Haptic/Audio based exergaming for visually impaired individuals

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ABSTRACT
Exergames are video games that use physical activity as input and which have potential to change sedentary lifestyles and improve associated health problems such as obesity. However, exergames are generally difficult for the visually impaired to play. In this research, we describe a method of interacting with exergames for visually impaired players.

Categories and Subject Descriptors
J.0 [**Computer Applications**]: GENERAL

General Terms
Accessibility

Keywords
Exergames, Visually Impaired, Wii, Audio, Haptic

1. PROBLEM
There are 7.8 million people living with visual impairments (VI) in the United States alone [1]. It has been shown that people with VI perform lower than sighted people on standardized physical fitness tests [2]. People with VI also have a lower average monthly income when compared to their sighted counterparts [1]. Social barriers are also present as the visually impaired might not have a partner or sighted guide to exercise with [3]. Safety concerns of the parents, teachers, and the visually impaired themselves are also important [4]. Self imposed barriers, such as not knowing what to do or the fear of being made fun of also restrict the amount of physical activities some people with VI are willing to do [5]. We propose a cost effective system of encouraging physical activity with enhancements for people with VI.

2. MOTIVATION
Traditionally, video games have done very little to increase activity amongst the players. In fact, studies have shown that traditional video games promote unhealthy behavior even more so than watching television [8]. Only 27% of children and 25% of adults engage in moderate-intensity physical activity each week [12].

A recent trend in video games is a genre called exergames [9]. These are video games that require exercise by the player in order to get the enjoyment from the entertainment of the game. Exergames require more input from the player other than the traditional button pressing. Games such as Dance Dance Revolution require the player to position his feet in such a way to match patterns displayed on the screen in time with the music. The release of the Nintendo Wii has strongly promoted the popularity of exergames. Games such as tennis and baseball can be played by actually swinging a controller (WiiMote) at the appropriate time based on the graphics displayed on the screen .

Although these games are fun and create exercise, they strongly rely on graphics and hand eye coordination in order to play them. This is difficult and essentially impossible for visually impaired players. Audio and haptic have been successfully used as alternative forms of feedback that allow users with VI to play games.

Additional audio cues can give the player an idea of what exactly is happening on the screen [10]. Currently speech is used as an addition to graphics, but it can be enhanced to be more descriptive to those who have difficulties seeing the screen. Sound effects also currently supplement the graphics, but they can be enhanced to provide more detailed spatial audio to assist those with VI. Using the left/right/front/back speakers can enhance the virtual representation such that a person with visual impairment can picture the state of the game. In addition to spatial cues, visual game state cues can be represented as additional audio cues as shown in a Battleship game modified for visual impaired players. And finally, an audio technique called sonification, uses earcons or sound radar to assist those with VI as demonstrated in the game Audio Quake.

Another cue that can be enhanced is haptic [11]. Haptic refers to the sense of touch. A common haptic cue used in video games is the rumble. The controller will rumble when something is happening. This is usually done to give a sighted player a more accurate representation of the virtual world being shown on the screen. For example when an explosion occurs, the controller will shake making the player feel as though he is actually a part of the virtual world. Traditionally haptic has been used as a tertiary form of cue in video games (visuals and audio first), but for games that are enhanced for visually impaired players it can be more of a primary cue. For example, when a rumble occurs, a

player knows that it is time to do something. A version of Guitar Hero, which is primarily a pattern matching hand/eye coordination game, was modified to rely mainly on haptic cues due to the fact audio cues would interfere with the musical context of the game [6]. This showed very promising results indicating that haptic can be used as a substitute when the visual cues are not available.

3. SOLUTION

In order to promote exercise for people with VI in an environment where they can feel safe and not need others to help them, we propose creating exergames with enhancements for VI. Based on the previous studies we will enhance the audio and haptic cues to give the player the ability to formulate a correct representation of the virtual environment based on those cues.

Cost will also be a consideration. We think this can be done relatively cheaply with off the shelf components. The technology packaged with the Nintendo Wii is very available and extremely cost effective while also being accurate and useful. With the built in accelerometers, speaker, and rumble we can detect the necessary information to determine the motion of the player. We can also provide enhanced non visual cues such as haptic and audio which have proven to make the games more accessible. With the popularity of exergames and the benefits they bring, we think making them accessible to people with visual impairments will provide an entertaining, safe, healthy and rewarding experience.

4. STAGE

We have created a software title "VITennis", or Visual Impaired Tennis where a basic tennis game utilizing the WiiMote has been modified with enhancements for visually impaired players. We have added spatial audio such that the player can tell whether the ball is going to the left or right of the screen. We have also added haptic feedback through the WiiMote's rumble capability which indicates when to swing and can give some status on the current state of the game.

We have had 1 preliminary trial with the game being played by 13 completely blind students. We monitored energy expenditure using wearable accelerometers and found levels of energy expenditure higher than regular video game playing. The energy expenditure was also high enough to contribute to the daily recommended dose of exercise for children. We plan to perform a long term study and analyze the long term benefits of exergaming for people with VI.

Our VITennis game only exercised the player's dominate arm, and with that we seek to explore how we can engage the visually impaired player in a whole body exercise using a haptic/audio based approach. We seek to construct a vibrotactile/audio exercise suit that also has basic motion capturing technology. Along with this suit we plan to develop several exergames that entertain the player while providing exercise in a manor that is accessible to people with VI.

Some research questions we seek to investigate are:

(1) How can we engage users with VI in whole body exercise?

(2) How can we provide a technique for motor learning that allows users with VI to correctly perform their exercises? This would include a method for motion capturing as well as providing whole body multi-modal feedback.

5. CONTRIBUTIONS

We hope to expand the very popular and healthy exergames genre to include those with VI. We also expect to promote exercise to a group who performs lower than average on standardized fitness tests.

6. GAIN

I have spent the last 10 years developing software for a gaming company. Participating in this conference will really help me understand what is needed to succeed in a research environment. The area of assistive technologies is very interesting to me, and I would like to learn what others are researching as well as receive feedback on my project from those who are experts in this field.

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