Playing Music with the Head

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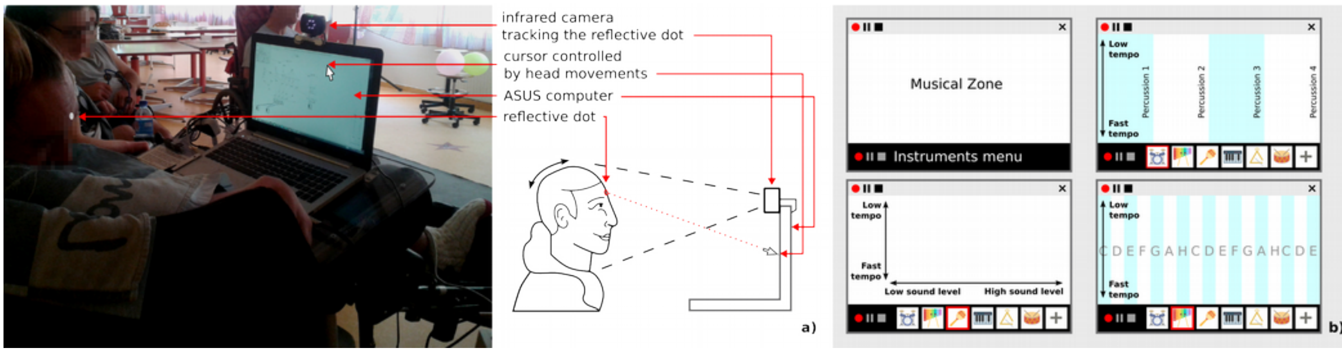

Figure 1: a) Hardware implementation. An infrared camera fixed on top of the computer tracks the reflections of a sticky disposable dot, fixed on the user's forehead. Head movements are interpreted as mouse movements. b) Software interactions. Top and bottom of the screen are used as menu. The musical zone allows for different interactions depending on the instrument. For example, a single percussion's tempo varies on the Y axis, while sound level varies on the X axis.

ABSTRACT

In this paper, we describe the co-design process leading to the implementation of an open source software enabling M., a person living severe motor, dexterity and speech impairments, to play music, either alone or with others. We first conducted participant observations in the nursing home she lives in. We then used regular iterations to facilitate communication and to enable her to participate to the design process. We outline how such design process can reinforce participation in different areas and contribute to the research on empowering adapted technologies.

Keywords

Computer Music, Pure Data, Infrared Tracking

1. INTRODUCTION

Ensuring the inclusion and equal participation of people living with an impairment is at the heart of current policies on disability. In France, where this project was conducted, a bill was passed in 2002 [8] to modernize the health care system. This bill strongly reinforced civil rights, and introduced the obligation for institutions providing support to write a personal project (with the objectives and associated means). Every year, it is assessed, discussed and renewed by the caregivers and the person living with impairment(s). According to the caregivers we interviewed in the nursing home where M. lives, this law changed the very way they do their work, as they had to accept that their residents should have more freedom, even if that meant that they could not be checking on at all time. It also means that the caregivers have since tried to introduce more diverse activities and to reinforce links with the local community. But this comes at a cost, and sometimes they may not find accessible products to achieve the goals expressed by their residents. To address these issues, they decided to engage in many different Do-It-Yourself projects and initiate collaborations with other non-profit organizations. One of this collaborator was the *e-fabrik* project (see efabrik.fr). Initially, it associates teenagers (called the apprentices), an educator (called the accomplice) and a person living with an impairment (called the associate) for the time of a project dedicated to improve an aspect of the associate's life, using local fablabs or workshops. They recently started to involve voluntary adults in their project as well. Such context exemplifies the potentialities of a Do-It-Yourself approach to assistive technologies advocated by Hurst and Tobias [3]. With this project, we investigate how the participation to such design process may reinforce participation in general.

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2. RELATED WORK

Interaction techniques for people with severe motor and dexterity impairments include tracking systems (either infrared or gaze-driven interfaces), simple joysticks, switches or buttons, tongue gestures on a physical device, speech input, and more recently brain computer interactions [4]. As for musical applications of these techniques, there are, to our knowledge, personal projects (e.g. [5]) or local projects providing either adapted traditional instruments, or programmable tools (e.g. drakemusic.org, reso-nance.org/malinette, orguesensoriel.com) that can be used with a variety of inputs or sensors. But these projects either are not sufficiently documented to be used in a different context, are not open source and thus cannot be easily modified for our specific case or come at a cost that may not be accessible to all. As for the design process, ensuring the participation of end-users has long been advocated in the HCI field [6] and was successfully implemented in similar cases, either to identify requirements, or to define low, medium or high level prototypes [7]. The use of iterative prototyping to enhance well-being and participation has also been proposed by [1]. As for the use of the Wizard of Oz technique (e.g. simulating the behavior of a system [3]), it is not, to our knowledge, commonly used in the design formalization process with people living with impairments, but it has provided useful insights in other cases when used for medium-fidelity prototypes.

3. DESIGN PROCESS

According to the process of the *e-fabrik* project, we were assigned by groups of three to local nursing homes. Residents had already worked on identifying a need with their caregivers, although this was redefined through iterations. The other two people from our group mainly worked on the technical implementation.

Difficulties. The main difficulty we encountered was communication. M. is speech impaired, and relies on facial expressions and head movements to convey her approval. She uses MindExpress, an augmentative and alternative communication software, she can control through head movements, using an infrared tracking system. But this system takes approximately 3 seconds per selected item. This is a time consuming process.

Context of use and first propositions. The main context of use of this application is a weekly drum class involving 10 residents of the nursing home. Before our arrival, M. already made use of a software converting mouse position in sound, used with her infrared tracking system (see Figure 1), but she could not fully control it by herself, as it necessitated to hold down the mouse key while playing. The music educator would do so, if not helping other participants. Furthermore, the possibilities of the software (number of sounds produced) were also quite limited. As it was not open source, it would have been difficult to modify it for M.'s purposes. During the first encounters and participation to the drum class, the music educator insisted on the necessity to design a *physical input device* that could take advantage of M.'s ability to slightly move her feet. Other solutions would have been tongue based input, or a button behind her head. But her occupational therapist vetoed both solutions for security reasons. However, she would look down whenever the music educator mentioned it.

Wizard of Oz as a mediating technique. To address this disagreement between stakeholders, we proposed and implemented a Wizard of Oz approach during a class. I would control the mouse according to M. movements, and to the three possibilities we had identified with her: 1) sound starts when M.'s foot moves and stops when her foot moves again; 2) sound is produced as long as M. foot is on the left; 3) sound varies depending X and Y axis parameter, and two non-musical zones at the top and bottom of the screen allows to stop playing. The software is thus entirely controlled through head movements. At the end of the experiment, we asked M. what she preferred. She agreed with the third proposition, moving her feet being exhausting, which settled the disagreement.

4. IMPLEMENTATION AND RESULTS

4.1 Interaction Principles

Following these observations, we started designing various interaction modalities: the rhythm, the level of sound and the type of drum need to be controlled on a two dimensional screen. There are a number of possibilities. The type of drums may depend on the X axis and the rhythm of the Y axis, but one could not have a rapid but low sound of drums. We thus used a trial and error approach and our own musical background to find satisfying compromises for M. The interactions chosen also depends on the type of sound generated (e.g. midi synthetizer, drums etc. See Figure 1). As stated by M.'s music educator and agreed upon by M.: “the objective is not to produce sound. It is to play music.” The interactions have to be evaluated further.

4.2 Technical implementation

The application was prototyped using Pure Data, a graphical programming environment for multimedia interactions. We then moved to a java application, using the jMusic library, as Pure Data could not be used to implement more complex GUI. All elements are open source and can be reused.

4.3 Impact on participation

The design process and the prototype enhanced participation in this aspect of her everyday life, but also had (sometimes unexpected) effects. During debriefing and evaluation sessions of the prototype, we would ask what other function she would like. M. proposed that “feminine” visual elements followed the cursor. It included singer Mylène Farmer, and various graphics she had collected. She also required other instruments or settings. She developed an active approach to the design of her tool, and asks for other accessible softwares (e.g. for browsing music). Thus, it confirms that a participant and iterative approach can be implemented in such context, but it requires quite some time for the development of a solution adapted to an individual only, even if the source code can be reused. Furthermore, if this DIY, volunteer and community based approach is suitable for the development of a new solution, the maintenance of the software is not yet ensured. It requires technical skills that may not always be available. On the impact of the software on her participation within the nursing home, we observed that she used our software to play in ways her music educator disagrees with (e.g. too loud, or with instrument he finds inelegant and would not have let her used before or to ironically punctuate his sentences). In other words, her participation and her use of the software allowed her to affirm her identity and her free will, including her freedom to disobey.

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