Augmented Accessibility: towards an Augmented Reality environment accessible to disabled users

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Abstract

This document explores the use of augmented reality techniques to improve the interaction mechanisms with computers employed by young children suffering from severe cognitive and mobility-related disabilities including autism or the cerebral palsy. The paper also describes early approaches in designing augmented reality applications to help children to improve the motion accuracy of the limbs in their therapeutic training sessions.

1. Introduction

The Educational Office of the Principality of Asturias, Spain, provides support for young disabled students through a network of specialized educational centers located in the cities of Oviedo and Gijon. The students in those centers suffer from different kind of cognitive and mobility-related severe disabilities such as autism or cerebral palsy.

The education of such kind of students represents a great challenge for their teachers in terms of interaction. Many of those students begin their educational process in those centers at the age of 2 years old or even less. The centers play a crucial role in the design of the educational strategies for these children. These strategies will allow them to learn how to control their limbs, how to recognize objects or people, how to communicate their ideas, etc.

The experience of the teachers at the school has shown that when computer tools are used to help in the learning process, the students are encouraged to learn, to participate and to interact with each other and with their teachers. In such educational environments, participation and motivation of the disabled students is crucial, so the use of information technologies in the class rooms is increasing.

Using mechanical input devices, such as special big buttons (the popular Jelly Bean switch), the young children are able to use their limbs clicking with their heads, arms, etc. in order to browse through collections of PowerPoint slides looking for the object or image asked for by their teachers. Other students with cognitive disabilities learn cause-effect relationships clicking the same buttons to play music or videos in their computers.

However, due to the different types of constraints and degrees of disability that these young students have, some of them have problems interacting with computers. For instance, users who can only move their arms for up and for a one sideway cannot use systems that emulate a mouse, since they would not be able to move it anywhere on the screen.

2. Mediated Reality and Natural Interaction in the Education Process

The Educational Office of the Principality of Asturias and the University of Oviedo are negotiating a mutual collaboration agreement for research into assistive technologies. The Human Communication and Interaction Research Group of the Faculty of Computer Science of the University of Oviedo participates in this framework trough the SHUBAI [1] project with the main goal of researching about the alternative ways of interaction in this learning process. This project began in January 2010 and will is expected to complete by the end of 2012.

This project aims to show that it is possible to introduce new services that respond to natural interaction dynamically on demand, being targeted to disabled users in Ambient Intelligence and (perhaps) also in Urban Computing based scenarios.

The main goal is the use of mediated reality, adding information to the perception of reality in such kind of users, increasing their motivation as well as encouraging the learning of cause-effect relationship; such is the case of students suffering autism. It is intended that much of the interaction between users and the objects around them will be performed through gestural interaction, either through cameras or using accelerometers included inside small mobile devices.

We are currently building a development framework (codenamed Nikko) able to connect different interaction devices to different learning objects. Nikko will also record the user interaction for evaluation purposes. This way, the teachers may track the evolution of the motion accuracy of their students when they interact with the learning objects.

Although the learning objects are mainly based on augmented reality animations and interactive objects, the system allows compatibility with classic learning objects used by the teachers, like PowerPoint slides and flash movies.

The interaction devices managed by Nikko are mainly webcams (for interaction recognition) and accelerometers for natural interaction (like the one included inside the Nintendo's Wiimote) and also classic input devices like mouse, keyboards or the Jelly Bean switch.

The interaction scenarios selected to test the services provided by SHUBAI include an ambient intelligence environment (indoors) to let the users play with different augmented reality objects which will mainly based on cartoon characters that will interact with users passing nearby. These interactive objects can be executed in computers placed along the building (mainly on the transit corridors) or in the sensory room(s). The sensory room is a special room with different gadgets (special lights, vibration pillows, etc) which goal is the stimulation of children with sensory processing disorders.

The location and detection of the presence of users in these environments (essential to allow the smart objects react to the user presence) would be sought through a combination of fixed location beacons and techniques of inertial interaction based on accelerometers.

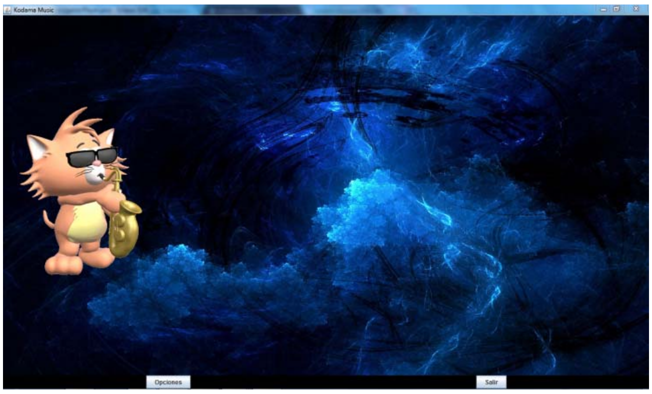

Figure 1. SHUBAI'S Virtual Music Player. The avatar plays his saxophone when the user shakes a Wiimote.

The first prototype developed in the scope of SHUBAI for the sensory room is our virtual music player, an avatar able to play random music whenever the user shakes his/her Wiimote (see figure 1). Depending upon the movement of the Wiimote, the music's pitch and/or rhythm is modified on the fly. This behavior not only helps treating sensory disorders but also teaches cause-effect relationships.

This game is also used for therapeutic treatment, teaching children on how to control their movements. The movements required to control the avatar are set up by the therapist according to the needs of each student. The use of augmented reality technologies allows users to watch themselves in the scene together with their avatars, reinforcing the feeling of participation in the task.

We have also completed a successful evaluation of other augmented reality-based technologies in the field of therapeutic treatment, prior of the development of our first prototypes. The Microsoft's Touchless library [2] allows a basic combination of augmented reality and natural interaction in a simple way. Perhaps it is not as advanced as the Java-based Processing [3] technology but it has a better learning curve for the development of simple prototypes.

Some of the examples of this technology included in its demo are powerful enough to comply with the therapeutic requirements of some of the students. The prototypes allow recognizing colors present in the scene captured by a web cam converting them into markers that can be used to interact with the computers.

Students wearing color markers in their limbs can learn to moving elements in the screen in a funny way. Using augmented reality techniques, a Care Bear [4] (or any other popular cartoon) magically appears on the student's limb. She/she can then move the bear to a specific location in the class room and to receive an award for the effort (normally we use a song or funny sound as a reward for children of 4 years old).

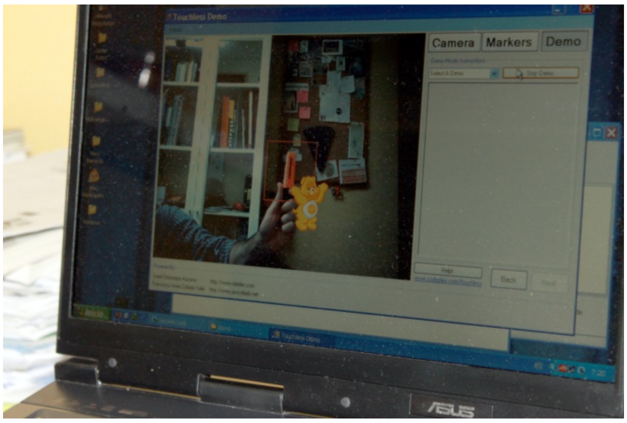

Figure 2. Our therapeutic treatment based on *Microsoft Touchless*. Users learn on how to control their limbs, when moving the care bears around their classroom.

This approach encourages the participation of the students in the training process. It also encourages group training and collaboration between different students to achieve simple tasks, since several students can participate at the same time. We plan to develop several videogames using this concept in the scope of the SHUBAI project. The main goals of such games in the field of therapeutic treatment are the improvement of movement coordination and pointing accuracy.

3. Future Work

Combining Augmented Reality with Natural Interaction we expect to encourage both kind of users (teachers and students) to develop and to participate into a more dynamic learning process. We have called Augmented Accessibility to this combination expecting to provide alternative ways of interaction with augmented perceptions of the real world to help handicapped and disabled users to deal with that world in a more effective way.

The SHUBAI project has just three months old and it is too early to present conclusive results, but the testing of the prototypes developed so far are quite promising. This technology under development has performed better than the assistive devices in some fields and in terms of price and flexibility. The Nikko framework allows the integration of current and future interaction devices by mean of a plug-in architecture and its connection with different learning training objects, making it a flexible alternative to the current assistive technologies.

Acknowledgements

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References

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