Open Surgery in VR: Inguinal Hernia Repair According to Lichtenstein

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Abstract

VREST (Virtual Reality Educational Surgical Tools) is developing a universal and autonomous simulation platform which can be used for training and assessment of medical students and for continuing education of physicians. A workstation consisting of two haptic devices and a 3D vision system is part of the VREST platform. Another part of the platform is a generic software environment in which lessons can be built by the teacher and performed by their students. Using the platform one can see, feel and decide as in reality. With the assessment tool the progress and skills of the students can be supervised.

The first lesson build on the VREST platform is an inguinal hernia repair according to Lichtenstein. This is an open surgery procedure. The VREST platform is used prior to the first operating room surgery of the resident. Interactive models and case dependant feedback is used to enlarge the residents’ cognition. This should reduce the training time in the operating room.

1. Problem

The demand for proper health care is a hot issue. With time the expectation of the quality and capacity of medical treatments rises. The number of surgeons has to grow and for the quality issue, new innovative techniques and instruments arise. This results in a situation in which more surgeons need to be certified in lesser time. Besides they have to be able to cope with techniques with a fast growing complexity. Patients expect to be treated by an experienced physician, who is trained with the last insights. The development of an effective education system for surgeons is inevitable to meet these demands.
2. Tools and Methods

VREST (Virtual Reality Educational Surgical Tools) is developing a universal and autonomous platform which can be used for training and assessment of medical students and for continuing education of physicians [1, 2, 3, 4]. Unlike existing virtual trainers, our workstation is capable to load different operations of varying types. With a webbased interface the surgeon as a teacher can build and adjust operation lessons and protocols. The software will translate it to a set of measurable parameters in a clear structure.

Next to the content management system the software comprehends a virtual reality surrounding in which an operation can be simulated in a realistic manner. With the usage of haptic devices, the student is able to navigate in the virtual world and feel his actions due to accurate force feedback. To generate a sense of touch which suits the natural behavior of tools and organs, spring meshes and finite element algorithms are used. With the usage of fast calculating collision detection and a fast force rendering algorithm, we are able to touch and manipulate highly complex organs. The meshes can be cut, pulled aside and sutured afterwards with the graphics and physics. To provide the user a high quality three dimensional perception, the virtual operation scene is rendered in stereo, and synchronized with shutter glasses. Furthermore we have integrated a mirror in the platform to present the virtual patient a natural way; lying on a table in front of the user. Analyzing the information from the virtual surgery room and the information gathered from the haptics, the system is able to train and judge the students’ skills.

3. Results

In order to validate the system the trainer is filled with an inguinal hernia repair operation according to the Lichtenstein Procedure.

The user is able to use different surgical tools and has to make decisions about how to treat the patient correct. In order to meet the reality the system is supplied with
different patients who vary in injury complexity and anatomy. The amount of the feedback is based on the level of the student. During the surgery, the student may consult a database filled with medical media. After an operation the procedure of the student will be matched with the actual surgery protocol and the result is sent to the surgeon. Once the student has reached sufficient competence a virtual certificate can be handed.

Figure 2: VR incision in inguinal hernia repair training.

4. Conclusion

With the usage of an autonomous teaching and assessing workstation the efficiency of the educational side of medicine will increase. More students can be educated at the same time, while the teaching surgeon has more time available for his normal clinical work. At this moment the workstation is used at a local hospital and the effectiveness is validated by comparing the results with a reference group. We are convinced that, in order to meet medical capacity demands, the usage of autonomous virtual trainers is insuperable in medicine.

5. References