Use of Serious Games for Motivational Balance Rehabilitation of Cerebral Palsy Patients

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ABSTRACT

Research studies show that serious games help to motivate users in rehabilitation and therapy is better when users are motivated. In this work we experiment with serious games for cerebral palsy patients, who rarely show capacity increases with therapy which causes them demotivation. For this reason, we have implemented balance rehabilitation video games for this group of patients. The video games were developed using the prototype development paradigm, respecting the requirements indicated by physiotherapists and including desirable features for rehabilitation serious games presented in the literature. A set of patients who abandoned therapy last year due to loss of motivation, has tested the video game for a period of 6 months. Whilst using the video game no patients have abandoned therapy, showing the appropriateness of games for this kind of patients.

Categories and Subject Descriptors

K.4.2 **[Computers and Society]** – *Assistive technologies for persons with disabilities*

General Terms: Design, Experimentation, Human Factors.

Keywords: Serious games, Video games, Rehabilitation, Vision-based interfaces.

1. INTRODUCTION

Each year a part of patients working with ASPACE (www.aspaceib.org), a cerebral palsy association, abandon their therapy due to loss of motivation. Cerebral palsy is a term used to describe a group of chronic conditions affecting body movement and muscle coordination. The main objective of cerebral palsy rehabilitation therapy is to maintain the patients' capacities. The progressive loss of capacities fuels the patients' loss of motivation as time passes.

Research studies show that rehabilitation results are better when patients are motivated [2] and serious games help to motivate users in rehabilitation processes [3]. A serious game is defined as a video game that allows the player-user to achieve a specific purpose through the entertainment and engagement component provided by the experience of the game. The cognitive and motor activity required by video games engage the user's attention. In addition, users focus their attention on the game and this helps them in forgetting that they are in therapy.

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In this project we transferred the ASPACE balance therapy tasks to a video game, in order to experiment if serious games are valid for motivational rehabilitation of cerebral palsy patients. The video game was implemented using the prototype development paradigm, respecting requirements indicated by physiotherapists and following the desirable features for rehabilitation serious games [1]:

- *meaningful play,* the relationship between player's interactions and system reaction.
- *challenge*, maintaining an optimum difficulty is important in order to engage the player.

2. VIDEO GAME DESIGN FOR BALANCE REHABILITATION

We implemented a video game that consists in changing the users' gravity center: trying to cause a specific body movement in order to change their gravity center. To do this, users must interact with objects that cannot be reached without changing their center of mass. This way, users focus their attention on the video game instead of their posture. The goal is not to improve the rehabilitation process itself, but rather to transfer the ASPACE balance therapy tasks to a video game in order to improve the users' motivation.

Recent technological advances have created the possibility to enhance naturally and significantly the interface perception by means of visual inputs [4], the so-called Vision-Based Interfaces (VBI). This is a good interaction method because the majority of patients ASPACE works with, cannot hold a device.

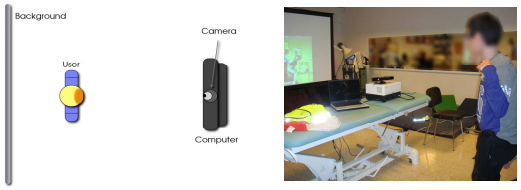

Fig. 1. Interaction space

To achieve the goal, users must delete a set of items that appear on the screen using their hand, before losing their balance. For this reason, users are located inside an interaction space that consists of a projection screen and is instrumented with a low-cost webcam (see Figure 1). The interaction is produced through skin color segmentation [4]. This configuration allows users to view

the video game whilst performing the interaction tasks. The interface requirements are:

- only one user shall be present in the space.
- the skin colored body parts, other than the hands and face, shall not be visible.

Following specialists' requirements and in order to make rehabilitation sessions adaptable to the characteristics of the different users, we defined configuration parameters to customize games and adapt them to different user profiles:

- **Delete pattern:** Specialists can create images that define the objects that users have to interact with.
- **Maximum playing time:** Specialist can set a time limit for each session depending of the users characteristics.
- **Contact time:** Specialists can customize how long users must be in contact with an element in order to delete that object.

We developed the game for 6 months, using the prototype development paradigm. During this period, in order to improve the game we tested the system with real users once a week. As a result all the information necessary to perform the different tasks was provided in an understandable way. The user is always aware that interaction has been carried out as the interaction object disappears from the screen and audio feedback is played. Moreover, at the end of the game, the user receives different types of visual and audio feedback, depending on the end game conditions. The system stores information about user interaction during each session, in order to simplify the specialists' work with regards to the patients' evolution. The games are adaptable to the users' skill, as the specialist can place the interaction objects in any region of the screen.

Figure 2 depicts the final game design. This design has the potential to be used in other rehabilitation systems. It is important to remark that there are two types of users: the user and the specialist, with different interaction objectives with the system.

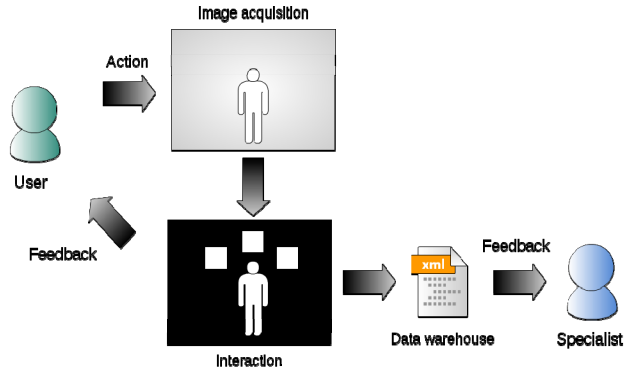

Fig. 2. Serious games design overview.

3. EXPERIMENT

Once the video game was developed,we began to test the serious game with a set of patients with cerebral palsy, for 6 months. Before the experiment each patient was evaluated using physiotherapist tests. At the end of the experiment the same tests were performed, in order to assess the patients' evolution.

The users set was composed of 4 adults with cerebral palsy who, in the last years, had abandoned their rehabilitation plan. Their families signed the informed consent. All were habitual users of the rehabilitation service offered by ASPACE. They were aware that rehabilitation sessions were focused at maintaining capacities rather than improving them and they had lost motivation due to their difficult situation and the repetitive nature of the exercises performed each session.

Table 1 shows a summary of patients' evaluation before and after the experiment.

Table 1. Summary of results

User	Pre-evaluation	Post-evaluation
1	Safety and autonomy for balance is regular, close to low limit.	Able to complete the games. Increase resistance of the biped position.
2	Body posture improper. Lower resistance in bipedal posture. Without security or autonomy for balance.	Able to complete the game. Increase resistance of the biped position.
3	High anxiety. Without security or autonomy for balance.	Increased level of confidence. Decreased anxiety.
4	Difficulty in spatial orientation. Without security or autonomy for balance.	Improvement in spatial orientation. Improvement in balance.

4. CONCLUSIONS

In this work, we experiment if serious games for rehabilitation can be used for motivational balance rehabilitation in cerebral palsy patients. The presented video games try to promote a specific body movement in order to change the users' gravity center.

Results show that users improved their balance slowly; improvements were also detected in individual items. With regards to motivation, in previous years the set of users had abandoned their therapeutic plans. Using the presented video games, no users have abandoned and they showed interested in continuing the rehabilitation process with the video games.

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