Background information

Erlangen, September 13, 2017

German Future Prize 2017

Anatomy Meets Cinema – Cinematic Rendering

To the layperson, the output of magnetic resonance imaging (MRI) or computed tomography (CT) scans is often nothing more than a meaningless jumble of forms in different shades of grey. It takes a trained eye to identify exactly what the images show. What if the inside of a human body could be visualized in photographic detail – complete with shadows and depth, as vividly as in real life?

Such a notion is no longer the preserve of science fiction thanks to Dr. Klaus Engel, Dr. Robert Schneider, and Professor Dr. Franz Fellner. Cinematic Rendering is a visualization technique that was developed by Siemens Healthineers experts together with clinical partners, and which uses raw data from CT and MRT scans to produce photo- and hyper-realistic 3D images of the patient using the diagnostic radiology software Syngo.via.

Siemens Healthineers researchers took their inspiration from the film industry and used this as a basis for developing the new medical visualization technology: An animated figure like Gollum in the film adaptation of the “Lord of the Rings” trilogy, for example, is entirely lifelike rather than a foreign object, despite having been digitally modeled and then retroactively inserted into the scenes in which he appears. This is achieved via a technique known as image-based rendering. In this process, a spherical panorama is captured using a reflective sphere, which records the current light environment for subsequent application to image datasets.

At the core of this innovation is the physics of light. Rays of light are made up of particles called photons. Photons interact with their environment: When light encounters matter, it is reflected, bouncing off in various directions. In some places it is absorbed, resulting in shadows. Up to now, medical 3D imaging has not leveraged these special characteristics of light. Previously, a simple ray casting model was used that produced images without precisely depicted depths and tissue structures leading to less realistic 3D volume visualizations.

For the first time, cinematic rendering enables photorealistic medical images – in this case, CT and MRI images – using techniques from physics: An algorithm simulates the complex interactions between photons and the scanned images of the patient's body. A randomized fraction of the most important of all the possible light paths is simulated using a Monte Carlo algorithm, and high dynamic range (HDR) light maps are used to define the light environment to generate realistic lighting effects. To make particular anatomical structures visible, the colors and transparencies of the MRI and CT acquisition data can be adjusted using a transfer function.

The process requires vast amounts of computing power and highly optimized algorithms, as hundreds or even thousands of light paths per pixel are calculated depending on the image resolution. The difference compared with the animation industry is that, besides calculating how light is reflected off the surface of the body, cinematic rendering also takes into account how light penetrates tissue and is scattered in different directions. In this way effects such as ambient occlusion can be modeled, whereby the depth of a fracture is taken into account. The deeper the fracture, the less light is able to penetrate, resulting in a range of shadows. The result is an almost perfect depiction of fractures and clearly defined organs and blood vessels – easily discernible from each other thanks to the inclusion of subtle shading and depth effects.

Since the beginning of 2017, cinematic rendering has found uses beyond research. Radiologists have access to the technology with the latest version of the Syngo.via imaging platform, allowing photorealistic clinical images to be generated from any CT or MRI scan. This does not cause any additional radiation exposure to the patient as rendering occurs in the postprocessing stage: with just a few clicks, a patient's images can be displayed on the monitor. Existing imaging data and images that have been generated using third-party scanners can also be displayed using cinematic rendering.

Using the new technology, a physician can access specific details about a patient's anatomy and pathology, facilitating a high degree of precision when planning the procedure. There are obvious uses for cinematic rendering in other medical disciplines, too: A 3D view of CT and MRI scans provides surgeons with key spatial information, for example. This is particularly true for surgeons specializing in musculoskeletal disorders, who can achieve insights into the topography of more complex fractures from 3D images. It will also be very useful for the planning and follow-up of vascular, neurological, and craniofacial surgery procedures and interventions. Better visualization enables surgeons to plan their interventions with more confidence, reducing the risk of complications in some areas.

The technology can also be used to assist communication between the physician and patient – especially when it comes to explaining the procedure and risks of a planned intervention. Photorealistic images make it possible to illustrate clearly how a fracture develops or how a tumor grows.

The technology also opens up new possibilities for medical students to learn more about the body – rather than dissecting cadavers, they can now use cinematic rendering to become familiar with the inside of the human body. Students as well as medical personnel and research assistants can gain a clearer understanding of the bronchial tree in the lungs, for example. The technology can generate very specific or comprehensive images of the body, from bone structures to soft tissue. Up to now, healthcare professionals such as nursing staff and physiotherapists have not had access to the insights that medical students gain through dissection: Cinematic rendering changes this, offering entirely new possibilities for studying human anatomy for people working in the medical industry.

Whatever the application, cinematic rendering generates photorealistic images of the human body with an unprecedented degree of plasticity. To explore the full potential of the innovation, Siemens Healthineers has created a prototype for surgical procedure planning that has special tools and a customized user interface. At different trials in European university hospitals, the added value of the technology is currently being trialed in different application areas. For instance, the Cardiff University Brain Research Imaging Centre (CUBRIC), a center for neurological imaging in Wales, is using cinematic rendering to research nerve fibers in the brain with a focus on the causes and development of multiple sclerosis. By visualizing nerve fibers and lesions, the researchers aim to gain a clearer insight into the adverse effects caused by the illness.

Molecular imaging is a further application area: PET/CT image data is used to visualize metabolic activity to track tumor development. Cinematic rendering highlights the increased metabolism of cancer cells, enabling physicians to identify tumors more clearly. The capacity to visualize uric acid at molecular level using Dual Source CT data is also useful, as cinematic rendering clearly indicates the emergence of gout in the hands. Dynamic processes like blood circulation in the body can also be visualized.

In addition, researchers from Siemens Healthineers are collaborating with clinical partners to determine potential application scenarios with augmented and virtual reality. For all further developments, the objective for the technology is to support clinical workflows to the greatest possible extent while ensuring a simple and efficient design and never losing sight of the most important factor: The patient.

Syngo.via can be used as a standalone device or together with a variety of Syngo.via-based software options, which are medical devices in their own right. Syngo.via and the Syngo.via based software options are not commercially available in all countries. Due to regulatory reasons its future availability cannot be guaranteed. Please contact your local Siemens organization for further details.

Further information and pictures are available at www.siemens.com/press/zukunftspreis2017.

Contact for journalists

Ulrich Kuenzel

Phone: +49 9131 84-3473; E-mail: Ulrich.Kuenzel@siemens-healthineers.com