Participatory Design of Virtual Reality Applications for Children Under Medical Treatment

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Abstract
This paper describes experiences and challenges of a participatory design process for a medical Virtual Reality (VR) application for children. A current research project focuses on the development of a VR environment for the playful reduction of children's anxiety in MRI exams. We use this as a use-case for the discussion of participatory design methods for VR applications for children under medical treatment.

Author Keywords
virtual reality; participatory design; social presence;
ACM Classification Keywords

H.5.1. [Information Interfaces and Presentation (e.g. HCI)]: Multimedia Information Systems: Artificial, augmented, and virtual realities; K.8.0. [Personal Computing]: General: Games.

Introduction
Nowadays, Virtual Reality (VR) technology is on the rise. Numerous innovative experiences are created and developers are experimenting with many forms of interaction and game design. Though VR has reached the mass market, there is only little knowledge about VR experiences for children. How children can best

Figure 1: The View-Master (Mattel) is the only HMD designed for children. It is compatible with Google Cardboard VR platform. This HMD has a solid hardware, but lacks IPD adjustment. It has to be held by users with at least one hand.

contribute to design VR activities is an open and active research question.

Virtual Reality Applications for Children

While the participatory design process can be challenging alone, especially with children, VR can add even more complications on top [1,2]. Current Head Mounted Displays (HMD) are tailored for adult users (except for the View-Master in Figure 1) resulting in hardware restraints like these:

- Head straps are too large for children leading too loose and uncomfortable fit
- HMD are too heavy for longer operation decreasing usage time for children
- Interpupillary distance cannot be adjusted properly for children's proportions

To briefly recap the current state of knowledge in terms of VR experience for children, we point out:

- Children seem to be not more or less sensitive towards cybersickness ([own observation], [7]) than adults
- They perceive presence in a deeper level compared to adults [3]
- Children have more difficulties in orientation and navigation tasks [4]

We speculate (and that is by no means yet grounded by sufficient evidence) that the design space of purposeful VR applications comprises many more invalid solutions compared to other software applications. So, co-design would be more restrictive and limited.

Participatory Design of Virtual Reality Applications with Children

A VR application is a "grand challenge" for participatory design. A HMD is classified as fully immersive display and thus excludes nearly every visual and acoustic perception of the user from reality. It covers much of the users face and immerses her or him deeply in a virtual environment. This renders many of the usual research methods futile: Facial expressions are hard to record, gesture often is occupied by input devices, think-aloud-protocols are hampered due to immersion, eye-tracking is not available etc.

For many children, VR is an overwhelming experience (in a positive sense). This enthusiastic experience, however, can influence the player experience towards an overly positive bias. While adult users in our studies ingeniously asked about isolated shortcomings or setup errors, children accepted every VR impression "as-is" and almost never complaint.

While paper prototypes can be very helpful in 2D interaction design, this method has its limits for 3D interaction. Here, often an early 3D prototype is required and children can only co-design content and story. This can limit the perception of self-efficacy in the design process. VR interaction design is comparable to playtesting in game design, where we encounter many brief feedback cycles with a limited number of users and qualitative questionnaires. It seems that VR applications due to their complex nature in respect of 3D interaction are less suited to open methods like Cooperative Inquiry or TRAck. Questions related to player experience are often of an abstract nature and refer to a past experience, which both can be difficult for children.

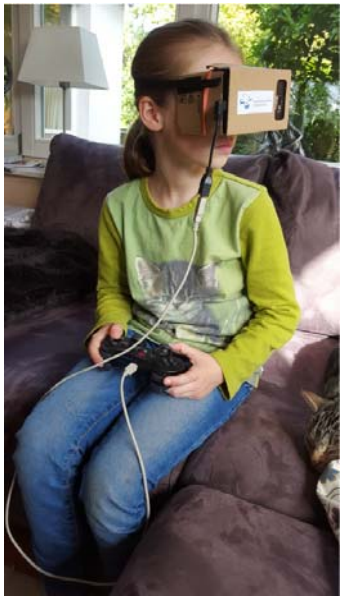

Figure 2: Playtesting a VR experience with (wired) game controller in a first explorative usability test on a modified google cardboard. The card-board is currently the lightest VR solution. Both hands are required for interaction.

Current Research

In a current research project, we are developing a VR system for reducing stress and anxiety of children undergoing an MRI scan. Equipped with an MRI compatible HMD, young patients shall be able to experience an immersive game in order to avoid sedation. VR seems a promising replacement for medical sedation with far less adverse effects [5].
The VR applications will consist of two components:
(1) In the preparation phase, we use elements of play-therapy. The patients will receive information about MRI exams and can experience a virtual MRI using a first-person perspective (cf. Figure 3). Users can also train to lie motionless for a better image quality.
(2) In the examination phase, the VR application will immerse the patient in a digital game for the time of the scan. Here, the VR application distracts from stress and anxiety of the situation.

We focus on two age groups: 5-8 and 9-12 years old patients, as these target groups might benefit most from the VR application. The development of the VR applications phase (1) and (2) pursues a typical participatory design approach with need identification, usage context analysis, requirements specification, prototyping and evaluation (cf. Figure 2). Several ideation and game design workshops with our target group have taken place and are still to come [6]. As we also have young workshop participants with an ongoing long term hospitalization, we also have child “experts” (cf. Figure 4) for many medical and treatment issues.

HCI Research in Medical Environments

During our cooperation with medical scientists, we experienced a large common ground in heuristic evaluation methodologies. However, clinical trials and HCI studies have certain differences and peculiarities. A clinical study aims primarily at ensuring scientific integrity and reproducibility of the results. In general, this is more a sequential process chain which naturally opposes an iterative design approach. Even harder to overcome is the traditional role allocation in medical treatment: doctors are “givers”, patients are “receivers” of knowledge. This seems also to be enforced by modern efficiency-oriented thinking.

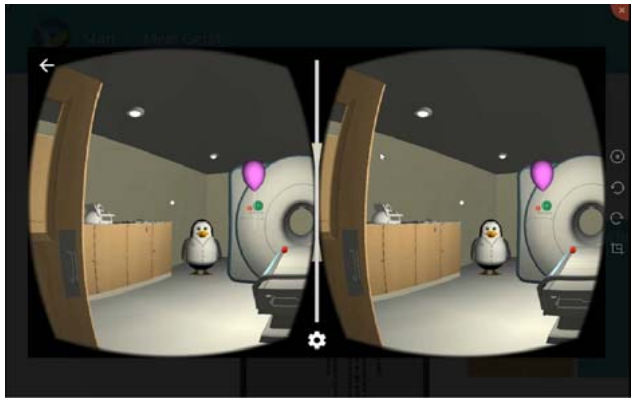

Figure 3: VR Training in first-person-view. Application developed with the aid of designers, media and e-learning experts, medical personal, doctors and young patients in a participatory design process.

This contradicts an interesting side-effect of a longer medical treatment, which is the growing expertise of the patient for the specific medical condition and its treatment. Here, even younger kids can acquire a considerable knowledge, making them “experts” for their disease or treatments. They become experts in their small field of expertise and are mostly eager to

Figure 4: Playtesting the preparation application in a hospital with long-term patients using the Mattel View-Master. Both hands are required, one for holding the device, one for interaction. The usage resembles looking through binoculars, they can easily be taken down.

share that knowledge with younger fellow patients or interested researchers. These young experts can be valuable design partners. Also, parents can be a valuable source of information as they spend long hours in medical facilities with their children.

To our experience a field study conducted by HCI researchers in daytime operation of a hospital can be extremely challenging. Even though these participatory activities offer enormous positive effects on long term hospitalized children. The benefits here can be twofold: The design process profits from the input of the children, whereas young patients experience self-efficacy and competence and often joy.

Conclusion

How to develop meaningful VR games for and with children has become an imperative research question. Undisputedly, these kinds of applications benefit from the co-design activity of its later users at all stages of the development. Children co-designing VR applications challenge some established HCI methods as some aspects need to be addressed by new techniques, perhaps inspired by game analytics, perhaps by completely new approaches. The upcoming HCI research agenda should investigate new fields to utilize the potential of VR applications for health in the future for the benefit of people.

In a medical environment, the design process requires an interdisciplinary collaboration of designers, HCI researchers, medical doctors and medical personal altogether with the involved children in focus. Despite many issues in a cooperation, HCI may find practical solutions for specific problems, what is very well received by committed medical personal, parents and children.

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