Project VIRFOCE : Laparoscopic Surgery training system

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The range of laparoscopic procedure that can be performed by most general surgeons is limited by the lack of adequate training procedures. The objective of the project conducted at the IMT-DMT / EPF-Lausanne is the development of a laparoscopic surgery training environment which allows to realistically simulate the interactions between one or several surgical instruments and the gastro intestinal organs. Such a learning tool including tactile force feed back as well as visual feedback would allow students surgeons to train gestures and optimize surgical procedures without any danger for the patient and/or ethical or political limitations.

IMT-EPFL's "VIRFORCE" program consists of three main modules : a visualization tool based on virtual reality techniques to generate the eye-hand coordination required by a laparoscopic procedure, a force feedback system that provides touch sensitivity and a communication module to deal with data transfer between these two modules and remote worksites.

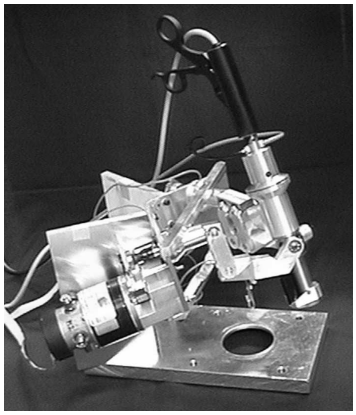

Figure 1 : Force feedback device

An overview of our surgery training force feedback device is shown in figure 1. The full system consists of an artificial patient, into which laparoscopic surgical instruments can be inserted to operate upon virtual organs displayed on a video monitor.

For an as close as possible to realistic three-dimensional visual simulation of the surgical intervention, the laparoscopic instruments and the anatomy of a "standard patient" have to be represented in a photorealistic virtual environment (shown in figure 2), and the surgical actions must be taken into account in real-time deformation of organic tissues. The employed deformation algorithms are based on standard mathematical modeling of tissues behavior. In order to achieve high photometric quality, the tissue models are texture mapped with real images.

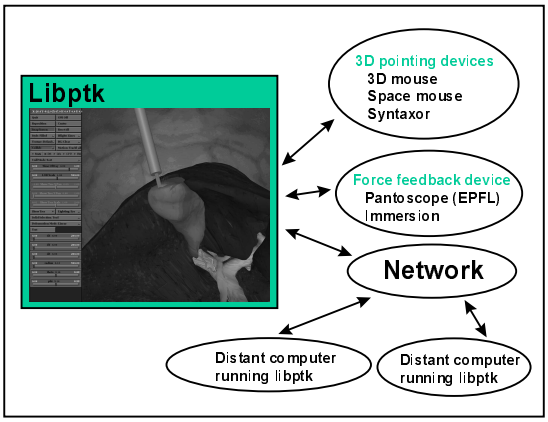

Figure 2 : Visualization program

Because of the substantial medical and financial benefit that "VIRFORCE" can lead, its first routine use is expected within one or two years. As the motions and forces can be easily scaled, microsurgeries of all kinds as well as several microassembly procedures could be made easier with this technology. A lot of projects are currently started in parallel to the VIRFORCE project.

In collaboration with the telecommunication Laboratory at EPFL, we are also investigating possibilities of surgical tele-teaching. We plan to connect our surgery training environment with a scalable multi-user communication platform based on ATM networks. This will allow for networking the know-how and gestual skills of a community of surgeons. Our ultimate goal is to provide the possibility of local and distant collaboration among surgeons, and cooperative training to students via audio-video communication with an expert surgeon.

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Selected publications

(1) R. Baumann et al., Force Feedback for Minimally Invasive Surgery Simulator, Proc. Medicine Meets Virtual Reality 4 - Health Care in the Information Age, San Diego, CA, January 1996 17-20, pp 564-579