Haptics Research in TAUCHI: Aiding Visually Impaired Children and Enabling Haptic Interaction

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ABSTRACT
Touch is one of the more recent senses being harnessed in multimodal interaction with personal computers and mobile devices. Haptics has a great potential for helping people with special needs, and making the use of computing devices more natural and concrete for all people. Still, there are great many things that are not known in sufficient detail to make constructing haptic interfaces a simple matter of programming. In this position paper I discuss the projects and ideas that our multimodal interaction research group has been working on within the past few years. In addition, I provide a glance at the upcoming activities that are under way or planned to be investigated in the near future.

Author Keywords
Haptic visualization, visually impaired children, haptics in desktop environments, haptics in mobile devices, kiosks.

ACM Classification Keywords
H5.2. Information interfaces and presentation (e.g., HCI): User interfaces.
K3.1. Computers and education: Computer uses in education.

INTRODUCTION
Multimodal Interaction Research Group is one of the six research groups in TAUCHI, Tampere Unit for Computer-Human Interaction. TAUCHI is the largest and internationally most active part of Department of Computer Sciences in the University of Tampere, Finland. Several groups in TAUCHI do research on multimodal interaction when it is related to their individual research direction, but the group described here is the only one focusing in a great extent on haptics. In the following sections I present the main directions of our haptic research, discuss some of the problems encountered, and give a glance at our upcoming activities.

HAPTICS IN DESKTOP ENVIRONMENTS
When Logitech [8] introduced their Wingman force feedback mouse and iFeel tactile mice built on technology licensed from Immersion Corporation [6] the general public was able to buy relatively cheap devices that introduced haptics in graphical user interfaces, and especially in games. However, neither of these products was a commercial success story, and it is getting harder to acquire one of these devices once the original stocks are depleted.

One reason for a relatively small success of these early devices is that the quality of the haptic feedback generated by these devices is low. Another, possibly equally or even more important reason is that the software provided with the devices was not optimal, at least not when first installed with default settings. With the iFeel mice the whole desktop tended to vibrate, which quickly made the users change their attitude from an initial “wow experience” to being irritated with the ever-vibrating and noisy desktop. Still, we believe that these devices have their uses. The Wingman force feedback has rather good force feedback capabilities, but mediocre tactile sensations. The iFeel tactile feedback mice produce somewhat better tactile feedback, but no force feedback.

When we started our haptics research, one of the first goals was to continue an earlier research on graph drawing and manipulation tools, originally introduced by Raisamo and Räihä [14]. The aim in this research has been to construct highly interactive tools, such as an alignment stick [14] that can be thought to have direct counterparts in the real world. Haptics was considered as a natural enhancement for these tools, since getting haptic sensations should make the use of tools more concrete. We have published two papers on using tactile feedback [12,13] and force feedback [13] with these tools. We have also carried out an experiment using a real stick to investigate objects haptically through vibration [10]. A possibility to continue this line of research is to apply haptics in 2D sculpting process [15].

HAPTICS IN KIOSK SYSTEMS

Another line of research where we have used haptics is interfaces for interactive kiosk systems. Haptic input through touchscreens has been used with kiosks for a long time. However, haptic feedback has been limited just to the pressure produced against the finger when it is pressed on screen. Here, we have had two approaches to improve haptic feedback. The first one involved placing a transparent foil on top of the screen containing thin metal guides to help the user to follow the navigation interface with fingers [1,2]. This passive haptic feedback solution (see Figure 1) makes it possible for visually impaired and blind people to use public service kiosks.

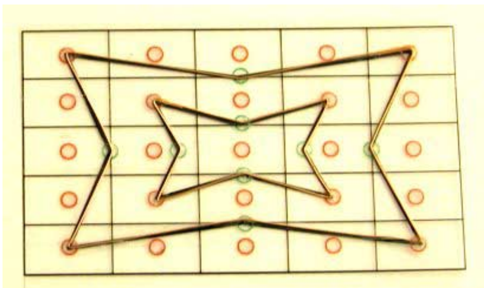

Figure 1. Tactile pointer layout for soft keyboard. [1]

The second approach involves using vibration through a vibrating pen that is used to inspect contents of the display [20]. This solution (see Figure 2) is not as practical as the first one since it requires a pen to intermediate haptic feedback, but here the feedback is active and can be produced and altered in the application when necessary.

Figure 2. Tactile feedback through a pen. [20]

Presently research on kiosk systems is not one of our main topics in haptics research, but it is possible that we continue studying it in the future. An interesting novel alternative the active haptic touchscreen [5] invented by F-Origin, Ltd.

HAPTICS IN MOBILE DEVICES

Our research on mobile haptics is closely related to research on kiosk systems presented in the previous section. This is due to the fact that the same inventions have been usable independent of the size of the touchscreen. So we have also used the metal guides [1,2] and the vibrating pen [20] in mobile interaction.

Much of our research on haptics specially aimed to mobile devices focuses on mobile games [3,4]. Haptic games have proven to be especially suitable for demonstration since they are engaging for many people who have tried computer games before.

It is expected that mobile haptics will be one of our main haptic research interests in the near future. Most of this research links to our main topic in haptics research, presented in the next section.

MULTIMODAL LEARNING ENVIRONMENTS FOR VISUALLY IMPAIRED CHILDREN

Our main area of research related to haptics is constructing multimodal gaming and learning environments for visually impaired and blind children. This research started in 2001 funded by Nordic Development Centre for Rehabilitation Technology (NUH). In this first project we designed and implemented multimodal games for visually impaired and blind children from 3.5 to 7.5 years of age [11].

Later we have constructed learning environments for children who are a bit older, from 6 to 10 years, since we found several problems when testing the games with very young children. One of the main problems was that it is rather hard to really know what a small child thinks or even how well he or she sees, since the child may not know how to describe it accurately. Another problem was related to their motor abilities needed to investigate the games haptically. Some children were too young to have developed motorics, and some may even have had multiple disabilities that nobody was aware of, since they were still so young.

High-End Learning Environments

Originally, we decided to construct the games and learning environments using the latest haptic technology, which at the time equaled SensAble PHANTOM devices [19]. We acquired a Reachin Display System [18] with a PHANTOM Desktop. This hardware has since been used in several research projects to construct multimodal learning environments [7,11] (see the setup in Figure 3). Often we have either removed or disabled the visual screen attached in the display. This has been done for two reasons: the visually impaired children could not see much anyway, and the mirror attached in the Reachin Display was in such a position that it was hindering a small child to use the PHANTOM without a risk of accidentally hitting the mirror.

Figure 3. A child is using one of our multimodal learning environments. [11]

Research on high-end learning environments continues in a project [7] funded by the Academy of Finland, Proactive Computing Research Program, and in a European project MICOLE: Multimodal collaboration environment for inclusion of visually impaired children [9], coordinated by us and funded by EU 6th framework program, Information Society Technologies, strategic objective eInclusion.

Low-End Learning Environments

High-end environments are suitable for doing research as reliably and efficiently as possible, but due to the price of high-end devices those environments can only be used in few sites even after they have been finished. That was the main motivation for us to start research on using inexpensive haptic devices, possibly building prototypes of new devices that could be used in such applications. We have just started this research funded by the National Technology Agency of Finland (Tekes) and private companies. The first results will be published later this year [17].

TESTING WITH THE HELP OF PHYSICAL MODELS

In addition to building learning environments it was highly important for us to develop a testing procedure for testing these solutions with visually impaired young children. Usability testing with children has always its own problems compared to testing with adults, and since our users do not see well or not at all, this makes testing even harder. We have managed to develop such a procedure that has been refined from its initial form [16] to its present state [11]. This procedure is in use in all of our present research projects in this field.

To familiarize the children with haptic surfaces and models to be tested we have constructed physical mock-up models of the virtual environments. The left part of Figure 4 shows a physical navigation path model that was tested in our first studies to find out whether this kind of navigation would be possible and suitable for small visually impaired children. The right part of Figure 4 shows the virtual model tested with the PHANTOM after investigating the real model. The use of the PHANTOM was mimicked in as great detail as possible, including the plastic stylus shaped exactly as the stylus in the PHANTOM Desktop. The reason for using the stylus with the real model was to train the child to understand how to investigate objects using a stick.

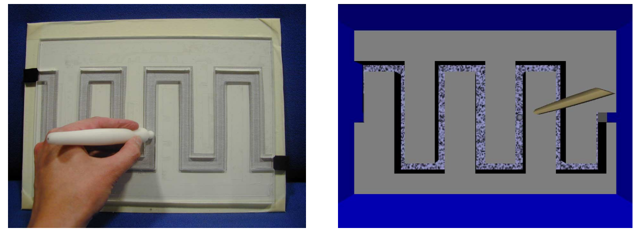

Figure 4. A real castle wall path model (left) and a virtually implemented castle wall path model (right). [11]

Figure 5 illustrates a similar situation as shown in Figure 4. In this case the physical mock-up model was used to help the small children to understand the task where different virtual materials were investigated. We also used this kind of process when improving the quality of virtual materials during iterative development of the prototypes. The children tried to recognize the virtual material that was closest to a certain physical material.

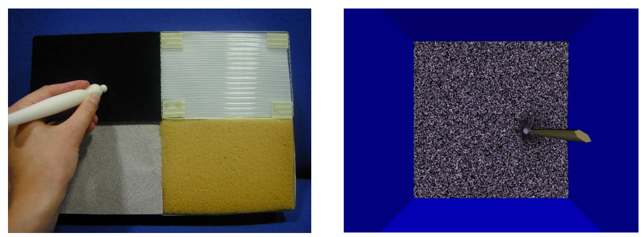

Figure 5. Real-world materials (left) and a virtually implemented sponge material (right). [11]

As the navigation interface was developed throughout the project [11] we made new mock-up models to introduce the interface to the children. Figure 6 shows the final prototype implemented in that project, and later used in new projects. The room metaphor with a corridor around it proved to be a good solution for our needs. There are doors in different walls of the room, and the actual room was chosen depending on the door through which the child entered in.

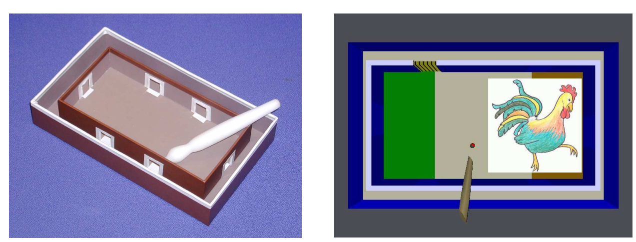

Figure 6. A real model of the navigation interface for the learning environment was made from carton (left). An application using the virtual interface (right). [11]

CONCLUSION

In this paper I have presented the haptics research directions of TAUCHI Multimodal Interaction Research Group. There are several lines of research where we plan to continue this work within the next few years. Haptics has probably the greatest potential for visually impaired and blind people, since it makes it possible to explore information through an expressive sense that they have often developed as a highly accurate way to inspect their surroundings. It is also important to find ways to use haptics in multimodal interaction where people with their senses intact would benefit from having sense of touch available. Just routinely adding haptics everywhere it is possible is not an optimal solution, and may even limit usability of the system by adding interference where it is not expected. If done inappropriately, this may even make the users to resist haptics and its use in common interfaces.

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