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DEVELOPMENT OF A BOXING AUDIO GAME FOR THE VISUALLY IMPAIRED

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Abstract: Social models of disability focus on empowering disabled people, through assistive technologies, to take part in activities such as sports that existing infrastructures prevent them from doing. This paper describes the development of a prototype game for the blind and visually impaired that simulates the sport boxing. In the said computer game, called Shadow Boxing, the player receives audio as well as vibrotactile *cues* that enable him to decide on a particular action such as whether to punch the non-player character (NPC) opponent or block the opponent's punch. Audio and vibrotactile *feedback* are also provided to inform the player of the effects of his action. The system processes 3D coordinate data from a Microsoft Kinect sensor to determine the player's actions. Increasingly complex versions of the game were played by a total of 40 players, who were male in the 16-21 age range, half of whom were blind. Although the sighted players generally outperformed the blind players in terms of number of games won against the NPC, most of the blind players won rather than lost, indicating that blind players can actually win the said game and, based on qualitative comments, enjoy computer games that use audio and vibrotactile cues. The system is one of the first, if not the first, to use Microsoft Kinect for creating games for the blind that simulate sports, thus enabling blind and visually impaired persons to enjoy not only exergaming, i.e., playing computer games that are also a form of exercise, but also simulations of sports like boxing that would otherwise be dangerous for them to engage in. Shadow Boxing therefore affords blind and visually impaired persons opportunities to enjoy computer exergaming, in particular boxing exergaming – opportunities which, prior to Shadow Boxing, were only largely available to people without such disabilities.

Key Words: computer games; blind; visually impaired; boxing

1. INTRODUCTION

Social models of disability (Barnes, 2012) focus on empowering disabled people, such as blind and visually impaired individuals, through assistive technologies for instance, so that they could engage in various kinds of activities, including playing games or sports, which existing

infrastructures might prevent them from doing. Recent examples of computer games that have been developed for blind and visually impaired people include: AudiOdyssey (Fernandez-Vara, Grigsby, Glinert, Tan, & Jenkins, 2009), which simulates club disk jockeying; VI-Bowling (Morelli, Foley, & Folmer, 2010), VI-Tennis (Morelli, Foley, Columna, Lieberman, & Folmer, 2010), Pet-n-Punch (Morelli, Foley, Lieberman, & Folmer, 2011), which is based on the 1975 arcade game Whac-A-Mole; and Showii (Cala, Co, Cue, & Tee, 2011), which simulates the sport Showdown, a kind of air hockey designed for blind players. All these computer games make use of the Wiimote, the remote controller of the Nintendo Wii (Nintendo, 2013). While arguably more interesting to use than a computer keyboard, the Wiimote can, however, be cumbersome to use by blind persons (Cala, Co, Cue, & Tee, 2011). A more promising input device would be the Microsoft Kinect sensor (Microsoft, 2012), launched in 2011, which is capable of full-body 3D motion capture without the need for any hand-held controllers.

This paper describes the development of a computer game for blind and visually impaired people that simulates the sport boxing, which, according to a Social Weather Station survey, was the country's most popular individual sport in 1999 (TxtMANIA.com), and which probably remains true today, especially with the international prominence of Filipino boxer Manny Pacquiao. In the computer game, called Shadow Boxing, the player receives audio as well as vibrotactile cues that enable him to decide on a particular action such as whether to punch the non-player character (NPC) opponent or block the NPC's punch. Audio and vibrotactile feedback are also provided to inform the player of the effects of his action. The system processes 3D coordinate data from a Microsoft Kinect sensor to determine the player's actions.

2. DESIGN

2.1 Game Setup

To play the game, the user must stand in front of the Kinect sensor, less than a meter away. Headphones or earphones with Bluetooth capabilities are recommended, but speakers may also be used. The vibration motors for vibrotactile feedback are sewn into a suit or long sleeved T-shirt and gloves as shown below (with the battery sewn at the back of the shirt):

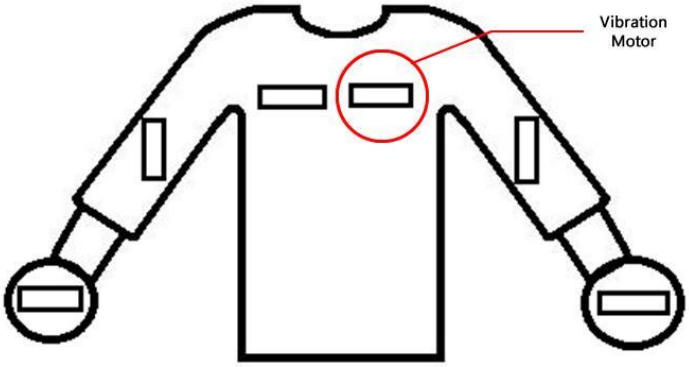

Figure 1. Player's Suit with Vibration Motors

2.2 Game Interactions

Player

A player is allowed to either block or punch. A punch reduces the opponent's health by 20 points unless the opponent blocks the punch. When the player's health reaches zero, the player loses a round. Whoever is the first to win three rounds wins the game.

There are two types of punches: regular and power. A power punch, which deals greater damage, has an additional gesture in which the player rotates his torso and punches out from his shoulders. However, there is a mandatory five-second period before another power punch can be executed. During this resting period, the player can execute regular punches.

There is only one type of block, which is where the player raises his or her arms presumably to protect his or her face. The arms cannot be less than one inch (70 to 80 pixels) apart to allow the Kinect device to accurately detect the different body parts.

Non-Player Character (NPC) Opponent

The player fights against an NPC, which can punch and block, with a two- to five-second gap between successive punches when the game is played in Easy mode. The NPC will also attack the player continuously when the player remains in a blocking stance for six seconds or longer.

System Cues and Feedback

The system will primarily interact with the player through sound and vibrotactile cues and feedback. These interactions will allow the player to know the current state of the game.

Different sound cues are used to indicate when the opponent has begun to execute a regular punch and a power punch. Different sounds are also used to indicate that the opponent is open to attack or when in its arms are raised in a blocking stance. Different sounds are also used to provide the player with feedback when a punch is blocked (whether by the player or the NPC), or when a punch connects (hits either the player or the NPC) and therefore decreases health points of the party that was hit.

When a player gets hit on the chest, the system will activate the vibration motors attached to the chest part of the player's suit. If the player is able to block the NPC's punch, the motors attached to the arms of the suit vibrate for one second. These motors will also vibrate but for a longer period (2 seconds) when the NPC has begun to execute a power punch. If the player's punch connects to the NPC's chest, the motors attached to gloves vibrate.

An announcer notifies the player if the game is paused or not, if he or she is too far or too close to the Kinect sensor, and if the player has won or lost the round.

Different background music is also played to indicate when the health conditions (Strong, Normal, Critical) of the player and NPC opponent are equal, when the player's condition is better than the opponent, when the player's condition is Critical, and when the player has won.

3. RESULTS AND DISCUSSION

The game was played by a total of 40 players, who were male in the 16-21 age range, half of whom were blind. The blind players were high school students from the Philippine National

School for the Blind; the sighted players were from De La Salle University, Manila. Each player was first given an orientation on positioning and execution of the blocking and punching gestures, and then allowed a practice session where they could experience the effects of punching, blocking, and listening to the sound cues and feedback. In each case, the computer was positioned such that the player could not see the game's user interface (which was designed not for the players but for the system developers and observers). Preliminary results are discussed below.

Figure 2 shows that 80% of the blind players won the game (against the NPC opponent), which indicates that the game is playable and winnable by blind persons, and at a rate that is not far behind that of sighted players. That more sighted players won could be explained by the fact that all the sighted players in the experiment had some experience playing (and winning) video games (rare is the digital native who has no experience playing a video game), whereas only a few (seven) of the blind players had experience playing (but not necessarily winning) video games. That some blind persons play video games is no longer an oddity (see e.g., (Platke, 2011)).

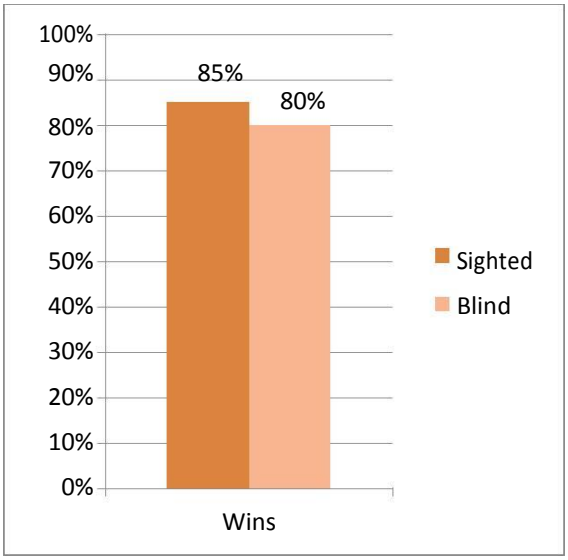

Figure 2. Comparative Wins of Sighted and Blind Players

Figure 3 shows that more sighted players won on the first round compared to the blind players. This suggests that the sighted players were more quickly able to quickly adjust to the game (again possibly due to their experience in playing video games) though the blind players

were eventually able to catch up.

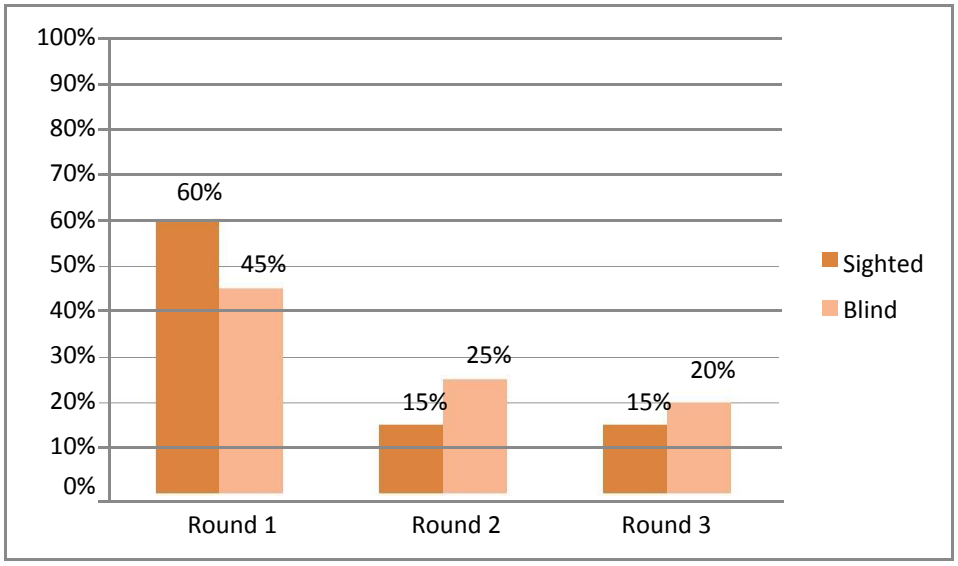

Figure 3. Wins Per Round

There were at least two distinct play styles observed from the 20 tested blind players. Basically those styles could be classified as: Offensive, in which ones doesn't block frequently but just launches a lot of punches; Defensive, in which one blocks most attacks and punches infrequently; or a mix of the two aforementioned styles. Each style had their own respective win and loss ratios, with the defensive players scoring better. This could be because the offensive players tended to jump around, which renders Kinect unable to recognize some of their punches.

The players got tired after playing the game. This was due to the movements of the players as well as the duration of the game. This suggests that game could be played for exercise or fitness benefits, though further experiments are needed to ascertain that. Feedback from the players indicates that they enjoyed playing the game, with the blind players enjoying the vibrotactile cues and feedback more than the sighted players.

4. CONCLUDING REMARKS

We have described a computer game for the blind and visually impaired that simulates

the sport boxing. The system processes 3D coordinate data from a Microsoft Kinect sensor to determine the player's actions. Increasingly complex versions of the game were played by a total of 40 players, who were male in the 16-21 age range, half of whom were blind. Although sighted players generally outperformed the blind players in terms of number of games won against the NPC, most of the blind players won rather than lost, indicating that blind players can actually win the said game and, based on qualitative comments, enjoy computer games that use audio and vibrotactile cues

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5. ACKNOWLEDGMENT

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