Sujet de thèse – PhD Subject Title:

Haptic communication in Collaborative Virtual Environments for Medical Training

Résumé – Abstract:

1 - The difficulties of medical knowledge transfer

Surgeons and other hospital professors are struggling to teach motor skills adequately as there is no existing solution to transmit movements and motors skills, including sense of touch and haptics, to a trainee. Learners rely on observation (the apprenticeship model) and listening but have to learn the correct hands operations by themselves.

We propose to build a new technology of remote collaborative training for medical motor skills learning, off-patient, based on collaborative virtual environments with efficient network links, high-quality graphics and haptics rendering.

There is nowadays a strong pressure to improve training, outside of the operating room and without real patients, having better medical skills training, and adequate curriculum with assessment techniques, so subjective and traditional methods could be modernize.

Based on our recent work published at HFES 2011 (the Human Factors society conference) and IEEE Haptics 2012, our research proposition will provide a new teaching paradigm that can solve some of the assessment problems with a real performance measurement and a new way of communication between the expert and the trainee.

2 - Importance of Haptics in Medical Skills

Existing surgery relies largely on laparoscopic, endoscopic or robotic-assisted surgery, where surgeons perform operations through a remote vision system (optical endoscopes or CCD cameras) using hand-held tools. In minimally invasive surgery (MIS), the manipulation of surgical tools relies, in large part, on image guidance. However, in highly delicate situations where precision and accuracy is critical for the success of procedures, the physician requires high haptic sensitivity. But kinesthetic perception is a difficult to verbalize and share, and despite its importance, trainees rely on themselves from learning, making their own acquisition of the motor skills, mainly through the visual channel and practice, with no clear assessment. We are interested in two unresolved issues in medical skills training:

- all medical simulators, in research or industry, lack in realistic haptic feedback, according to the medical experts, if haptics is available at all,
- there are no standardized methods to measure a person haptic sensitivity under the tool wielding paradigm, despite many psychophysics tests and experiments have been conducted to understand the sensory feedback from the movement of the human hand.

3 - Importance of Training and Mentoring Haptics

Although, in our everyday tasks we receive a great deal of information using haptic feedback, current user interfaces are still highly visual in nature, with audio. But the haptic modality can be crucial to understand the use of the system and haptic feedback can be used as an additional channel of communication.

Moreover, Haptic Communication is an effective way of transmitting haptic information to others, using passive motor learning for motor skills acquisition, or using an active direct link to exchange information or correct trajectories. Haptic Communication can be used effectively in mentoring, teaching or assistance of local or remote operation.
4 - The scientific challenges

There are challenging and unexplored issues to deal with real-time haptic communication, co-located or remotely, including:

- New design method for haptic devices, creating a breakdown in robot design to a user/task centric haptic device design,
- Evaluation of human haptic sensitivity, but also being able to measure the overall user’s experience,
- Understand and develop haptic communication in virtual environments.

5 - Breakthrough

The outcomes of this project will provide a solution for motor skills training in medical schools and long life training, in local and distant situations.

6 - What will the student do?

The main student task will be to develop and evaluate a platform for Real time collaboration and Communication for remote medical training, mentoring and assistance (in a virtual environment, we are focused on remote learning and mentoring, with no real patient, no tele-surgery or tele-operation of robots) between experts and trainees or isolated medical staffs. He will take advantage of the advanced software platforms already existing in both teams, to be able to build quickly a new proposition. He will be a strong vector for this CSIRO internal collaboration.

Designing and evaluating the platform, the student will reach a high degree of expertise in the new field of Virtual Environments for Medical Training, with a focus on Haptic communication.

Other dependant goals linked to the research performed in the team are:

- Reaching a meaningful haptic interaction level in surgical simulation, compliant with medical experts’ expectations, exploring the human factors that affect the design specifications of force feedback haptic interfaces,
- Study haptics as an additional communication channel, exploring the role that haptic feedback plays in supporting cooperation and collaborative skill training,
- Build an efficient haptic communication and haptic evaluation protocol to be used in remote/local medical skills training,
- Conduct quantitative and qualitative human studies to explore the effect of haptic feedback design on user experience

7 - The student experience

The student will benefit from the expertise of both CSIRO and IRISA teams, and the experience of Cedric Dumas and Thierry Duval.

- The student will be introduced from the beginning to the 2 teams,
- The student will share the AEHRC close connections with the Queensland Health Skills Development Centre and medical experts at the Royal Brisbane and Women Hospital,
- The student will benefit from the expertise of each place, being at the middle of the collaboration, in
  - Medical Simulations (Dr Dumas, CSIRO),
  - Collaborative Virtual Environments (Dr Duval, IRISA).
- The student will work in an international network of research.
This project is a multi-disciplinary project with knowledge/experts in human factors, haptic perception, virtual environments, surgical simulation, graphics programming, medical skills training and collaborative environment.

With a main focus on haptic communication and a clear objective, the student will provide a common training platform for the CSIRO surgical simulations softwares, using existing core technology of the two teams.

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**Début des travaux - Work start date:**
1/10/2013

**Bibliographie - References:**


S. J. Lederman, “Tactual roughness perception: Spatial and temporal determinants,”

