Non-visual Drawing with the HIPP Application

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Abstract

An audio-haptic drawing application prototype has been developed in a project and iteratively been tested by five pupils who are 8-13 years. The application has been used by pupils, assistants and teachers to access graphics and create graphics that are accessible for pupils with severe visual impairment or blindness. We have observed a spread in the actual use of the system that seems to depend on the special pedagogical knowledge of teachers and assistants, their learning focus, and the age of the pupil when they start using the system.

Keywords

Drawing, audio-haptic, learning, multimodal, visual impairment, graphic.

Introduction

Persons who have visual impairments are excluded from accessing certain types of information that are accessible to the general public. Screen reading software and Braille displays or text-to-speech systems are used for enabling access to text, but for accessing graphics, especially digital graphics, no standardized technology is in widespread use. In education, preprinted material is often used, which forces teachers to plan well ahead of time to be able to produce or borrow the material they need. This makes the learning situation less dynamic, and it is hard to produce tactile material on-the-fly. Because of this, pupils with severe visual impairments also get less exercise in the reading and understanding of graphical material, which will exclude them from certain information in their grown-up lives.

Related Work

As described in *Drawing and the Blind* (Kennedy) and *Art Beyond Sight* (Axel and Levent), people with visual impairment can find an interest in drawing by hand. Several tools exist to enable this activity.

An existing supportive technology for creating graphics is a CAD application which has been developed to enable users to create drawings with the help of audio and keyboard. This is accomplished by a structured approach of dividing a drawing into small parts which thus enables the user to draw segments of a drawing (Kamel; Kamel, Roth, and Sinha.). In 1996, Kurze presented a tactile digital drawing application that combined a digitizer pen with a thermo pen. The thermo part of the pen raised lines on swell paper, and the digitizer recorded the movements to save them digitally. An idea for a voice recognition system for vocal tagging of the drawings was also presented (Kurze). The greatest drawback of that particular application was that the drawings could not be dynamically edited. The possibility to use the PHANToM for drawing and

exploring drawings has previously been investigated. Two different applications were developed, with a few years in between. The first application ("Paint with your fingers") was created by Niclas Melin in 1995 (Sjöström and Rassmus-Gröhn), and the target users were children with blindness. This application focused on the possibility to paint colors, and to give them different haptic textures to make it possible to distinguish them from one another. The second application took the results from the user trials of the first application, and improved the functionality (Hansson). The resulting application prototype provided the user with the possibilities to choose colors from a palette and draw with them. Like the previous application, different textures were applied to the colors. Also, a dividing line between drawn segments of different color was added.

HIPP builds on a system called AHEAD and presented extensively in Rassmus-Gröhn. During the time of the development of the AHEAD application, a couple of other non-visual drawing applications were developed. One, created by Crossan and Brewster, is evaluated primarily as a tool for teaching handwriting to blind pupils (Plimmer, Crossan and Brewster). The application can be used in collaborative mode, where a teacher can guide the trajectory of the pupil's pen. Thus, that application focuses on the guiding and the learning of shaping letters correctly. Another application created by Gutierrez is primarily for single-user drawing, and it features tools for zooming and different modes of exploration, e.g. free exploration, guided exploration or constrained exploration (Gutierrez). T. Watanabe et al. have also presented a compound technology solution using a tactile display device, a 3D digitizer and a tablet PC to enable blind pupils to draw and feel their drawings (Watanabe et al.), and to access general graphic material. This system has been evaluated in school with a Kanji (Chinese characters) learning system and tactile games, as well as in geography and history lessons.

More recently, Lévesque et al. have presented a different solution for exploring schoolbook illustrations via laterotactile deformations of the finger skin combined with a 2D exploration (Petit et al.). Like the HIPP program, it envisions the support of vector graphics (Lévesque and Hayward) and supports multimodal drawings through the MaskGen software. Compared to HIPP, it enables more different types of tactile rendering, but although the more recent version is more dynamic and supports zoom functionality (Lévesque et al.), it does not enable drawing.

Another type of hardware called Hyperbraille enables bimanual graphical exploration (Prescher, Weber, and Spindler). The device consists of a 2D pin array much like braille displays and is made primarily for rendering the window-based GUI of a computer, including the possibility to zoom. Some drawing is possible, but not in a direct free-form way as shown in hyperbraille.

A handbook has been published with more details on the pedagogical perspectives behind the use of HIPP (Fahlström and Björk). One important concept is the intersubjectivity between the teachers or pedagogues and the child, through the drawing. As stated in Fleer, it is important to create an intersubjectivity where the adult and the child can meet and agree on the object and focus of their activity (the drawing). This should enable the child to link the activity back to their own life and the adult to bring in specific concepts. More details about intersubjectivity in HIPP can be found in Björk.

Method and System Design

We have used a participatory design process in a school context to develop an audio-haptic non-visual image editor and explorer (Rassmus-Gröhn, Magnusson, and Eftring; Rassmus-Gröhn). The system, called HIPP (for Haptics In Pedagogical Practice) and the methods around

it, while undergoing continuous improvement, were evaluated in four schools by five pupils who are partially sighted or blind, their teachers and assistants.

The drawing application is written C++ and Python on top of the H3D API (Sensegraphics AB) and Cairo graphics (Cairo graphics), and is available as open source code (Rassmus-Gröhn and Szymczak). It uses a combination of haptic and sound feedback to display information to the visually impaired user. The haptic feedback is displayed via the PHANToM OMNI device, and drawn objects are tagged with a number and text string which is spoken by the application each time a user selects it.

Fig. 1. HIPP Concept Picture. The pen for haptic feedback of the drawing on screen, the speaker for spoken feedback or sound effects related to the point the pen is touching.

Objects can be manipulated in different ways: moving, resizing, copying, pasting and deleting. Additionally, shapes can be transformed into straight lines, rectangles or circles. The manipulation tools are fitted with auditory icons, which are feedback sounds designed to resemble a real world manipulation of similar nature (Gaver). E.g. the copy function sound effect is a camera click.

Results

The extent and mode of use of the HIPP system has varied for the different pupils. It has been used both for the own creation of drawings (made by the pupils) and exploring of school material, such as diagrams, maps or other illustrations. To begin with, the teachers were very focused on teaching--transferring knowledge in pictures to the pupils--and would generally start talking about maps and mathematics figures as being the biggest problem in school. This seemed to get more prominent the older the pupils got, and the playful experimentation with the digital material (in the form of the HIPP system) was not pursued as much, and this seemed to lessen the number of uses of the HIPP system in the classroom.

How to teach pupils with blindness to draw is not self-evident, but one approach that showed to be fruitful was to let the pupils do doodle-drawings with the HIPP system, much as younger sighted children do when learning to hold a pen at 1-3 years of age. These doodles were then interpreted by an assistant who would say things like, “Oh, what you are drawing there looks like a rose, would you care to bring it home to give to your Mom?” And then they would print the drawing on swell paper (which raises the black lines on the paper) and explore it as well. When the pupils later took the initiative to draw something, visual interpretation and communication around 2D drawing conventions were discussed.

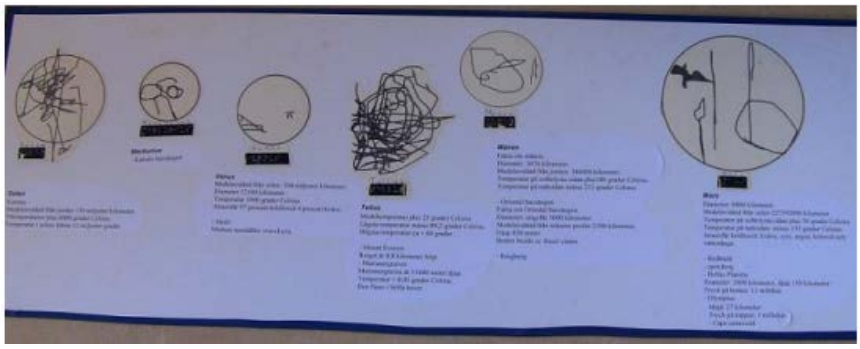

Fig. 2. Solar System Printed on Swell Paper

For example, one pupil would like to draw a planet from the solar system. Therefore, the pupil started to ask questions like: “How do you draw a planet? And how do you know that the planet you draw as a circle, is in fact a sphere? And how do you draw the craters on the moon? How about the mountains?” From the pupil’s initiative, a whole wealth of discussion topics around 2D drawings, scaling and perspective came naturally from working with the system in a real life activity. The fact that the drawings were not only kept in the digital format, but also printed on swell paper and examined appeared to help convey the meaning and importance of graphical images.

Fig. 3. A Part of an Ocean Collage in the Classroom. The shell and the bird above it are created with the HIPP application, and colored with crayons inside the swelled lines.

In Sweden, most pupils with visual impairment are integrated in regular classes. Since pupils with visual impairment have different learning materials it can be difficult to take part in the creation and exchange of graphics, which is important as a learning tool especially for the younger children. HIPP can also be part of those activities, which is shown in Figure 3.

Discussion and Conclusions

As can be seen from the examples above, the HIPP application has sufficient functionalities to be of use in the classroom. However, it puts some demand on the pedagogical personnel surrounding the child, and we have seen how the computer skill and the knowledge of special pedagogy have an impact on how often the tool is used and in what situations. It should be recognized that such skills are important also with other material and pedagogical situations.

Learning to draw, and also being inspired to draw, is indeed possible with the help of HIPP. Printing swell paper copies of the drawn pictures, sometimes in several stages before the picture is finished, helps making the build-up of pictures clearer to the pupil. We have also seen how the task of drawing something triggers questions about 3D-2D projections, and about certain conventions in drawing, for example how you usually draw a car from the side, and not from the top.

With the younger children, a playful approach has been more pronounced, and we believe that this is one reason that it has worked better. The root cause for the playful approach can be the pedagogy for smaller children as such, but it may also have to do with the escalating demands on the pupils as they grow older. They simply have no time to learn a new tool in a playful manner. This indicates that introducing a new tool like HIPP should be scheduled in the lower classes, although care needs to be taken since we have also experienced clashes with other new tools being learned such as Braille displays or new keyboards.

We have seen that in the schools where HIPP has been used primarily as a transmitter or conveyor of school material such as maps, drawings and diagrams, the HIPP drawing application has been used less. Our analysis is that without the knowledge of what a picture is and how you create it, the decoding and understanding of pictures is harder for the pupils. It also puts a greater demand on the assistants or teachers actually creating the material and spending preparation time working with HIPP. The time needed to spend on a new tool, even if it is seen as useful, is hard to add on top of the other work that is already done in school.

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