Designing therapeutic games as casual games for all

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Abstract
A large set of pathologies can make it impossible for several users to use an OS (Operating System) or a software. In fact, most User Interface (UI) are developed around WIMP (Windows Icon Menu Pointer) interfaces while Post-WIMP interfaces are not yet widely used. While consoles designers have started to include this paradigm in their products and have a long history on ergonomic studies, most of these approaches are not exploited to give the opportunity to disabled people to use a computer or a game console. In this paper, we present the first step towards a multimodal interaction approach for designing therapeutic games. This approach is conceived to work in conjunction with a *game for all* design. This means that not only the game has to be usable by regular user and disabled people but also that the conceived game has to be fun for both targets. In this paper we present a first set of interview we conducted with four therapists. These interviews allowed us to present a first solution to use several devices in order to deal with different pathologies (i.e. a multimodal approach) that we applied to a cross platform game.

Author Keywords
Games for health, gamepad, tablet, therapeutic

ACM Classification Keywords

H.5.2 [Information interfaces and presentation]: Input devices and strategies (e.g., gamepad, touchscreen).

Introduction

A large set of pathologies can make it impossible for several users to use an OS (Operating System) or a software. In fact, most User Interface (UI) are developed around WIMP (Windows Icon Menu Pointer) interfaces, while Post-WIMP [10] interfaces are not yet widely used. While it's true that modern OSs start to focus on this paradigm, consoles designers have included this paradigm earlier than computer industry. Unfortunately these approaches are barely exploited for accessibility to disabled people.

In this paper, we present the first step to a multimodal interaction approach for designing therapeutic games. The game has to be fun for disabled people but also for regular user. We present a first set of interview we conducted with 4 therapists. These interviews allowed us to present a first solution to use several devices to deal with different pathologies. This methodology is applied to the design of a game named *Hammer and Planks* we developped. The game is quickly presented in the paper to explain how the design and the multimodal approach intersect to create a game for all.

This paper is decomposed in severals sections, Section 2 is dedicated to existing works for disabled people. Section 3 presents the conceived game. In Section 4 we present the first step towards a multimodal approach to create therapeutic games for all. The last Section concludes and presents future works.

Related works

Vision

Visual representation is an important part of computer experience and a great part of feedbacks are based on this feature. Thus a great number of researches have focused in the past on vision pathologies to make computers accessible to the whole population. Industry has also shown a growing interest for this kind of pathology. In this section we focus in particular on blind, color blind and accuracy issues because solutions for these pathologies are well studied in literature. For example, visual accuracy is enhanced through the use of a magnifying glass centered on the mouse cursor, this approach is described in [5]. For blind people, solutions like screen readers were proposed in [2]. These solutions are based on voice systems which are able to read out loud the information on screen. Other specific devices have also been developed around tactile interaction allowing the user to read the screen with his fingers [9]. Other approaches have emerged with the growing interest in games developed for tablets. *Les editions volumiques* [1] has developed a video game based on the usage of a paper house and a tablet called Ghost Family. It is a sound based game in which the player has to catch ghosts, hence blind people are able to play it and particularly enjoy it. For color blind people some operating systems or softwares include parameters to enhance contrast in the user interface. For example the game *Battlefield 3* proposes an option to switch between color presets in order to improve contrast between team members and enemies color.

Motor Skills

Other pathologies such as upper limbs impairment are widely studied in the computer field. A large part of computer interactions are based on finger, hand or arm motion. We use fingers to tap on a keyboard, the hand to move the mouse and the arm to interact with motion games. A large panel of solutions have been proposed based on user nose tracking in order to interact with computers [11, 12]. The goal of these methods is to track the user nose using a camera device to map nose movements to the mouse pointer. Other approaches are based on eye tracking: user eyes can be tracked to manipulate the mouse pointer of the computer [4]. Industry has also proposed several techniques to give users the ability to interact with computers. For example on **Apple**'s **OSX**, voice recognition has been added to the system. **Nuance**'s **Dragon NaturallySpeaking**, a speech recognition software, provides also input on OSs to help disabled users. These interactive solutions start to be deployed also on mobile phones. On the other hand, movement has been a new way of interaction in video games. We can find this kind of interaction in several papers, mostly concerning serious game topic, for example in [8]. Games industry has also showed its interest in this topic. Current generation consoles have interaction devices based on movement: **Nintendo**'s **Wiimote**, **Sony**'s **PlayStation Move** or **Microsoft**'s **Kinect**.

Finally, for partialy or fully disabled people, interactions with a computer remain very complex. Some systems have been developed to use brain computer interfaces (BCI). These devices are plugged on user head and use blood pressure or electrical signal of the brain. The computer is able to map any signal to a computer interaction. More recently, this method has been adapted to a tetraplegic patient giving him the ability to use two robotic arms [3]. While BCI will be an important part of computer interaction in the future, this technology still needs important surgery in order to be accurate and is very expensive.

A game for all: Hammer & Planks

The idea of the game described in the rest of this paper was born from the interaction with an institute of occupational therapy in France. Following a discussion on the current usage of the **Wii** game console in therapeutic rehabilitation and the inability to adapt games to therapeutic goals, the idea arose to create a game dedicated to rehabilitation. The conception of the game was focused on equilibrium training for people with balance disorders (specifically the case of hemiplegic people). A gameplay making the player to move from right to left, and from front to back was required in order to achieve the therapeutic goal.

The game was chosen as rehabilitation method firstly because a task-centered rehabilitation is more effective than asking a person to do different kinds of movements without specific goals (see e.g. [7, 6]).

A main drawback of classic therapeutic games design is the lack of intention to appeal healthy gamers, hindering the possibility of social rehabilitation. Often this happens because the gameplay is not enough taken into account, while development efforts are only focused on the educational or training message (the so-called seriousness of the game).

The second drawback is the high specificity of each movement based rehabilitation game. Most rehabilitation games are designed around a specific pathology. Then problems arise. What if the game needs to be used in another context ? For example can a game for post stroke rehabilitation be reused in the setting of back pain rehabilitation ? The problem is deeper than it appears if we look at it from the research point of view. While it's true that a game conceived for cognitive rehabilitation may not be adapted for motor rehabilitation, why motor rehabilitation games don't share similar types of interactions as motor laws in human being are generic ?

In our opinion, this problem affects both game design and interaction levels.

Our goal for this project was then to propose a serious game for the rehabilitation of hemiplegic people which could be used also by the general public with only little or no modification.

Game Dynamics
Our first step was to avoid the main drawback of a gameplay not appealing to healthy gamers. We worked hard on the game design which at the end consisted of about twenty documents detailing the character design, the level design, and so on.

Hammer and Planks (the final game) is a vertical shooter. It consists of a 2D environment scrolling from top to bottom in which the player controls a boat that can move from left to right and top to bottom, and use its cannon to shoot enemies. The goal is to defeat all enemies without being destroyed by bullets, reefs or other obstacles. In this way the player will pass through a serie of levels and use what he found to improve his boat.

This kind of game is suitable for rehabilitation purposes. Indeed the simplicity of the gameplay allow players to get feedbacks on their performance in the form of in game score, which is mesured primarily with criteria such as the number of enemies sunk. On a therapeutic point of view, the gameplay adapts itself in order to cope with specific therapeutic goals. For example, if the purpose of the rehabilitation is the training of left limbs, the game will generate more enemies to catch on the left side and more obstacles to avoid on the right side. The idea behind the boat improvement is linked to the patient's rehabilitation: as a player he rebuilds his boat in the game, as a patient he rebuilds his movement ability.

Customization without Discrimination: a Multimodal Approach

In the initial therapeutic version, the patient was considered as a different player from the healthy one. First of all his boat couldn't sink. Additionally, there were some functionalities that could be disabled, changing in this way the gameplay. While this approach works well in a controlled setting with someone who explicitly states that the person playing is a patient (which in literature can go under the label of *adapting difficulty under therapist control*), it will not work with a wide dissemination of the application in a non controlled setting. Using the classical approach we would have fallen into the assumption - not necessarily negative but not useful in our setting - that each disease may actually require a different gameplay. Rather than asking the patient which kind of disease he has, which not only would have implied to have planned every cases of pathology but also would have presented possible problems of discrimination in a social setting, we preferred to propose the same gameplay with adaptable ways of interaction.

The experts' analysis
In order to choose a useful set of devices for the game, we asked 4 experts (a functional rehabilitation professor, an occupational therapist, a physiotherapist, and a physicist) to test several devices historically or currently used to play games. The test lasted between 3-4 hours for each expert and included the test of 7 devices, ranging from the old **Nintendo**'s **SuperNES** controller to current generation **Kinect** and **Wiimote**. For each device, we conducted a semi-structured interview asking: if experts already knew

the device; if the device could be considered usable in a therapeutic context. We then let them use the device with a game and re-asked the last question to see if using the device lead to the discovery of new possibilities of usage.

For example the **SuperNES** controller requires a lot of coordination skills and dexterity, it cannot be used with all patients. The **Sony**'s **PlayStation 3** controller opened ideas for a mirrored use of right and left hands - for example in the case of a stroke patient - but also for coordinated hands usage. The **Wiimote** was interesting because it is possible to use both classical buttons and accelerometers, allowing to work with limb inclination with patients. The **Kinect** has a main advantage: the possibility to play without any device attached to the body, opening the possibility to attach weights to limbs to train limb power. Usage of tablets was considered interesting in particular for hemiplegic and paraplegic people.

Discussion

The primary objective for us with those experts' interviews was to collect up ideas on the usage of different game devices for rehabilitation purposes. However during the session they also tend to comment directly on the general interests of games for health. Their comments were very interesting because they brought their personal experience inside the interview twice: first of all as rehabilitation experts and then as human beings. For example one of them stated "I am an athlete and I love to monitor my sports performances. And I think that video games are a great way to monitor the activity of a patient." And another expert: "I personally don't like games but I think they can be useful for rehabilitation purposes as I know that we do not rehabilitate two people in the same way. Therefore video games should be part of the rehabilitation arsenal." Their personal experience was mirrored also in their device preference. An expert used to bi-manual rehabilitation found more interest in devices allowing this kind of therapy. An another one considered the usage of the **Nunchuck** (**Wiimote**'s left hand controller) too complicated as it was complicated for him. This kind of comments underlines the importance to collect experts coming from different rehabilitation fields. This allows a wider overview on the subject. The last interesting aspect was their capability to underline when a device could be used in a therapy and not only for which kind of pathology. All experts strongly underlined the possibility to use different devices in an additive approach: i.e. start rehabilitation with a first device then add other ones after the patient has shown significant progress.

Conclusions and future works

The analysis we conducted allowed us to understand which device was best suited for each usage in combination with the game described in Section 3. We then tested this approach during a game event which allowed us to get feedback from both healthy and unhealthy players at the same time. The results of this experiment are currently submitted to the FDG 2013 conference and attest on the good direction of our approach. For this reason we are planning to continue to work in parallel in both directions: a game for all design strategy, and a multimodal approach.

Until now during our tests, we used only classic devices (**Wiiboard**, an **iPad** and a **XBox** controller). For a second analysis we plan to (i) enlarge the analysis of controllers from the history of video games, (ii) use joysticks and steering wheels with force feedback, (iii) analyze interaction devices such as eye tracking and sensory helmets.

We are also planning to design dedicated devices from the data collected during the interviews. Finally, we are collecting a panel of disabled persons to do usability tests on the same kind of devices in order to compare experts' opinions and players' acceptance.

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