Using raw data to create photo-realistic images of the body's interior

Klaus Engel has revolutionized X-ray imaging with his cinematic rendering process.

Klaus Engel of Siemens Healthineers in Erlangen, Germany, has led medical imaging into a new era with cinematic rendering: instead of sectional images that only radiologists can assess, this procedure converts data from X-ray machines and computed tomography (CT) scanners into photorealistic images of the inside of the body. For this, Dr. Engel has won an award as Inventor of the Year 2016 in the category *Single Outstanding Invention*.

Klaus Engel

Principal Key Expert for Visualization at Siemens Healthineers

Klaus Engel

Inventor of the Year 2016

"Medical images become understandable."

Sometimes, an invention is a game-changer. Since X-rays were discovered more than 100 years ago, the images have improved regularly but both classic X-ray images and CT scans can only be interpreted properly by experts. Laypeople can hardly recognize anything in the gray shades of these sectional images.

But computers have evolved and can now convert ever larger volumes of data into precise images at an ever faster rate, and Engel, a computer scientist and specialist for visualization in connection with computer animations, has tracked this process very closely. "I have been a keen computer gamer since my childhood," he says, "and the progress made in computer graphics over the years inspired me to develop the cinematic rendering procedure." The name refers to the progress in animation technology driven, above all, by the movie company Pixar. Developers at Pixar were the first to enhance computer-animated cartoons with lighting effects like in nature. This is the only way to make the cartoon figures look plastic and act realistically. Rendering is the process in which images are generated from raw data.

"It became clear to me that the right lighting is what counts in medical imaging, too," our inventor explains. Procedures already existed for CT scans to present arteries, veins, bones and tissue in 3D but there was no realistic lighting and thus no true spatial dimension. You can only achieve that if you know how the structures would reflect light if they were freed from the surrounding tissue.

"It was hard to find out how the light particles – photons – would behave," Klaus Engel explains. The propagation of light is a highly complex matter. Every light ray is scattered innumerable times when it hits the viewer's retina. Skin, for example, absorbs some of the photons and releases them at another point. It is therefore extremely difficult to represent human skin artificially, as the grand masters of painting were aware a long time ago. Since even the most powerful computer cannot cope when it comes to real-time computing of

"We want to get much more out of the raw data."

the millions of light paths that every object reflects, Dr. Engel and his team came up with the idea of using mathematical Monte Carlo simulation to identify and compute only the most significant photon paths. The depth of an image is created by means of soft and hard shadows as well as reflections – in short, everything that makes it look realistic.

Klaus Engel worked on the algorithms for years. The majority of his 52 registered inventions which led to 35 patent families with 28 granted patents, revolves around the cinematic rendering procedure. "Setbacks kept occurring at the beginning. The images were not built right or it took too long," the researcher reports. But he believed firmly in the success of the project. Finally, the cinematic rendering procedure was presented to the public in November 2014. The images attracted attention in the medical community throughout the world. Since then, many medical practitioners have loaded the software on to the imaging systems and used it in trials to plan surgery, to communicate with patients and colleagues and for education. In parallel, they gather the experiences which are needed to obtain approval as a medical visualization procedure. Even when that goal has been attained, the previous forms of images will not become superfluous. "Diagnosis with the aid of sectional images and conventional scans is still required in some circumstances," says Klaus Engel. He has not reached the end of his research by any means: "We want to get much more out of the raw data."

SIEMENS.COM/INVENTORS

SIEMENS.COM/PRESS/INNO2016