Using Haptics in Computer Interfaces for Blind People

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ABSTRACT
This paper has its roots in Certec's efforts to find a way to use haptic technology (i.e. touch based interfaces) to provide new computer interaction techniques for visually impaired people and those with physical disabilities.

The paper presents a set of recommendations that we have formulated during our research and development work. These rules of thumb are grouped under the headlines Navigation, Finding objects, Understanding objects, Haptic widgets and Physical interaction.

Keywords
Haptic interface, blind, sense of touch, visual disability, guidelines

COMPUTER ACCESS FOR PEOPLE WHO ARE BLIND
Computer access and the wide adoption of the Internet as an information channel have given blind persons access to information that used to be almost inaccessible. The fact that text in digital form can be easily accessed have actually given blind persons a new way of communicating with the rest of the world.

Most blind computer users have a screen reader combined with synthetic speech and/or a Braille display. This gives them access to text on the screen, but not to the graphics. Haptics interfaces use the sense of touch in the user interaction. With a haptic interface it is thus possible to feel shapes that are based on digital information. There are now computer programs available that present some of the graphical information in a GUI via a haptic device.

THE EXPERIMENTS
We have been working with haptic computer interfaces and haptic games for blind people since 1995. This paper presents a set of recommendations that we have developed in the course of our research and development work.

The user tests and experiments that we have conducted have not been designed to achieve or test these principles. But they have emerged and been refined with "reflection-in-action" and "reflection-on-action" [4] during our tests and software development. We have found these recommendations useful, and we believe that they can work as general guidelines for all developers of haptic interfaces for blind people.

The articles and reports on our haptics work that have been published so far cover the following: User tests of a haptic memory game "The Memory House" with nine blind persons [7, 8]. Pilot studies of Immersion´s "FEELit desktop", radial haptic menus, and a search bar with two blind persons [9]. Informal demos and tests of a haptic battleship game, a haptic painting program and several other small programs with more than 20 blind children [5, 7]. Informal tests of a haptic maze using a force feedback joystick by children with different visual disabilities [3].

We have also been inspired by the work of other groups, in particular J.P. Fritz and K.E. Barner's haptic graphing system [1]

Most of our work has been carried out with "the PHANToM", a high performance, 3D haptic interface from SensAble Technologies. But we have also used other devices such as force feedback joysticks and the FEELit mouse from Immersion Corp.

Rules of thumb for point interaction haptics - what it requires from the design

Navigation

- Provide well defined and easy-to-find reference points in the environment. This is necessary to facilitate navigation. Natural reference points are for example the corners of a room. Good reference points are easy to find and come back to, and they should also be easy to identify [7].

- Do not change the reference system unnecessarily. A disabled haptic button should not be removed, but rather "grayed out" for example by giving it a different texture and making it impossible to click. This way the button can still be used as a reference point even though it is nonfunctional. [7].

Finding objects and getting an "overview"

- With pure one-point haptics it is easy to miss an object even if one is really close to it. It is important to compensate for this when designing haptic software by using an enlarged interaction point, magnetic objects, or different surface characteristics, for example [7, 9].

- It can be just as difficult to determine that an object does not exist, as it is to find an object. It is always easier to move along some kind of path (a ridge, a groove, a magnetic line, etc.) to the place where the object is located or where there is no object [7, 9].

- In both of the above cases one can also choose to give the user a "virtual search tool" [9] instead of changing the virtual objects. A virtual search tool could be for example a bar, or a magnet.

Understanding objects

- If it is not absolutely necessary for the haptics to feel like something real, it may be beneficial (and sometimes essential) to help the user follow the outline of the object. It is easy to make a thin touchable hose easier to find by giving it the appropriate attractive force. Without such a force it is almost impossible to feel the hose in 3D [1].

- Sharp edges and corners are much more difficult to feel and understand than rounded shapes when they are felt from the "outside". The user almost always loses contact with the object when moving past a sharp corner, thereby disturbing the cognitive process that translates the impressions received into an inner picture. Moreover, it is difficult to determine the size of the angle; many users believe that the angle is more acute than it really is [7]. This also means that a direct translation of VRML models is not satisfactory in a haptic environment for people who are blind. It is necessary to even out the edges, or at least use normal interpolation to minimize the problem of sharp edges.

Haptic widgets

- When going through a thin wall or past an edge, the finger often accelerates a great deal. Consequently, the next wall or edge should not be very close since there is a risk that the finger will go through that wall as well (sometimes without the user noticing). In this case it can sometimes help to replace the thin walls (between the areas) with a magnetic line that pulls the user to the center of the area instead. The problem becomes apparent when one wishes to represent menus and coordinate systems [4, 9].

The physical interaction

- Be careful with the manipulandum design. The manipulandum is the tool that the user grasps in his hand. In the PHANToM the manipulandum is a stylus or a thimble. In other cases it might be a mouse-body, a joystick handle or some specialized tool. The choice of manipulandum can affect the haptic sensation a great deal. This is because the form and surface of the manipulandum have an effect on how the resistive force is applied to the user, the kind of movements used, and the feeling of being in contact with the virtual object. For example, a thimble with sandpaper on the inside causes many people to use less force when grabbing a virtual object because they get the sensation that the objects are less slippery [2, 9].

CONCLUSION

Haptic interfaces can be used in many different kinds of computer programs for blind people. We have found that our haptic programs in general work better when considering these guidelines, even though we do not claim to have the complete knowledge of how digital objects should be accessed haptically in all cases. We will continue our work with haptic interfaces and expect to refine and add to this list continuously.

REFERENCES

1. Fritz, J. P., Barner, K. E. Design of a Haptic Visualization System for People with Visual Impairments, *IEEE Transactions on Rehabilitation Engineering*, vol. 7, No 3, 1999, pp 372-384.
2. von der Heyde, M. Psychophysical experiments in a complex virtual environment, *Proc. of the Third PHANToM User Group Workshop*, Dedham, MA, USA, 1998.
3. Johansson, A., Linde, J. Using Simple Force Feedback Mechanisms to Visualize Structures by Haptics. *Proc. of the Second Swedish Symposium on Multimodal Communication* Lund, Sweden, 1998.
4. Miller, T., Zeleznik, R. An insidious haptic invasion: Adding Force Feedback to the X desktop, *Proc. of the Third PHANToM User Group Workshop*, Dedham, MA, 1998.
5. Schön, D. *The Reflective Practitioner*, Basic Books, 1983.
6. Sjöström, C. Jönsson, B. To Use the Sense of Touch to Control a Computer and the World Around You. *Proc. of the AAATE conference*, Thessalonica, Greece, 1997.
7. Sjöström, C. *The Phantasticon - Haptic Interfaces Give New Possibilities for Blind People*. Master's Thesis, Certec, Lund University, Sweden, 1997.
8. Sjöström, C., Rassmus-Gröhn, K. The sense of touch provides new interaction techniques for disabled people, *Technology & Disability* Volume 10, Number 1, IOS Press, 1999.
9. Sjöström, C. *The IT Potential of Haptics – Touch Access for People with Disabilities*, Licentiate Thesis Certec, Lund University, Sweden, 1999.