Towards an Interactive Leisure Activity for People with PIMD

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Abstract. We address the possibilities of truly interactive systems for people with Profound Intellectual and Multiple Disabilities (PIMD). These are intended to improve alertness, movement and mood. We are working on an interactive ball that follows body movement and an interactive floor mat for this target group. We explain the key features in the design that are essential for the possible success.

Keywords: Snoezelen, Interactive Therapy, Profound Intellectual and Multiple Disabilities, PIMD, Interactive Ball, Interactive Floor Mat.

1 Introduction

Interactive Entertainment is meant to be fun and might be beneficial for people with profound mental and intellectual disabilities (PIMD) as well. Such systems can increase alertness, mood and body movement for people with PIMD, three goals often targeted by care staff. People with PIMD are a heterogeneous group that generally have an intellectual developmental age of 24 months or less, have multiple mutually reinforcing disabilities and are dependent on others for their every-day activities [7], [9], [10]. There is a fairly limited amount of activities and especially interactive entertainment for people with PIMD [2], [13]. Therefore, many people with PIMD are likely to have too small an amount of non-sedentary activities and have to do with passive activities such as watching television and lying on a waterbed [15]. Creating interactive entertainment for people with PIMD may help to create alternatives, but the design process is hard for several reasons. One has to take into account a wide range of peculiarities, disabilities and abilities. Also the process to obtain ethical approval for experiments is an extensive procedure. The evaluation phase is complicated due to the inability to verbally interact with the participants. Instead people with PIMD mainly

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communicate through body movements [14]. Affective measurements, such as indicators of happiness or agitation, are therefore often based on behavior interpreted from video recordings and on interviews with care staff [2,3].

This user group is especially vulnerable with regard to living a meaningful life [2], [7]. At the same time it is recognized that entertainment might contribute to self-efficacy, self-esteem, autonomy and creative explorations even for people with special needs [1,2], [12]. Recent developments in technology show an array of ways to facilitate the creation of interactive systems [8]. Especially technologies such as depth cameras that can detect body posture and gross body motion (e.g. Kinect) and pressure sensors for the Arduino that are easy to implement can be useful in tapping into the limited non-verbal movement skills of people with PIMD.

Based on the interpretation of non-verbal movements more truly interactive systems can be created. This goes beyond merely turning a product on or off – it should include a developing dialog of actions and responses [2]. Such systems provide an expressive experience that is capable of captivating people in the target group [2]. We think such systems help in heightening their alertness and triggering them to move more and will result in positive effects on their mood.

In this paper we follow up with related work on electronically powered systems stimulating people with PIMD. We then describe our preliminary work, including the rationale behind two concepts we are currently developing. We finish this paper by summarizing our view and the next steps in our research.

2 Related Work

One of the few leisure activities offered to people with PIMD is *snoezelen* which takes place in a multi-sensory environment. It is intended to stimulate alertness of the people with specific needs [11], [13]. It contains, for instance, bubble tubes, aroma dispersers, projector wheels and tactile boards [4]. However, there is a lack in evidence that these environments are indeed effective. Individual differences could play a role herein, some people with PIMD might get more alert in these instrumented environments and others are more alert in their natural environments [13]. Munde et al. suggest that waves of alertness occur for this target group and that making use of these moments of alertness could help their learning abilities and overall development [9].

Several hundreds of products are available for people with special needs. Only a limited amount is suitable for people with PIMD, offering only limited interactivity (cf. [2])[1]. From these, Snoezelen® Soundbeam, an interactive music system based on movements, was one of the very few systems that we call interactive (more than a trigger button) and that seems suitable for many people

[1] Catalogs were selected based on Google searches with a combination of keywords including *interactive, toys and snoezelen*, *PIMD* or *special needs* and several catalogs suggested by therapists [4]: achievement-products.com, barryemons.nl, dragonflytoys.com, enablingdevices.com, fisher-price.com, flaghouse.com, mikeayres-design.co.uk/, snoezeleninfo.com, spacekraft.co.uk and wilkinsinternational.com.au

with PIMD as it responds to gross motor movements and produces visual and audible stimuli. Another interesting system that also targets several modalities, is the Therapeutic Motion Simulation (TMS) developed by vita-care[2]. It originates from hippotherapy but tries to provide a safer, easier, less costly way to provide a horse riding like experience, including the movement,vibration,visuals and sounds.

Between 1988 and 1995 Kitt Engineering developed the Motion Interpreted Media Interface Control (MIMIC). The MIMIC suite, provided an interactive experience with sounds, visuals and MIDI effects based on a video stream. After seeing some children with autism behaving very expressive in such an installation they were involved in a three month pilot using their system for people with special needs at the health care organization Eemeroord (currently Sherpa). The touch of an object and movements from arms and other body parts could be linked to playing sounds. For some people with special needs it stimulated movements that were not performed before.[3]

Finally, a series of interactive prototypes were developed by Lund University, including a flexible physical canvas that could be pushed for visual and auditory responses, a cuddleable toy/robot that moved and produced sounds based on the cuddling intensity, and an interactive waterbed. In evaluations, the children would take initiative for interaction and enjoy these kind of interactions [2], [5,6]. The interactive waterbed reacts to the movements of a child lying on it, see Figure 1. Based on these movements it provides an interactive *'wavescape'* consisting of sounds accompanied with subsonic vibrations. This provides a continuous non-obtrusive experience that can be tailored to the arousal of the children *[H. S. Larsen, personal communication, March 31, 2014]*. [4].

This latter research is, at least to our knowledge, the only scientific research in which *'truly interactive systems'* for people with PIMD were created. Based on the related work we conclude that people with PIMD are offered a limited amount of active leisure activities. The products that do exist have a limited interactivity. Some people do become alert in Snoezel environments, but it seems to be highly dependent on the actual person and tailored interactivity might add to the experience for more types of users. In an attempt to improve this situation by creating interactive systems, we have to address several aspects of people with PIMD in our design.

3 Our Approach and Ideas

Many people with PIMD, are showing large amounts of self-regulatory behavior, such as the stereotypical rocking, staring at fingers while moving them and making non-verbalized noises [4]. These actions can be a starting point to initiate interaction as they are likely to occur anyway. Visual impairments make

[2] `www.vita-care.eu`

[3] The original Dutch coverage of the system for Eemeroord by newspapers can be found on `http://www.kitt.nl/Previous_Work_MIMIC.pdf`

[4] Movies and more information can be found on `http://sid.desiign.org/`

Fig. 1. The interactive waterbed, figure used with permission from the author

it hard to distinguish colors or detailed shapes, although several persons with PIMD are capable of seeing contours and objects with high contrast. Therefore, moving physical objects seem more suitable than projected images and screens.

We applied this in our first interactive concept: an interactive ball. The ball will respond to the upper body movement (e.g., the stereotypical rocking behavior) and to the head orientation of the user. The ball will be lying in front of the user. When the user is not focused on the ball, it will gently try to regain focus by playing some sounds, a wiggling movement, and LEDs changing color. When it is in focus it tries to persuade the user to move. This is done by letting the ball move according to the upper body movement of the user, and playing sounds to indicate responsiveness. The ball itself is powered from the inside, comparable to an RF car [5].

Our second concept is not yet in development. It is based on the rocking motion observed with users lying on a bed-like mat on the floor. Using pressure sensor technology in the interactive mat we can easily recognize the rocking movement. In response, the intensity and rhythm of music can be changed based on the recognized movements, rhythm of movements, and non-verbalized noises. To tailor this system for users that need more intense stimuli, this can be combined by adjusting the color and brightness in the environment.

4 Technical Implementation for an Interactive Ball

The ball we are working on moves by changing the center of gravity with three servo motors connected to weighted arms, see Figure 2. The system is powered with 10 AAA batteries. A 50 cm big pre-fabricated water-resistant expanded polystyrene ball is used for the outside. Inside there is a circular laser-cutted

[5] The basics of the concept are also explained in a movie that can be found on `http://hmi.ewi.utwente.nl/interactive-ball-save15years-2014.mp4`.

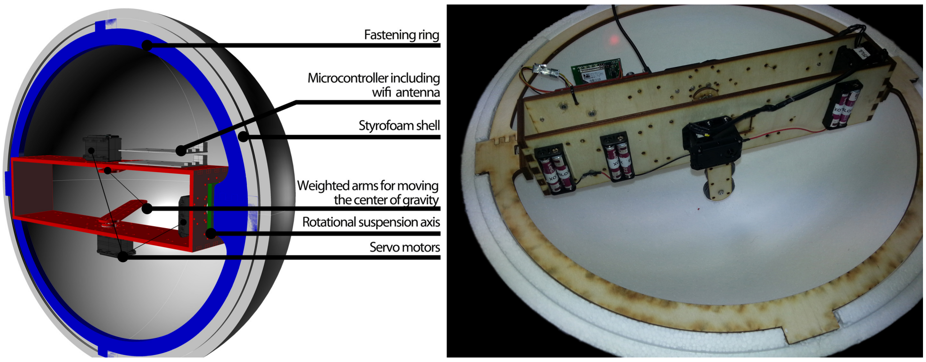

Fig. 2. A 3D-model and prototype of the interior of the ball

plywood frame holding a revolving frame containing the electronic components. In this way it should be able to move on its own in two dimensions. In our current implementation, we chose to restrict the ball to a one-dimensional left/right movement.

For tracking the head position the head joint of the upper body tracking is used of the Windows Kinect SDK 1.8. The recognition of focus towards the ball, is done with the Microsoft Face Tracking Software Development Kit for Kinect for Windows[6]. Currently we only move the ball when the face is properly detected but the upper body tracking has a higher recognition rate than the facial feature recognition and this allows for testing alternative interactions. The position of the ball is recognized with a straightforward background subtraction tracking algorithm based on a webcam feed. Based on the difference between the head position and the ball's position the ball stops, or is moved either to the left or right. In order to transmit these movements to the ball, the ball contains a local wifi hotspot and TCP/IP server. The intensity of the interaction, the intervals of grabbing attention with sounds and the type of sounds can be manually adapted to the user (during run time), in order to improve the effect of the interaction and possibly allow for a larger set of users.

5 The Next Step

Although we have been working on this topic for some time we still realize it is hard to truly understand the user group. In the coming months we are starting the first user tests, first verifying some of the technological parts on healthy people, followed by gathering feedback from therapists and responses of users in a set of pilot tests. In these pilot tests we propose to use 'within session' tests to see what settings of the ball will be optimal for the users. The alternating changes within a condition involve changing sounds and having responsive lights. They

[6] `http://msdn.microsoft.com/en-us/library/jj130970.aspx`

are convenient to overcome the mood swings of users, day-by-day variations, and large differences between users.

Subsequent exploratory long-term tests are planned to measure that an interactive system can indeed add something with respect to the dimensions of alertness, movement and mood, for people with PIMD. We will do this both with automatic measurements and more traditional measurements: interviews, observation and manual annotation. With these research activities we hope to motivate and inspire others as well to bring some extra entertainment to the lives of people with PIMD.

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