than the time span of 16 weeks that was suggested by Resnick [6] as the point after which motivation to exercise starts declining. Longer-term studies are needed to establish the staying power of social influence to continue to motivate individuals, especially older adults, to exercise.

A second aspect of motivation is making exercise fun, such as through a game. When designing games for older adults, Gerling et al. [5] recommends considering people with a wide array of abilities ranging from physically fit and active individuals to individuals with chronic illnesses. The design needs to be uncomplicated and use simple interaction techniques since most of the users in this age group have very little experience using computers or playing video games [5].Becker [1] showed that older adults find it difficult to make fine mouse movements and that using standard input devices can be a challenge. Thus, when it comes to playing games on the computer, devices that allow natural gestures for interaction would be better than other input methods. Theng et al. [7] show that gesture-based games developed on the Nintendo Wii[1] are more accepted by older adults; older adults find the Wii less intimidating to use than typical console game controllers. The Wii detects body gestures using the "Wii Remote" controller, based on an accelerometer and held in one's hand. The Microsoft Kinect[2] is a similar technology but completely avoids the need of attaching any device to the body and detects motion by the use of various cameras. Both Wii and Kinect use IR beams for sensing motion. Since the Kinect uses similar input methods to the Wii, but with no physical device, meaning less invasion of the technology into their

[1] http://www.nintendo.com/wii

[2] http://www.xbox.com/kinect

experience, the Kinect could be even more successful with older adults than the Wii, which has seen wide uptake in the form of Wii bowling leagues [9].

This project focuses on how an exercise game built on the Microsoft Kinect platform can be used to bridge the gap between the physical challenges of aging and the need to maintain exercise. We are following a user-centered approach to develop the game. This paper reports progress on the game design and development process so far. We have gathered data by conducting a focus group with older adults, designed and built a prototype, and developed and tested the initial game to find usability issues in the design.

Data Gathering

In order to understand how older adults approach exercise and what exercises are beneficial to them, two explorations were conducted: (1) a discussion with a field expert, and (2) a focus group with older adults.

Discussion with Field Expert

We had an informal discussion with a Wellness Manager, who's been guiding older adults and motivating them to exercise for five years. This discussion gave a better understanding of the common exercises that are recommended and suggested to older adults to maintain physical health. The prime problem areas were identified as: (a) flexibility, (b) strengthening, (c) walking, and (d) balance. The WHO also recommends balance training and muscle strengthening exercises for the 65+ age group [8].Common strengthening exercises include arm curls and side arm raises, but these often involve additional equipment like an elastic band, soup cans, or dumbbells. A variation of side arm raises can be done without the weights, and acts as a stretching exercise for the limbs and improves flexibility. Because walking and balance are also important, we will explore ways to incorporate these into our prototype in the future. After the discussion, and considering the capabilities of the Kinect, arm raises were chosen as a suitable exercise for implementation. We expect a Kinect-based game involving arm raise exercises will motivate older adults to move their arms and increase the range of motion.

Focus Group

We also conducted a focus group with older adults to elicit the outlook that older adults had towards exercises. The participants were recruited from a senior center to which they belong. The focus group consisted of 5 participants (3 females) in the age group of 65 to 90 (mean = 73). The focus group lasted for one hour, during which they were encouraged to share their stories and views on three topics: (1) motivation to exercise, (2) interest in playing computer games, and (3) initial feedback to a demo of a Kinect game. The participants were paid $10 as compensation for their participation. The participants were also asked to fill out a short demographic questionnaire. From this data, we can determine that the participants of the focus group, though diverse, were people who exercised on a regular basis and hence a highly motivated group. Future work will include users of varying levels of motivation in order to understand how attitudes differ. The discussion revealed that all of the participants walked on a regular basis and enjoyed the activity and saw it as pleasurable. However, they were also intimidated to take a walk by themselves because of safety issues. They saw socializing as a motivating factor for them to exercise. They appreciated healthy competition and even indulged in it, but not unhealthy

competition. As stated by one of the participants, "…we are not in competition with each other. We are in competition with ourselves…" Three out of the five participants had started exercising because it was recommended by a doctor or a therapist, but ended up continuing for its own sake. One of our participants had low vision and expressed concern about using only visual feedback; the game should have alternative forms of feedback such as audio. Lastly, the participants were shown a video of the Sample Shape Game (Kinect SDK Demo). The reaction to the video was a mix of amusement, excitement and fun. They liked the stick figure avatar in the demo game, and even wanted to try the game on the Kinect.

Design & Prototype

The focus group discussion and consultation with the expert informed our design of the Kinect game for arm raises for older adults. The design requirements we developed based on this data gathering were: (a) should be able to exercise either standing or seated, (b) avoid having arms raised constantly for extended periods, (c) keep score and display it in a large font, and (d) have the stick figure with the skeletal tracker. With the knowledge gained from the early data gathering, and having explored the capabilities of Kinect, a game with the goal "touch the circle" was designed. Touching the circle successfully by raising the correct arm to the correct height increases one's score. To add challenge, a square was added which when touched reduces the score. The shapes appear at 5 different heights from arm-at-sides to arm-raised-vertical. Each round includes one phase with just the right hand, one phase with just the left hand, and one phase with both hands simultaneously. The game provides visual cues as to where to touch by where the shapes appear. Currently, the game loops sequentially through all the phases and shape heights, but random orderings can be added in future versions. The Microsoft Kinect Xbox 360 sensor and the Kinect for Windows SDK v1.0 beta 2 were used to implement the game. The prototype game was implemented in C# using Microsoft Visual C# 2010 Express. A screenshot of the implemented prototype is shown in Figure 1.

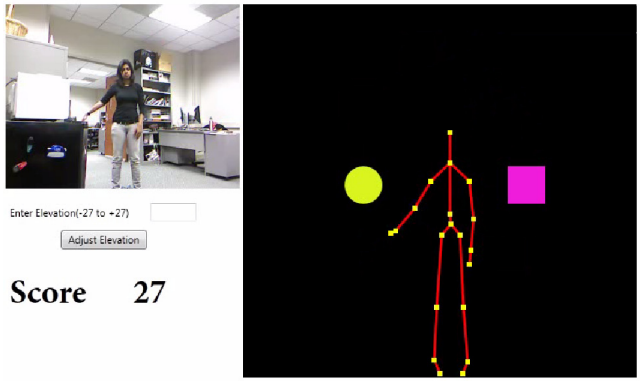

Figure 1: Final implemented prototype of the game.

Evaluation & Results

The prototype system was tested with users in the age group of 20 to 30 to uncover early on any usability or interface and interaction design issues that may arise while using the system. (We wanted to avoid showing our target users, older adults, an immature system and potentially discouraging them from exercise or the Kinect platform.) The usability study was conducted with 5 participants (2 females) in a lab. Four participants had used the Kinect before for playing games. The participants were asked to fill out a standard System Usability Scale (SUS) Questionnaire [2], to which we added an additional question on how

accurate the system was perceived to be in recognizing the user's motions correctly. The responses were given on a five-point Likert Scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). On average, the responses to the positive questions were above 4 and the responses to the negative questions were around 2, indicating an overall positive response from our users. The application was perceived to be easy to use and easy to learn. The participants could use the system confidently and found it to be accurate. Other feedback and observations from the users' verbal comments were: (a) the score wasn't easily noticeable, (b) the stick figure was fun to watch, (c) three participants set a personal best score they wanted to achieve, and (d) the participants showed good motivation to continue playing past the usability session. We do expect that a more mature user interface and game system, including score tracking, leader boards, various levels of difficulty, and additional exercises, would be needed to fully develop the potential of this platform for motivating exercise.

Conclusions and Future Work

The results of the usability study were promising. A prototype game based on physical exercises was implemented using the Kinect that was considered fun to play. Further development is needed to bring the game to a point of evaluation with older adults to test the hypothesis that it really motivates them to maintain an exercise routine. Such development will include (1) adding more interactive features to control the game; (2) improving the game graphics and visualizations; (3) increasing game complexity; (4) adding social and motivational aspects to the game; and (5) play-testing the game with older adults (throughout the process).

1. Interactive Features: Voice as well as gesture commands needs to be added to stop, start, and pause the game. The shapes should be placed in a random fashion so that the game isn't predictable in order to require the user to look and think before moving their body. Since the score wasn't very noticeable to users in our usability study, we will add an animation over the skeletal image that shows the change in score, e.g., +1 or +3, or -5 or -3. Right now it takes cognitive effort to compute the change in score to realize the difference. Also, maintaining a high score list will be a good idea, since it was one of the topics that specifically came up in the focus group and seemed to foster healthy competition among the older adults.

2. Graphics and Visualization: The skeleton can be replaced by an avatar to make it look more sophisticated. Because some users seemed to like the skeleton, the game can allow users to have an option of choosing an avatar or the skeletal image. Also, adding background music and interesting audio effects can make the game more appealing. For example, we have considered adding an outdoors metaphor to the game in which the player's avatar is standing in a garden; the goal might be to touch the butterfly and avoid the bee. To increase game realism, this version can also have background sounds of birds chirping. This idea was inspired by the focus group where the participants liked the idea of walking because of the pleasurable view of nature. Bringing that view to someone who isn't in a condition fit enough to go for a walk may be beneficial.

3. Game Complexity: Various difficulty levels from which the user can choose will be added. Also, rewards that the user gets each time they reach a score milestone may help motivate them to continue playing.

This application can also be extended to include various mini games for different exercises. This game can be adapted for stroke patients too for their therapy.

4. Social and Motivational Features: This game will be extended to have two or more players play together competitively or cooperatively, either in person or over a network. Support for leader boards and score-based achievements will help foster healthy competition and enable social engagement during exercise.

5. Play-Testing with Older Adults: Another focus group should be conducted with older adults, with more participants of more diverse motivation levels, wherein we will seek feedback on the system developed and further information on attitudes toward exercise. The system can later be tested for usability and fun by users belonging to the age group of 50+. Also, a longitudinal study where users use the system for a longer period of time will help shed light on how motivating and encouraging the system is over extended periods of time.

Though there are many things still to improve, this project has begun to develop the basic requirements and understanding necessary for implementing an exercise game for older adults using the Kinect. We will conduct further iterations of the user-centered design process with target users in order to improve the game and maximize its ability to encourage older adults to maintain an exercise routine.

Acknowledgements

We would like to thank Teresa Reymann for her guidance and also the senior center staff and members for their help and participation.

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