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RENDERING MEDICAL INTERVENTIONS VIRTUAL AND ROBOT

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Summary: **Medical virtual simulation** represents the present and future of medicine development. Development of computer assisted training system, in the anatomic pathological virtual environment allows navigation and interaction with this environment, as wanted and in real time frame. For an efficient simulation, the following objectives should be integrated: the geometric model – graphic representation, the physical model (elasto-dynamic), the model– user interaction (handling).

The world has always been fascinated by robots. People dreamed of building, using, and enjoying their advantages. If in the beginning they were only present in our imagination, in books, today they are real.

1. ROBOT SYSTEMS

Surgery benefited relatively late of the advantages of this technology. Initial use of robots in surgery started at the end of the 80s when an industrial robot was used to sustain instruments for stereo tactic biopsy in neurosurgery. At the end of the 80s IBM built the first robot used in clinical practice, named "Robo-doc". The first use of a robot in human surgery was a transurethral resection of the prostate. In 1993 Computer Motion, Inc., introduced a voiced controlled arm, AESOP (Automated Endoscopic System for Optimal Positioning), used for sustaining instruments, of the optic in laparoscopic surgery.

Nowadays, the most complex and efficient robot used is the DaVinci system developed by Intuitive Surgical Inc. (Sunnyvale, CA, USA) in 1995. With the DaVinci system in 1998, Carpentier achieved in Paris the first robot assisted cardiac intervention, a mitral valve replacement.

In recent years, we witnessed a spectacular development of medical technique, in the direction of gradually replacing classical, conventional methods with minimum invasive surgery and then with computer assisted surgery.

Advanced technologies already implemented in diagnosis procedures, now successfully used in surgery employ ***artificial intelligence***.

The concept of telerobotic surgery was developed by the US Defense Department, in order to provide overspecialized medical assistance to severe cases, even directly on the battlefield. The first prototype was completed in California, at SRI International, by Phil Green. The system included two high performing video cameras, fitted on a surgery table located in the battlefield, which transmitted the image of the operating room (open surgery) and of the patient at a remote computer, from where a surgeon controlled the arms of a telerobot which "was operating" on the patient.

Currently robots offer surgeons the possibility to make gestures they cannot make with instruments used in minimum invasive surgery.

The first generation of surgical robots has already been installed in various operating rooms around the world. In the USA alone there are over 3.5 million surgeries each year completed by means of robots.

Nevertheless, these robots have no autonomy, they do not work alone, but still need human control, they need to be guided by a surgeon from the tele-system or through voice control.

Currently there are three types of surgical robot systems: AESOP, the DaVinci system and the ZEUS system.

Surgical robots play an important role in increasing safety of interventions because they prevent and eliminate human errors (they reduce the range of involuntary movements, they prevent erroneous gestures etc.).

Operating rooms for robot surgery

Robot systems were created exactly to improve interaction between surgeons and the technical environment, thus optimizing system performance. If in traditional surgery there is direct interaction between anatomic structures and surgeons, mediated by classic standardized instruments, in minimum invasive techniques tissues are handled only by surgical instruments, and direct hand-tissue interaction is replaced by intuition.

Robot surgery tries to partially solve the issue by gesture accuracy and three-dimensional vision. Systems that could offer sensing data on organs and which could be sent to the surgeons fingers are being studied.

The experience so far has proved that robots manage to reduce the intervention duration, the inter-surgery incidents are less rare, the post-surgery pain and morbidity are lower.

If so far surgery developed the most, new relevant technology and equipment allow a higher degree of implementation in various medical fields.

In this view, the medical field certainly represents the field where simulation needs require a beneficial use.

2. COMPUTER AIDED SURGERY. VIRTUAL REALITY

Computer aided surgery is the term used to describe one of the most recent research fields in medicine, which covers both the latest surgical processes and the technology which makes them possible.

In the simplest sense, ***Computer Aided Surgery*** **(CAS)** is a boundary field between informatics, medicine and robotics. CAS represents the use of computers, robotics, optics and virtual reality to obtain the best surgical result in minimum period of time.

In other words this research field will allow a surgeon to operate on a patient, in another room or perhaps in another city, with micron accuracy. This can be achieved by using by the surgeon of robots and hydraulic and pneumatic handlers, controlled by means of special equipment: gloves connected through wires to various terminals and for 3D environment, all these being performed under the strict surveillance of computers.

The CAS concept is related to many of the most revolutionary recent approaches in surgery. One example might be the so called “minimally invasive surgery” (Minimally Invasive Surgery - MIS). The surgery is completed with instruments provided with video equipment, by very small painless incisions and with short healing time.

Aided surgery is also a ***simulation method of a virtual surgery***, completed on three-dimensional models of human organs, rebuilt from data taken from various scanning systems. Thus, a complex intervention which is imminent for a patient can be carefully planned, before starting to actually dissect live tissue.

CAS is currently used:

- To design innovative treatment methods for diseases which require a surgical approach.
- To improve treatment technology. New revolutionary instruments as laser, micro-surgery instruments, equipment with robot systems, can be first tested by virtual simulations and approved with regard to safety and compatibility of use in the human body.
- CAS programs can monitor post-surgery patient behavior, administering medication and recovery of affected tissues, by simulations with accelerated time.
- In surgical preparation (training) programs.

By using ***punctual simulation and sensor reaction transducers*** (force feedback), such C.A.S. modules provide ***a virtual environment close to reality***, where practicing surgeons can learn classic procedures or can experiment others new.

For teaching purposes currently are used:

a) Medical simulators. Use of simulators justifies its efficiency by:

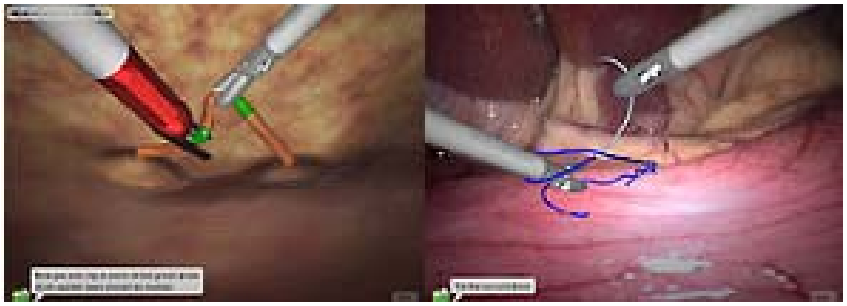
- the possibility to reproduce a high number of situations when reality of particular conditions and conceiving of a high number of imaginary situations can be simulated;
- saving important material or even human resources by acting in a virtual environment;
- initiation, training and perfecting the use of equipment and methods without their actual use being necessary;
- monitoring in time the failures in use and concluding many aspects which require corrections, improvements or even fundamental changes;
- Fast recovery of investments in such virtual systems.

a.1. LAPSIM – simulator

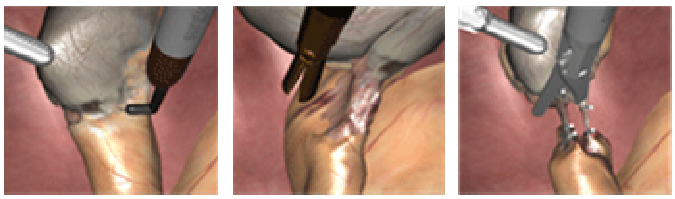
The use of video feed-back, based on monitors or other types of outer units render laparoscopy adequate for learning and training in computer based systems.

LAPSIM Software consists of 3 components:

- ***Lapsim Basic Skills ver.3.0– basic software***



- Lapsim Dissection - add-on



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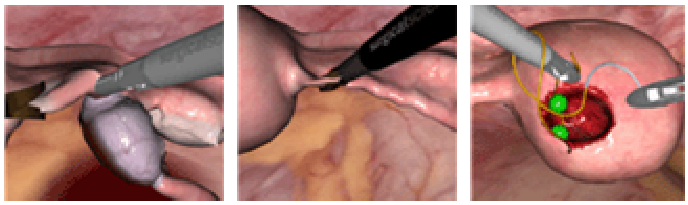
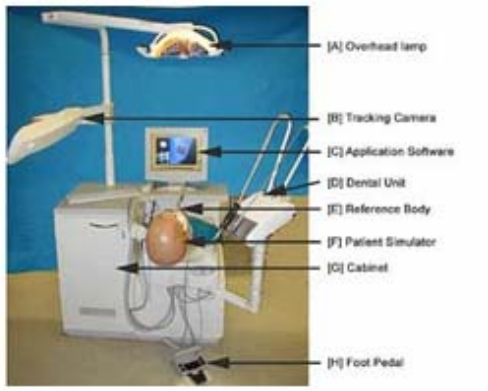


a.2. DENTSIM – dental simulator

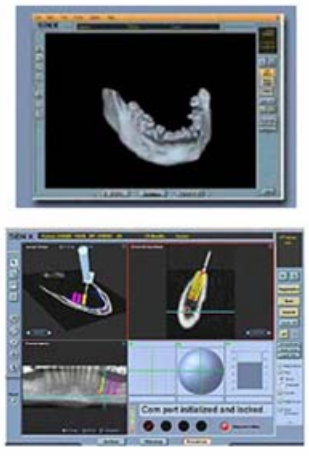


Dentsim is a revolutionary dental system for learning, training and qualification in dental methods. Using the newest graphical techniques and simulation technologies, the system provides the most authentic way of training currently in the world.

b) Computer aided surgery

b.1. IGI system - Image Guided Implantology

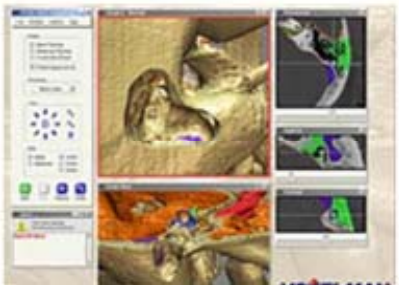
At first a virtual implant is added on the CT image (Computer Scan) by means of work instruments of the IGI system.



During the surgical procedure, the surgeon is assisted for an accurate positioning of the implant.

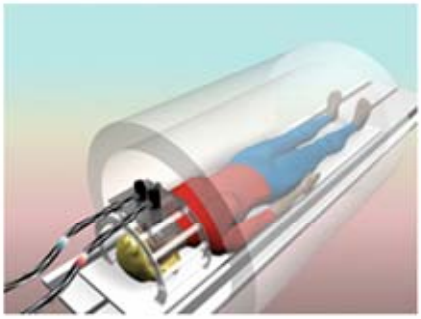
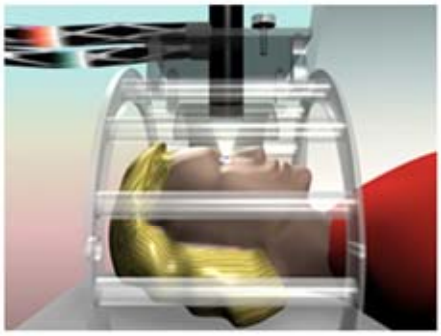
b.2. TempoSurg – average ear surgery

The system with feedback possibilities simulates surgeries of the average ear: implants, operation on tumors and other treatments being unique by the constant stereoscopic three-dimensional visualization by means of 3D shutter glasses.

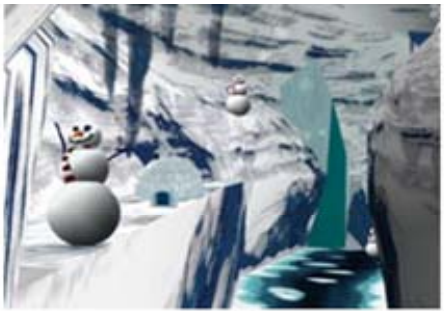
c) Virtual treatment of pain

c.1. ***Virtual Reality Analgesia****:* the illusion of entering virtual reality is created. During the introspection in the imaginary world, the patient senses a reduction of pain. The device facilitates research of the human brain in order to discover the phenomena which generate pain reduction.

c.2. Water-Friendly Virtual Reality.

Hunter Hoffman created and Jeff Magula built an optical fiber VR with the role of distracting the burnt patients' attention from the physical pain. The patient is placed in a water tub and by means of VR accessories the virtual world gets the patient's attention, resulting in reduction of the activity of the attention centers by accelerating the centers for vision and focus. Thus pain which usually accompanied change of bandages is much diminished.

c.3. ***Virtual reality at the dentist*** Who has not dreamt of a dental intervention which passed very quickly and without pain or fear of the "dental equipment"? Now this is possible with the help of virtual reality. By means of special devices, the child can play while the doctor completes the intervention.

Although it is still at the beginning, rendering medical interventions virtual and robot, will allow dissemination of knowledge and operator skills in the entire medical community.

The main ***advantages of aided surgery*** are:

- General availability of difficult surgical techniques;
- Creation of new surgical procedures;
- A new market of CAS applications and reduction of social costs an intervention implies (reduced hospital time, more efficient medication).

Upon applying the concept of surgical robots, or completely automatic surgeries, the following should be considered:

- ***Patient security***. If in the industrial environment application of robots is possible, the possibility of malfunctioning, which could jeopardize human lives, would make it impossible to place robots in the operating room;
- ***The unexpected*** – robots are perfectly adapted to repetitive, boring and dull actions, especially those hazardous for a human operator. In surgery very few operations are similar to others, and the unexpected can occur anytime;
- ***Decision making*** – robots did not develop so much that they are able to make complex decisions in complex situations.

3. CONCLUSIONS

The purpose of this paper is informative and the aim was the general presentation of results for robot implementation and the virtual world in a very sensitive filed– **medicine**.

The main conclusion of the paper is that visual simulations have a higher degree of teaching application; taken images can be transferred into multimedia formats, as mpg, and further used in educational and planning steps of the treatment.

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