

A Mixed Reality Simulator for Feline Abdominal Palpation Training in Veterinary Medicine

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Abstract. The opportunities for veterinary students to practice feline abdominal palpation are limited as cats have a low tolerance to being examined. Therefore, a mixed reality simulator was developed to complement clinical training. Two PHANToM premium haptic devices were positioned either side of a modified toy cat. Virtual models of the chest and some abdominal contents were superimposed on the physical model. The haptic properties of the virtual models were set by seven veterinarians; values were adjusted while the simulation was being palpated until the representation was satisfactory. Feedback from the veterinarians was encouraging suggesting that the simulator has a potential role in student training.

Keywords. mixed reality, haptic, veterinary training, feline palpation

Introduction

Veterinarians use palpation as part of many clinical examinations but these procedures are difficult to teach and learn especially when the structures being felt are inside the body and therefore out of sight. Simulators are increasingly used in veterinary education [1] and recently a virtual reality (VR) haptic-enabled simulator, the Haptic Cow, has been developed for teaching palpation of the bovine uterus. This has been successfully introduced into veterinary undergraduate training [2] and has been shown to equip students with useful, transferable skills [3]. Veterinarians using the simulator identified other areas of training where haptics might have a role including abdominal palpation of small animals, i.e. dogs and cats. In these species, the abdominal contents are assessed by palpating structures through the body wall. The veterinarian feels for changes associated with, for example, kidney, liver or bladder disease, or may be trying to detect a tumor or foreign body (an object that has been swallowed accidentally). When learning these skills, students need plenty of opportunities for hands-on practice. However, this is difficult to achieve with cats - a species that has a very limited tolerance to multiple examinations, especially by novices.

In this paper, we describe the ongoing development of a simulator to teach feline abdominal palpation. The aim was to use mixed reality - a physical model and VR - which has been shown to provide more realistic simulation than VR alone [4].

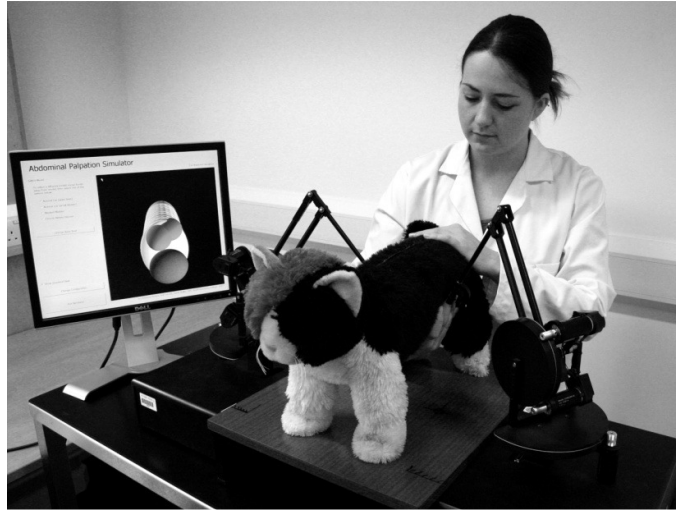


Figure 1. A veterinary student using the feline abdominal palpation simulator. Two PHANTOM premium 1.5s are positioned on either side of a modified toy cat with virtual representations of the chest and abdominal organs superimposed on the physical model.

1. Methods

The simulator consisted of two PHANTOM Premium 1.5 haptic devices [5] and a toy cat (Figure 1). The virtual models were developed in OpenHaptics [5] and using ProtoHaptic [6], a 'drag and drop' environment for creating and manipulating haptic objects. The feline model was composed of geometric primitives such as spheres, cylinders and tori. These were rendered using their parametric equations resulting in a smooth surface, which veterinarians preferred to a polygon mesh as catching occasional 'edges' affected the believability of the illusion. An initial prototype included basic models of the chest, represented by the ribs and intercostal muscles, and the kidneys and bladder in the abdomen.

The toy cat was modified by inserting a rigid metal skeleton and the feet were fixed to a platform to ensure that the position remained constant. The skeleton was wrapped in bandages to represent the musculature of the limbs and back, and the chest and abdomen were lightly stuffed. The PHANTOMs were positioned on either side of the toy cat and aligned so that the virtual model was superimposed on the physical model.

The initial prototype was evaluated and improved by seven veterinarians. The simulation was palpated with the dominant hand positioned under the abdomen and the thumb and middle finger in the thimble gimbals, one on either side of the body (Figure 1). The toy cat's fur provided tactile information to the rest of the hand. While being palpated, each virtual object's size, position, rotation, and haptic properties (stiffness, damping and surface friction) could be adjusted using slider bars on a dialog box. The veterinarians were also asked to comment on the overall impression created by the mixed reality model and the simulator's applications in veterinary training.

2. Results

With the input from the seven veterinarians, simulations were developed that included a range of normal and abnormal cases e.g. urinary disease. The veterinarians' comments about the level of realism achieved were encouraging and the combination of the toy cat and the virtual model was considered to improve face validity. Using the simulator, trainees can practice performing an examination: first moving backwards over the ribs, then pushing into the abdomen to locate the right and left kidney, and then feeling for the bladder further back and lower down. The veterinarians suggested that there would be benefits in using the simulator before, and as a complement to, examining live animals particularly as the instructor can follow the movements 'inside' the cat on the computer monitor while directing the trainee and identifying structures palpated.

3. Conclusions

A mixed reality simulator has been developed that successfully combines virtual and physical models: structures are palpable 'inside' a toy cat. The simulator has potential to address some of the current training issues including insufficient opportunities for hands-on practice and the difficulties giving effective instruction or feedback when teaching a palpation-based procedure. Providing simulator training would also reduce the welfare issues and patient safety concerns associated with using live animals in training, particularly for complete novices.

Our aim is that the simulator will be made available in the clinical skills laboratory and further work is underway to increase the range of structures represented including adding other abdominal organs, lymph nodes, tumors and a heart beat (palpable in the cat through the chest wall). As with any new teaching tool, it is important to demonstrate training benefits and studies are planned to investigate the simulator's contribution to student learning.

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