

Visual realism in surgery simulators is the focus of research in the Institute of

Researchers develop new computer graphic tools from videos of actual procedures with the aim of improving the training of surgeons

A micro camera and surgical instruments are introduced through small incisions into the patient's abdomen in a minimally invasive procedure. From the images transmitted to a monitor, the doctor then performs the necessary interventions. Used for diverse types of intra-abdominal surgeries and gynecological and urologic procedures, laparoscopic surgeries have several advantages over conventional ones, such as shorter surgery time, faster recovery time and smaller scars.

However, proper training is necessary before the doctor performs this type of procedure. Future surgeons practice operations in virtual simulators – a kind of videogame in which they are free to train, without the fear of making a mistake, in a stress-free environment and without patient's involvement or ethical implications associated with animal use. The simulators also make it possible to perform a bigger number of laparoscopies and reduce the risk of complications and postoperative infections.

Unlike videogames, whose graphics have become increasingly realistic over time, the current surgery simulators have a low visual realism and can't capture the entire richness of details inside the human body. The models used today are similar to one which was developed at the Institute of Informatics of UFRGS about seven years ago. Among the reasons for this technological gap lies the difficulty in acquiring and processing living beings data. However, simulation fidelity, with realistic images that behold the diversity of situations that the surgeon may eventually go through, is crucial for the training. Operations planning can be maximized and the risk of surprises and complications can be reduced.

With the aim of making these simulators more similar to reality, researchers from the Institute of Informatics are developing computer tools that will generate high-resolution graphics, much closer to the so called photo realistic effect – reaching a perfection standard in which we can't distinguish virtual from real. From real laparoscopic videos, the researchers extract data about living organic tissues, which are used to improve the synthesized images. The study involves professors, undergraduate research apprentice students, master's and doctorate students, as well as medical practitioners of Hospital de Clínicas de Porto Alegre, represented by Professor [Leandro Totti Cavazzola](#).

A perfect example is the research carried out by doctorate student [Augusto Luengo](#). During his master's research, advised by professors [Marcelo Walter](#) and [Anderson Maciel](#), Luengo was fully committed to the development of a method of rendering images of living organs based on mathematical algorithms of global illumination. Global illumination is a technique used in 3D computer graphics that aims to bring more realism to the scene. The algorithms don't take only into account the direct light that goes straight to the object – as is the case of local illumination used in current simulators –, but also the light reflected by other surfaces in the environment. For instance, the light that is introduced into the abdomen to aid the surgery is reflected in a varied way by irregular surfaces of different organs in there.

This interaction between light and environment was what the researcher aimed to reproduce. For his doctoral research, started in 2014, Luengo intends to expand his work to cover also the representation of the texture of organs. "In the master's program, we only work with the reflexes, as if the material was homogeneous. But the organ is not homogeneous, it has layers, veins... and we also want to simulate that." Another idea of the researcher is to portray the patients' differences and individual characteristics to the simulators. For instance, a teenager's liver with a balanced nutrition is very different from an elder's liver with a high-fat diet.



During his master's research, Augusto Luengo proposed a method of rendering images of living organs based on mathematical algorithms of global illumination - Photo: Ramon Moser

At the same time Luengo is improving his research methods and results, other researchers are developing studies in the same field, like [Dennis Giovani Balreira](#)'s master's thesis, which sought to represent the internal structure of a human liver. Luengo expects the new simulator to be completed in about three years.

Dissertation Theses

Title: Rendering of in-vivo organs through sampling of BRDF with laparoscopy

Author: Augusto Luengo Pereira Nunes

Advisor: Marcelo Walter

Co- advisor: Anderson Maciel

Program: Graduate Program in Computer Sciences

Title: Visualization system for the interior of objects with internal structures for surgery simulation

Author: Dennis Giovani Balreira

Advisor: Marcelo Walter

Co- advisor: Anderson Maciel

Program: Graduate Program in Computer Sciences

Key- words: Computing; Computer graphics

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