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Haptic Feedback in the Training of Veterinary Students

Stephen Brewster, Michelle Montgomery Masters, Aidan Glendye
Glasgow Interactive Systems Group, Department of Computing Science, University of Glasgow

Nik Kriz
Weipers Centre for Equine Welfare, University of Glasgow

Stuart Reid
Veterinary Informatics and Epidemiology, Universities of Glasgow and Strathclyde

Abstract

This paper reports on an initial study into the use of haptic (or touch) technology in the training of veterinary students. One major problem faced in veterinary education is that animals can be harmed by inexperienced students who are trying to learn the skills they need. The aim of the work described here is to provide haptic models to simulate internal examinations of horses so that students can learn the basic skills required on computer and then transfer to real animals with much less risk of doing them injury.

Section 1: Introduction

This paper reports on an initial and on-going study into the use of *haptic* (Schiff & Foulke, 1982) technology in veterinary education. The University of Glasgow has a commitment to the implementation of non-invasive procedures for diagnostic and education purposes in Veterinary Medicine, wherever possible. As part of the continued development in the use of technology in veterinary education (e.g. ultrasonographic facilities, collation of electronic archival materials) Virtual Reality is now being explored as a possible aid to teaching and in particular to replace invasive examination procedures.

Section 1.1: The problems

One major problem in the education of veterinary students is the danger faced by animals when being examined by inexperienced students. The students need to gain experience in internal examinations (a key method for diagnosing problems and diseases) but it can be dangerous. The animals may become stressed, be injured or may even die because of unskilled internal examinations. Large classes of students mean that each person may only get a very limited amount to time learn the practical examination skills required.

Another problem is that the students must learn about a whole range of diseases and problems as part of their education. At the time during their training when they are learning about a particular disease there may be no animal available with the particular disease in question. This means that students may not be able to consolidate their learning with practical experience.

Section 1.2: The solutions

We are investigating ways to solve these problems by using haptic devices that allow users to feel virtual objects. We are currently working on models of horses in conjunction with the Weipers Centre for Equine Welfare. There are three main benefits from our solution:

- *Safety:* The use of haptic models to simulate problems allows the students to learn in a safe environment. They can learn on the models without endangering any animals. Once they have gained sufficient skills on the models they can then move on to the live animals with much less chance of doing harm.
- *Cost:* The cost of education is also reduced. A large number of students can interact with the haptic models very quickly and cheaply. They can also do this much more frequently than would be possible with live animals.
- *Flexibility:* The flexibility of the models is great. It is possible to simulate a range of diseases that the students would not normally experience. Different stages in the progress of a disease or condition can also be simulated. This can be done at the time the students are learning, allowing them to try out their theoretical knowledge immediately in a practical setting.

This research could also be applied to human models and the training of doctors. Many of the difficulties mentioned in the area of veterinary education also apply to human medicine.

Section 2: The technology

The technology to feel virtual objects is just now becoming available (Massie & Salisbury, 1994, Bryson, 1995). It was first developed so that users could feel objects in virtual environments. Minsky (in Blattner & Dannenberg, 1992) describes the technology thus: "Force display technology works by using mechanical actuators to apply forces to the user. By simulating the physics of the user?s virtual world, we can compute these forces in real-time, and then send them to the actuators so that the user feels them".

The device used for the work described is a PHANToM (see Figure 1). This is a very high resolution, six degrees-of-freedom device in which the user puts his/her finger in a thimble or holds a pen at the end of a motor-controlled, jointed arm. It provides a programmable sense of touch that allows users to feel textures and shapes of virtual objects, modulate and deform objects.

Figure 1: The PHANToM haptic device from SensAble.

Section 3: Previous work

Even though the use of haptic technology is new, such haptic devices have been used in VR systems that allow, amongst others, remote operation of machines (tele-robotics), remote surgery or molecular docking systems (Blattner & Dannenberg, 1992, Vince, 1995, Hinckley *et al.*, 1994). It has proved useful in the training of surgeons operating on humans. However, there have been no examples of its use in veterinary education.

Section 4: The haptic models

As mentioned, we are developing haptic software models that will simulate the feel of parts of a horse under examination. An example of one of the models we are developing can be seen in Figure 2. This shows two horse ovaries. The ovaries feel correct and they move in appropriate ways (if pressure is applied they can be moved in three dimensions in a realistic way). Both ovaries have very smooth, taut surfaces. The left ovary is softer and slightly smaller than the right one. A follicle can be seen on the left ovary (indicating ovulation is about to take place). This sticks out from and is much softer than the rest of the surface.

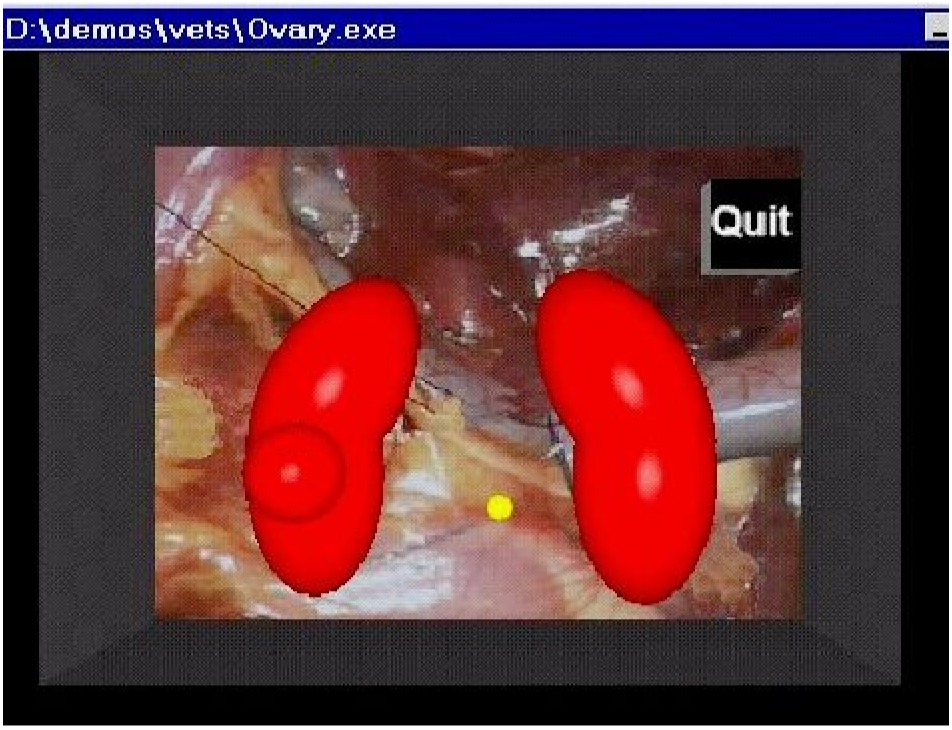

Figure 2: The model horse ovaries. They have been rotated 90 degrees to make them easier to see. The yellow dot in the centre of the picture is the haptic cursor.

The visual representation of the ovaries is built in OpenGL. The haptic representation is built using the GHoST software toolkit from SensAble. When vets are doing internal examinations they cannot see the ovaries, so the visual images are mainly for illustrative purposes. However, a visual representation is beneficial when learning to use the system. Our software allows the visual representation to be removed as required.

The PHANToM device only allows the user to feel with one finger, not the whole hand. This, however, is not a limitation as vets will only use their thumb when feeling the ovary in a real examination.

Section 5: Evaluation

The development of the models has been performed using an iterative, participatory approach. Computing scientists have been working closely with vets to ensure that the models are correct. This has involved the building of initial prototype models and their continual refinement via expert user evaluation. After four iterations we now have a set of models that feel correct to expert vet evaluators. The next stage in our work is to carry out evaluations with vet students.

The evaluations on students will allow us to test our models with our real users. We will discover if the models are usable: can the vet students interact with them, use the device, etc. We will also be able to find out how effective they are: can students correctly identify the particular diseases and conditions we have simulated in our models. Initial trials with students will be pilot studies to allow us to refine our models further. After this has been done we will move on to a full test with vet students to answer the questions we have.

Section 6: Conclusions

One problem in veterinary education in that students must learn how to do internal examinations of animals but in doing so can be dangerous for the animals. Another difficulty is that there may not be an animal available with a particular disease when the students are studying it. The availability of haptic devices means that these problems can now be overcome. We have developed a set of haptic models of horse ovaries that will allow students to learn in a safe, cheap and flexible environment. Once they have learned the necessary skills they can move to working with live animals with much less risk of danger.

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Stephen Brewster

Department of Computing Science

University of Glasgow

Glasgow, G12 8QQ, UK

Tel: 0141 330 4966

Fax: 0141 330 4913

Email: stephen@dcs.gla.ac.uk

Web: www.dcs.gla.ac.uk/~stephen