Using Video Games for the Rehabilitation of Children with Cerebral Palsy: A Pilot Study

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Abstract. Video games have become a tool for motivating players in performing tasks they would not otherwise perform. We present the use of video games controlled through XBOX KINECT, to facilitate rehabilitation of children with cerebral palsy. Specific movements to promote children's rehabilitation of reduced balance and postural control were used with video games suitable for children between the ages of 5 – 12 years old. To evaluate the rehabilitation and motivation potential of the video games, a pilot study with 7 children between the ages of 9 – 12 years old was performed. The children played the aforementioned video games for 6 weeks, twice per week. Physiotherapists used the Paediatric Balance Scale to assess clinical their balance and postural control in 14 dynamic and static tasks before and after the experiment. The results are promising, both in terms of motivating children to attend their rehabilitation sessions, and in terms of rehabilitation potential.

Keywords: KINECT, video games, rehabilitation, cerebral palsy.

1 Introduction

Games are intimately tied to entertainment and pleasure. Video games in fact, are now a favorite pastime for both young and "young-at-heart". As a Nielsen study shows, online games are now more popular computer applications than email [1]. Because of this trend, and because games are thought of as fun, video games have been used in a host of other applications, to promote tasks that some may consider boring or uninteresting. Thus, serious games have been developed for education [2] and various types of training (such as medical and military) [3], and more recently gamification of various business processes has been proposed [4]. These applications leverage the fact that games motivate people to perform otherwise mundane tasks (for example people will kill insignificant monsters in World of Warcraft, solely to either complete game objectives or to level up their character – this is called grinding [5]). In this paper we discuss our attempt towards leveraging video games, played using the XBOX Kinect, that motivate children with movement difficulties to perform exercises that will help rehabilitate them. Specifically, we use the case of 7 children with cere-

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bral palsy on a a skiing video game, modified to incorporate rehabilitation movements to move the player's avatar.

Cerebral palsy is a term used to describe various posture and movement disorders seen in children who for various reasons developed a non-progressive lesion of the central nervous system [6]. The symptoms and disabilities of cerebral palsy vary greatly including motor and regularly cognitive disabilities with social implications later on when children have to go to school. Traditionally, intervention on such population targets the symptoms of motor impairments such as spasticity, decreased range of motion (due to muscular contractures), muscle weakness and decreased mobility, with a number of specialists being involved.

Currently, rehabilitation programs have begun to shift focus from minimizing deficits to enhancing functional participation/training, addressing in this way more aspects than solely motor dysfunction [7]. The implementation of exercises directly related to functions necessary for the child's everyday life, such as stair walking, has become a crucial aspect in clinical sessions, i.e. [8, 9]. In addition, experimental work in the field of motor learning and biomechanics [10] has led to models that pay attention to motor control, strength and aerobic capacity.

Treatment methods usually presuppose one to one contact between the physical therapist and the patient. Therapy can be a routine of practicing skills solely between the therapist and the patient, without much of parental involvement, in an enjoyable social activity indoors. Moreover, group therapy is not usually being conducted in this clinical population since the patients can be very diverse presenting attentional and cognitive deficits that resemble group work difficult. In either case the therapist at present can only provide individual treatment tailor made to the needs of each child at hand.

The current developments address the importance of child's participation in the therapy and function within a social environment via meaningful activities. The child's motivation and satisfaction is an issue gradually placed into focus, since motivation is an important factor for the success of the therapy [11]. Recent models identify the patient as an active participant in his/her own therapy, and the role of the physical therapist is to "coach" this process. The provision of children with some control over the therapeutic exercises, with variation in the sessions is desirable also for the fact that secondary improvements can be seen, such as a boost in problem-solving abilities and self-esteem [12]. Therefore, treatment methods should place the child as an active participant in his/her treatment and this presupposes high motivation and satisfaction levels.

Participation of the family in the treatment after a certain age when the child becomes part of the school environment is crucial. For the 5-12 years old children with normal cognitive level as well as for puberty, therapy will go on improving motor skills necessary for an adaptation to the school environment including ability to keep up with physical/social activities (participation in sports). It is at this point that exercise has to shift slowly from the physical therapy room to promote participation in the social environment via meaningful activities.

Thus, the motivation behind our research is to use activities that allow for social and physical interaction in a fun way that will motivate the child towards taking an

active role in his/her treatment, all the while being entertained and motivated to do so. As video games have also been tied to other positive effects on children [13] we believe that in the long term video games for rehabilitation will enable a host of positive changes in the children that use them.

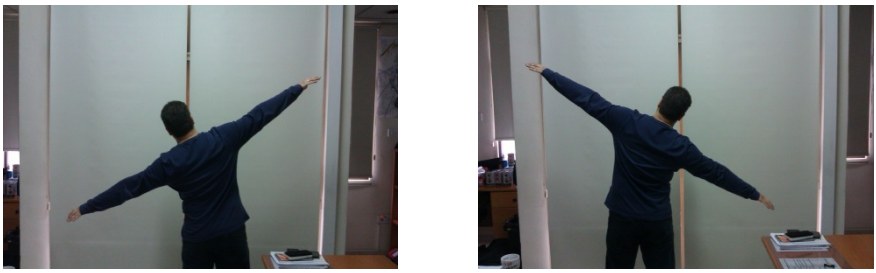
2 Video Game Design

The video game developed is a simple forward scrolling game, that requires the player to move a penguin left or right to go through pairs of flags and reach the end of the course without crashing. Time is limited, thus the children were required to finish the course before the time ran out. Figure 1 displays a screenshot from the game.

Fig. 1. A screenshot from the game used during the experiment

Our focus was on the way the player would interact with the game, because the interaction would provide the "hidden" rehabilitation abilities of the game. We considered three major platforms that are widely available to recognize player movement: Nintendo Wii, Playstation Move, and XBOX Kinect. We chose Kinect, because Kinect does not require the player to hold a controller. Rather, it recognizes the movements of the player through machine vision. A second reason that led us to choose Kinect over the other technologies was the ease with which we could find tools that support the modification of games so that they can work with the platform. The key to the video game was that it would be a normal game not designed for

players with disabilities. As already mentioned, cerebral palsy was preselected as the syndrome that would be targeted by this pilot game. The video game interactions were thus designed by collaborating with physical therapists that specialize in neurological rehabilitation of children as well as adults, who selected specific movements that the players need to perform to interact with the game. For the pilot phase of the game, which included the completion of the first level, two movements were selected for player interaction. Figures 2 and 3 show the movements that move the avatar left and right in the game world.



(a) (b)

Fig. 2. Movements for going left (a), and going right (b)

Here is another place where selecting Kinect was beneficial. Because the game will be used to rehabilitate as well as entertain, the movements needed to be performed as close as possible to an ideal standard. Because the Kinect SDK provides us with immediate access to a virtual skeleton of the player, we were able to fine tune motions so that the avatar of the player would not react, unless the movement performed was within an acceptable threshold of the expected motion. Hence, we expected that playing the game would provide real help towards rehabilitating its players.

3 Method and Results

The design was a pilot study with a pre – post test design. The participants were 7 children age 5 – 12 years old. The children were classified as GMFCS (5 of them) level I and (2 of them) level III. They were asked to play specific video games by first earning and then using the aforementioned movements. We used the game described in section 2. The children were standing (except the two children – level III sitting) and moving into flexion, extension, lateral bending, and flexion, extension for the 1st game and rotation instead of the side bending of the torso for the 2nd game with open arms. The children were trying to maintain balance and coordination to achieve the collection of the objectives in the game as fast as they could. The experiment ran for 6 weeks and for 2 times per week, and during a given week the children were asked to perform their normal rehabilitation program, and to also attend meetings during which they played the selected games. Physiotherapists used the Pediatric

Balance Scale to assess clinical their balance and postural control in 14 dynamic and static tasks before and after the experiment. We collected the average score (time and collection of objectives in the game) of their 12 sessions to see also the ability of coordination and balance. We interviewed parents and children for the participation in the game

According to the Pediatric Balance Scale (Maximum Score 56) we can see an improvement on balance and postural control after assessing the children at the end of the experiment in all the 7 participants. Also as we saw that the children from session to session were becoming better on their time finishing the game.

4 Future Work and Conclusions

In this article we have discussed our effort to build a rehabilitation game for children with cerebral palsy. We briefly explained how we designed the game, but more importantly we discussed how the interaction between the player and the avatar uses movements that aim towards rehabilitating the player.

Our very preliminary results are promising towards providing motivation to the player to perform those movements that allow for the player's rehabilitation, as was evident by the play session of one child, and the subsequent discussion with the child and its parent. We plan to continue pursuing this avenue, by testing the game with more children with cerebral palsy, and formally measuring their motivation through the Pediatric Volitional Questionnaire [15].

After the pilot testing, we plan a longitudinal study with a group of children with cerebral palsy using our game together with their physical therapy sessions, and a group of children that will not use our game. We expect that the group of children that uses our game will display more improvement after a period of months than the other group.

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