Background Information

Erlangen, November 21, 2018

RSNA 2018 in Chicago: South Hall, Booth 4136

Exploring the possibilities offered by digital twins in medical technology

- **AI-powered digital twins enable the simulation of individual organ physiology, with the ultimate aim being to simulate the entire human body to better understand patient health and predict changes as well as therapy outcomes**
- **Process optimization applications allow the impact of operational changes to be predicted in a protected and virtual 3D environment**

For some time now, digital twins have been used in other industries, where they help to optimize processes in manufacturing, workflows, and machine modeling. Siemens Healthineers has now applied the concept of digital models to human organs and workflows. The optimization of hospital processes is just one of the innovative uses for digital twins. Processes are analyzed, and cost and quality optimization parameters are examined and ultimately selected based on the insights gained. Simulating organs or even the whole human body, on the other hand, requires an AI-powered bio-physiological model. Such models require a tremendous amount of computing power, something that has only recently become widely available. Following on from initial research projects to create simulations of the human heart, other organs are now gradually being included on the path toward the vision of a digital twin of the entire human body.

The digital twin

Digital twins are part of a technology that links the real and digital worlds and stems from an intuitive technique that leverages artificial intelligence to turn data into actionable insights. First, millions of examples of curated data are leveraged to train deep learning neural networks. In a second step the neural networks are used to approximate parts of a combined individualized multi-scale physiological model. This holds the potential for evaluating the effectiveness of tailored treatments, paving the way for the expansion of

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precision medicine. Digital twins mirror reality and can detect problems that would otherwise remain imperceptible. They represent the next step towards the goal of providing "the right treatment for the right patient at the right time." Digital twins in medical care differ greatly from the industrial approach and rely heavily on personal data such as laboratory diagnostics and imaging, rather than existing data of a factory layout, for example. Digital twins and the digitalization of healthcare contribute to increase value by expanding precision medicine, transforming care delivery, improving patient experience.

Digital twin of organs

The first organ to be precisely simulated using these methods was the heart. Based on MR images and ECG measurements, the model simulates the physiological processes of a patient's most vital organ. Virtual planning can then be performed to visualize its responses to treatment on a computer before the actual intervention. Siemens Healthineers is developing intelligent algorithms that generate digital models of organs based on vast amounts of data. Cardiologists tested the use of these algorithms in cardiac resynchronization in a research project at the University of Heidelberg. Cardiac resynchronization therapy is a treatment option for patients suffering from chronic congestive heart failure. It involves an advanced pacemaker that resynchronizes the beating heart using two electrodes, one implanted on the right ventricle, the other one on the left ventricle. The Heidelberg cardiologists created a digital twin of the patient's heart, virtually implanted the electrodes, and virtually generated electrical pulses. If the asynchronous pumping of the virtual heart was corrected, it served as an indication that resynchronization therapy could also be successful in the real patient. This is an excellent example of using digitalization and artificial intelligence to help physicians develop more precise prognoses. The simulation of different scenarios not only improves treatment but also offers the potential to realize extreme time savings.

The vision – a digital twin of the human body

Digital twins of other organs are already being developed. Siemens Healthineers is pursuing an ambitious vision – that someday there will be digital twins of individual patients' entire bodies. These digital companions are intended to be more than just sophisticated anatomical models. In addition to a patient's clinical information, they could also contain cellular, molecular, and genetic information. If a patient's physical condition is already known ahead of time, physicians could decide whether a specific drug would be likely to

help and at what dosage it should be given. The final stage of this vision is to identify health problems even before they become clinically detectable. Data collected over the patient's lifetime could provide insights into the aging process and the patient's state of health. In combination with artificial intelligence, the digital twin could detect and highlight other risks through comprehensive patient observation. Digital twin technology is continuously being updated with new data being gathered, making the algorithms increasingly more accurate, with ever more data being collected and results evaluated. This individual prediction could potentially be helpful at allowing to continuous coaching of a patient to ultimately prevent disease.

Digital twin of workflows

In addition to the treatment of individual patients, digital twins could also help to optimize workflows, departments, or even entire organizations, such as hospitals. Throughout the world, budgets are under increasing cost pressure, while inefficient workflows and unnecessary deviations remain undetected. Time is a critical factor in many areas of healthcare, and every minute saved by optimizing processes can significantly improve patient experience and transform the delivery of care. The possibilities offered by creating a digital twin of individual processes and, ultimately, of entire hospitals or even workflows beyond hospital boundaries, have remained largely unexplored. On the U.S. market, there is tremendous interest in the optimization of processes and workflows – a trend that has been recognized by Siemens Healthineers and the Medical University of South Carolina (MUSC). In a strategic partnership focusing on creating value, they plan to explore a range of options, including process optimization using digital models of the hospital's daily routine. The goal is to offer patients the best possible care, and, at the same time, set a new standard for other hospitals. Several scenarios can be simulated as digital twins and their effects on process efficiency represented without incurring major costs. The technology is currently being used at the MUSC Shawn Jenkins Children's Hospital and the Pearl Tourville Women's Pavilion and is improving both patient and family experience as well as maximizing efficiency.

Digital twins can provide comprehensive support in these areas, and Siemens Healthineers is applying its extensive knowledge in the field of artificial intelligence in several projects. The company will be demonstrating the use of the digital twin and other applications involving AI and digitalization at RSNA 2018 in Chicago, South Hall, Booth 4136.

For more information on RSNA 2018, please see siemens-healthineers.com/press-rsna.

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Siemens Healthineers enables healthcare providers worldwide to increase value by empowering them on their journey towards expanding precision medicine, transforming care delivery, improving patient experience and digitalizing healthcare. A leader in medical technology, Siemens Healthineers is constantly innovating its portfolio of products and services in its core areas of diagnostic and therapeutic imaging and in laboratory diagnostics and molecular medicine. Siemens Healthineers is also actively developing its digital health services and enterprise services.
In fiscal 2018, which ended on September 30, 2018, Siemens Healthineers generated revenue of €13.4 billion and adjusted profit of €2.3 billion and has about 50,000 employees worldwide.
Further information is available at www.siemens-healthineers.com.