Fraunhofer

FIRST

FRAUNHOFER INSTITUTE FOR COMPUTER ARCHITECTURE AND SOFTWARE TECHNOLOGY FIRST

CAMIS

Computer Assisted Minimal Invasive Surgery

Minimal invasive surgery is a routine clinical procedure. However, when using an endoscope surgeons can only see a small section of the interior of the patient's body, which sometimes makes it very difficult for them to find their way around. That is why Fraunhofer researchers are working on computer-assisted tools to improve the development of devices and support surgeons' work (computer-aided surgery).

Hardware Simulator

Using a simulator, researchers are testing the optical and mechanical properties of future devices. To do so, they begin by developing a virtual prototype modelling the device's desired functionalities. This enables requirements and functionality to be tested on the model at any early stage. The model is used to carry out a requirements analysis that forms the basis for the optical and mechanical components under development. Early evaluation of the virtual system makes it possible to significantly reduce the risk of the device not being accepted in clinical practice, even before a physical prototype is built. It also allows optimization of individual components through hardware-in-the-loop testing without the need for the time-consuming process of building and testing physical prototypes.

Modelling Organs and Devices

Fraunhofer researchers' core competence is in developing the required models – both of the hardware and of the human body (tissue and organs). Their behaviour – say, in the case of haemorrhage, injury caused by the device or movements – must be precisely modelled. For this purpose, a physically based simulation was developed that visualizes soft bodies (organs) as a mass-spring system (MSS). An MSS is a computer graphics tool commonly used in medical simulation to determine the deformation behaviour of polygon-net-based objects, which are rendered as mass nodes, mechanical springs and dampers. Besides integrating soft and solid bodies (bones, instruments), particle systems were implemented to simulate haemorrhaging, smoke produced by the sclerosing of cuts, and small tissue parts. To simulate the endoscope camera, its optical properties (field of view, lens distortion, line of sight, depth of field) and chip properties (image noise, resolution) and the endoscope's complex halogen light source are modelled. Users can test the various properties (e.g. optical properties, field of view, range and speed of motion) of the simulated endoscope prototype on their computer screen. The GPU-supported computation of the simulation results allows high frame rates and thus a swift, interactive response to changes. To visualize the instruments and organs, special rendering effects (differences in lighting, fine structure of surfaces, modelling of the endoscope's light source) were developed in HLSL pixel shaders.

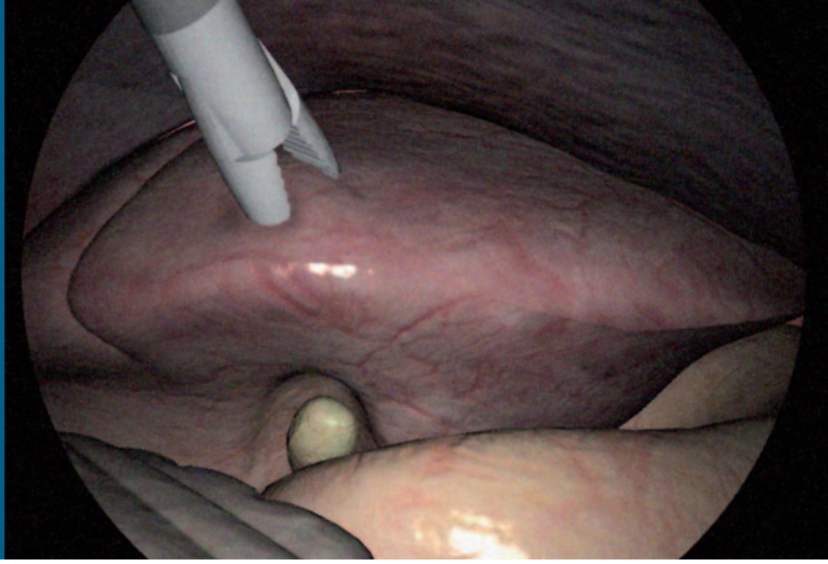

Image-processing technologies by Fraunhofer FIRST support the development of medical devices and allow for a better view during minimal invasive surgery

Simulators of virtual devices can also be used for developing other medical products. They make development faster and less expensive. Fraunhofer FIRST offers its customers from the medical technology sector services including model generation and prototypical development of simulators.

Real Time Processing of High-Resolution Image Data on GPUs

Nowadays, medical devices such as endoscopes and microscopes produce high-resolution images and videos in HD quality. The high resolution requires powerful image-processing techniques. Thanks to their long-standing expertise in computer graphics and parallel processing, Fraunhofer researchers are able to implement image processing on GPUs (graphics processing units). In a variety of projects, they have developed complex GPU-based solutions for the auto-calibration of multi-projector systems, medical simulation and visualization and computer vision applications. On account of their high degree of parallelism, GPUs are particularly well suited for executing compute-bound processes such as real time image processing. The fact that they enable a large number of processes to be executed in parallel means that high volumes of data can be analyzed quickly and efficiently. Application examples are denoising, edge detection, structure analysis and auto-focusing. It is the deployment of GPUs that allows, say, Fourier transformations or optical flow to be used for real-time video analysis. Use is made here of technologies like NVIDIA CUDA, OpenCL and shader languages, which by abstracting from the hardware programming allow the swift and flexible adaptation of algorithms.
The development of the hardware simulator and methods for the real-time processing of image data is being funded by the Federal Ministry of Education and Research as part of the Endoguide project.

Services Offered

- Generating models for the simulation of medical devices, organs and tissue
- Developing hardware and training simulators for medical technology
- Developing customized algorithms for the real time processing of medical image data
- GPU processing (implementation and parallelization of image-processing applications on the GPU)

Technologies Supported

- CUDA, OpenCL, HLSL
- PhysX, Simulation Open Framework Architecture
- DirectX, OpenGL
- 3ds Max, Maya, Blender

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