Rehabilitation Games

Designing computer games for balance rehabilitation in the elderly

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ABSTRACT

Falls due to poor balance are a leading cause of injury and death among the elderly. Appropriate training can improve balance control and reduce falls risk but traditional exercise programs are dull and repetitive and so have poor adherence. We believe that through the use of purpose designed computer games, exercise programs can be made more engaging, resulting in increased adherence and faster rehabilitation.

In this paper we describe Balance Rehabilitation Games project at UNSW. The aims of this project are to design a game which will appeal to older adults while incorporating appropriate balance exercises. We discuss the design issues that arise when working with a target audience that is not usually part of the video game market, and delivering appropriate exercises without making them boring.

Keywords

Game design, balance, physical therapy, rehabilitation

1. INTRODUCTION

As we age, our bodies lose strength and our bones become brittle. A decline in sensorimotor function and lack of exercise (e.g. from long hospitalisation) can result in frailty and postural instability, increasing both the probability and the danger of falls [**?**]. Falls that could be shrugged off in youth can become serious or even fatal. Fall prevention is thus a very important health issue among the elderly.

Clinical studies have revealed that participation in falls-prevention programs which incorporate strength and balance training can reduce the risk and incidence of falls in older adults [**?**]. However adherence to exercise training is often poor. Exercise programs can be dull and repetitive and participants lose interest quickly, particularly when faced with little immediate improvement.

Reluctance to exercise is not unique to older adults. Among other age groups, video games have proven to be an effective way to address this problem. Using interface devices such as the Wii Fit balance board, exercise can be incorporated into the control of a game. The game can entertain the player(s) while rewarding and reinforcing healthy movement.

So far these studies have largely been targeted at a younger audience who are already experienced gamers, and it may seem unusual to suggest that video games could also benefit an older age-group, but there are good reasons to why this could be the case. Immobility and the resultant social isolation place many of the usual sources of entertaining physical activity out of reach. Networked computer games can offer a source of escape and socialisation that may not be possible offline. Anecdotal evidence suggests that games such as Wii Bowling (for which there are national nursing-home leagues) are making this a reality.

In this project we take up the challenge to design a game specifically for older adults to promote exercise for balance rehabilitation. The game we have designed is a maze-solving problem for one or two players. A basic prototype has been constructed and is undergoing playtesting. In this brief paper we shall report on our design process and the results gained so far.

2. THE GAME

Figure 1 shows an image of the game. It shows a top-down view of a maze with several "treasures" to collect. The object of the game is to navigate the maze and collect all the treasures. The player's score is their final time through the maze. Players move forward by walking in place on a Wii Fit balance board. Longer 'strides' produce more rapid progress, to reward better balance rather over rapid stepping.

Cooperative and competitive two-player versions of the game are also being prototyped. In the cooperative version, the players work together to collect all the treasures and finish the maze as quickly as possible. In the competitive version the treasures are omitted and it is simply a race to

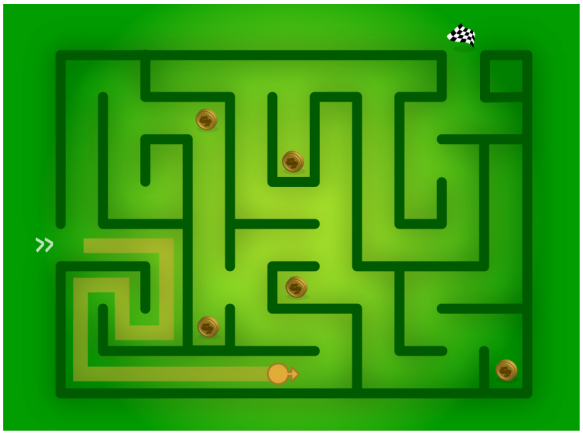

Figure 1: The maze game.

complete the maze as quickly as possible.

In future versions of the game we plan to add obstacles in the maze. When an obstacle is encountered the player will have to perform a specific exercise (eg: squatting or standing on their toes) in order to get past it. In this way we can add a variety of difficult exercises to the game.

3. THE DESIGN PROCESS

We have been using a player-centric design process, consulting with both potential players and physiotherapists throughout the development of the game. In this we have had the assistance of the Prince of Wales Hospital 'Stepping On' exercise class and the Montefiore Nursing Home. Our process has been informed by the Mechanics-Dynamics-Aesthetics (MDA) model [], first establishing the requirements for the game and then designing dynamics and mechanics to generate them. At each stage we have presented our designs to our focus group of players, as a pitch or a prototype, for testing and feedback.

3.1 Requirements

In a serious game such as this our requirements are both aesthetic and functional. That is, our game must be both fun to play and provide beneficial exercise. The aesthetic requirements were established by interviewing members of the Stepping On exercise class and consulting with diversionary therapy staff. Functional exercise requirements were provided by therapists. The requirements we established are:

Social fellowship. The game should provide an opportunity to interact with others. This was a large motivating factor in exercise class attendance. Both cooperative and competitive games met with approval.

Physical challenge. The game must push the players to challenge their balance in a variety of ways, such as reaching, standing on one foot, squatting, etc.

Mental challenge. Current exercises were often physically taxing but offered no mental engagement. Several participants expressed a fondness for puzzles and card games. (But see the note on dementia below.)

Fantasy. Participants would talk enthusiastically about the activities they used to do when they were younger and more physically able. The idea that these activities could be revisited in computer simulation was positively received.

Sensory engagement. There was a general fondness for music, particularly opera and musicals.

The functional constraints we faced were:

Physical fitness. The game had to be short as the players would not be able to exercise for long periods of time. It should also be adjustable to various levels of physical mobility. Poor eyesight can also be an issue.

Cognitive ability. Dementia is a common problem among the elderly which leads to diminished problem-solving ability and a propensity to get lost.

Computer literacy. Many of our participants have never owned a computer and expressed reluctance at having to learn how to use one.

3.2 Brainstorming

Having established our requirements, our next task was to brainstorm a collection of ideas for the main activity of the game. Since the game was to be inherently physical, our brainstorming also took on a physical form. We adapted the common "What Are You Doing?" game, familiar to improvisers as a warm-up exercise to encourage idea generation. Players stand in a circle, with one person in the centre miming an activity. After a time another player enters the circle and asks the performer "What are you doing?". The performer answers with the name of a *different* activity which the entering player has to adopt, while the previous performer rejoins the circle.

In our case we gave the performer in the centre a WiiMote and a Wii Fit balance board to incorporate into the performance. Any activity could be performed, there was no concern to make it a game. Once the usual performance anxiety was overcome, this process produced a variety of different game ideas which were the seeds for a more conventional brainstorming process.

From this process, five ideas were chosen and developed into game ideas that were pitched to the exercise class: gardening, conducting music, Tai-chi, sky diving and maze exploration, The maze game we a popular choice with both the focus group and the design team. It fit well with our design goals and it had a clear and simple core gameplay which could be extended in a variety of ways.

3.3 Prototyping

The game is currently undergoing a process of prototyping an playtesting. Two tests have been performed so far. The first prototype was a simple storyboard to flesh out the gameplay and discuss how different exercises could be incorporated into it, as well as to provide some sample artwork. The ideas met with general approval, and it was emphasised that the graphics had to be large and visually contrasting for players with poor eyesight.

The second prototype implemented the basic control for navigation: moving forward and turning. Movement was achieved by walking in place on the balance board, and turning by rotating the WiiMote. Several issues arose in testing. The two main ones were a) the walking behaviour favoured fast shuffling over balance, and b) the turning control was far too complicated and confusing (even for one of the authors). As a result of this feedback the original walking mechanic has been replaced with a 'skating' motion that accelerates the avatar the longer the player can remain on one foot, and the turning control has been greatly simplified.

Our next prototype, to be tested in early January 2009

implements more gameplay elements, including treasure collection and multiplayer competition and co-operation, and a later prototype is planned to implement obstacles and increase the variety of exercises.

4. FUTURE WORK

In time we aim to clinically evaluate the final game to establish whether it is an effective way to promote exercise. If this is successful we hope to develop a variety of other games, both to provide different exercise and appeal to different audiences. One particular concern is that our current game may be too difficult to understand for dementia-suffering players. Perhaps some of the existing research into architectural design for dementia could be adapted into adapting our game or creating games for this audience.

Another aspect of our project that we have not mentioned so far is the logging and examination of player data by physiotherapists. Our future plans include visualisation tools for the therapists to allow them to evaluate patient's progress. Until now exercise performance has largely be judged by eye, and formal evaluation has been cumbersome and time-consuming. The game's ability to record large amounts of data as the players exercise is a very valuable facility, and one we intend to take advantage of.

5. CONCLUSIONS

We have presented a brief outline of the Balance Rehabilitation Games project. This is a challenging design problem for a target audience not generally addressed by the games industry. In building the game we have learned much of the value of iterative, player-centric design. So far the game has been received with enthusiasm by players and therapists alike. We hope to soon be able to prove that by providing a fun experience we can engage players in their exercise and produce lasting improvements to their physical well-being.

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7. REFERENCES