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# Haptic Visualisation

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This paper describes two exploratory and ongoing projects in haptic, or tactile, visualisation. The first is a study evaluating the performance of vet students exposed to virtual reality (VR) training materials. The second details work investigating the haptic rendering of mathematical data in the form of graphs to facilitate access by blind users. Both of these areas stand to benefit greatly through VR. If vet students can be trained virtually then the inherent dangers to the animals reserved for training purposes can be radically reduced; with a sufficiently advanced rendering engine a blind user could gain access to graphically presented information previously unavailable to them.

Keywords: Haptic, touch, blind users, vets, multi-modal interaction, visualization, virtual reality, training.

## 1. HAPTIC TECHNOLOGY

The technology to feel virtual objects at a high fidelity is just becoming available. In the work described here a PHANToM (figure 1) is used to instantiate virtual objects. This is a very high resolution, 6 degrees of freedom device, consisting of a motor controlled jointed arm. Users operate the device by placing their finger in a thimble at the tip of the device. This affords a very natural interaction with the objects.

Figure 1. The PHANToM from SensAble Technologies.

## 2. VETERINARY TRAINING

The most significant problems with training vets are the risks conferred to their initial patients. Trauma, stress and injury can all be caused by unskilled internal examinations. Furthermore, in the course of training vets there is no guarantee that they will be exposed to all relevant diseases or symptoms – suitable animals may not be available. Finally, there are financial constraints as to the number of animals that can be maintained for training purposes. This can lead to students receiving very limited practical training and also to animals being subjected to significant numbers of examinations. These problems can all be solved through the use of VR and haptics. If haptic training can augment a large percentage of the practical work then the danger to animals can be diminished, many symptoms can be simulated in software and the amount of available practical work can be increased.

To provide these solutions we, in conjunction with the Glasgow Veterinary School, have produced models that simulate equine examinations (Brewster et al, 1999). Figure 2 shows a model of two horse ovaries. These haptic models have been developed using an iterative, participatory approach. Prototypes were built and then subject to continual refinement via evaluation by expert vet users. Evaluation of these models is now taking place through the comparison of subjects exposed to them with subjects exposed to more traditional, animal based, training mechanisms.

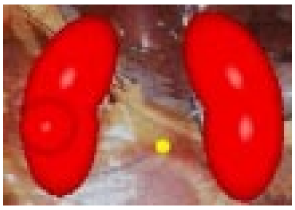

Figure 2. Horse ovaries

## 2 VISUALISATION

Visualisation is the art of presenting complex information in such a way that it is simple to understand. A simple example is a graph. It is a very basic construct, yet contains a large quantity of information that is difficult to describe otherwise.

Computer based visualization techniques are now becoming highly advanced but they primarily rely on very high-resolution displays to present detailed graphical information. Visually impaired users have little access to the information presented in these systems (Edwards, 1995). Current visualization techniques for displaying information non-visually rely on synthetic speech and Braille. In both cases words or digits are presented sequentially. This is a poor mechanism for visualization. Consider a sighted person reading a matrix of numbers. He/she could immediately make certain inferences about the data, for instance that larger numbers were present at the right hand side. However a blind user experiencing this information sequentially would find it hard to make these same inferences. The situation becomes worse with any visualization techniques that rely on graphically represented data. For instance graphs, or complex three-dimensional plots.

Haptic technology has the potential to solve some of these problems. Our current work (Brewster & Pengelly, 1998) is investigating the haptic rendering of graphs. An example is pictured in Figure 3. In this model the user is confined to a small haptic workspace which restricts movements to the interesting areas of the graph. The information pertaining to the graph is presented by extruding it from a flat wall at the back of the workspace. The grid lines of the graph are raised slightly so that they can be felt but not enough to provide any significant resistance. The axes of the graph are large quarter cylinders. The lines of the graph itself are half cylinders.

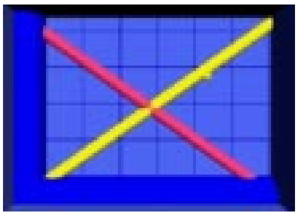

Figure 3. Haptic graph

Initial evaluation of haptic graphs and bar charts has taken place. Subjects in this evaluation were sighted but could not see the graphical representation. Sighted users were used because our supply of blind users is limited. It is hoped that we can resolve the main problems with the models in these tests. Future evaluations will involve blind subjects.

Assessment of these models came in the form of questionnaires. Questions asked ranged from high level queries about the location of the maximum point on a graph to very low level. For instance questions were asked about whether gaps should be present in between the bars in a bar chart, or on the helpfulness of the grid lines presented.

This information has proven invaluable to our research effort. We are now incorporating these results into the next generation of haptic models. Work on these revised models will use more quantitative measures to fully evaluate our designs.

## REFERENCES

Brewster, S.A. and Pengelly, H. (1998) “Visual impairment, virtual reality and visualisation.” *Proceedings of the First International Workshop on Usability Evaluation for Virtual Environments,* British Computer Society, 24-28.

Brewster, S.A., Montgomery Masters, M., Glendye, A., Kritz, N. and Reid, S. (1999) “Haptic feedback in the training of veterinary students.” Accepted for *EdMedia'99*.

Edwards, A.D.N., Ed. (1995) *Extra-Ordinary Human-Computer Interaction.* Cambridge University Press, Cambridge, UK.