Revolution in the healthcare sector?

Digital Patient Twins improve diagnosis and therapy

Creating a Digital Twin of a static machine is certainly already demanding But how much more complex must it be to digitally recreate dynamic organisms like humans? Fraunhofer IESE is addressing the associated challenges and potential of Digital Patient Twins in the digital health domain. The institute's researchers are contributing their extensive expertise so that the efficacy of medications could be tested on the digital twin- even before a real person swallows the first pill.

What is a Digital Patient Twin?

Basically, the Digital Twin of patients is defined as a virtually precise, dynamic simulation of biological entities. Such a highly developed model can, for example, replicate cell structures, tissue, organs or entire patients and ideally contains all the information of the real counterpart. Digital Patient Twins are dynamic, i.e. they take into account changes over time and can simulate basic physiological processes, making it possible to make predictions about physiological functions, for example when taking certain medications.

The path to predictive health monitoring

Digital Patient Twins have enormous potential for a wide range of applications. For example, the models could help to visualise metabolic processes in the body. A great opportunity in medicine is that the digital twin can be used to clarify the effect, interaction or side effect of a medication – before a person takes the drug for the first time. This is similar to a Digital Twin in production, where machines can be maintained with foresight: The way is therefore paved for predictive health monitoring. And new doors are also opening up in terms of prevention, as the virtual image can indicate the onset of a disease at an early stage or reveal an increased, specific risk of illness. This means that patients can be protected from long-term consequences by taking timely countermeasures.

Digital Patient Twinning could also have a favourable effect on the topic of 'clinical studies': it should be hopefully become possible to simplify such studies on real people and shorten their duration by simulating the efficacy or dosage by Digital Patient Twins in advance. There are a few examples of clinical studies worldwide with Digital Patient Twins, with diabetes as a leading disease in several cases.

The challenge of the human organism

In principle, we have extensive knowledge about the molecular mechanisms – in other words, how cells work and interact with each other. However, humans are not machines that can be precisely replicated and predicted. Therefore, Digital Patient Twins will always face the challenge that this molecular complexity cannot be directly replicated, at least with todays technologies.

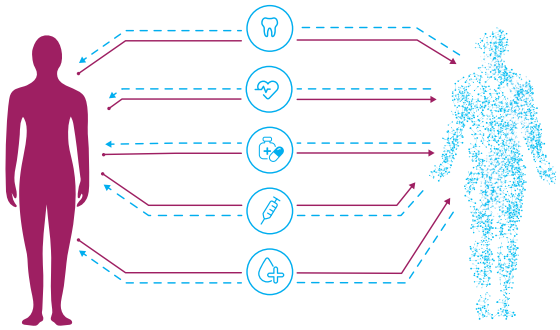
Despite the necessary abstraction and limitations, digital twins like the replication of individual organs, can still support medical advances A good example of this is the successful use of a Digital Twin Heart in cardiology. Ano-her example is the digital lung twin, which is individualised for patients. In future, this twin model will enable doctors to use computers to test various treatment and ventilation methods in advance – with the aim to ventilating each patient as gently as possible.

Enormous amounts of data are the basis

In order to create Digital Patient Twins, huge amounts of high-quality (medical) data is needed– in other words, long-term data covering a person's entire life. Assuming that all the data were available, it would still be a technical challenge to integrate the information from different data sources into a shared database. And data protection is of course also a sensitive and crucial aspect in this context. Who is authorised to access this data and from where? Who authorises access? The dependability and trusworthiness of the algorithms on which these analyses are based is also a decisive and not uncritical factor as medical decision would be based on the mathematical outputs.

Digital Patient Twins promise enormous potential for medicine, as they will hopefully soon be possible to detect diseases at an early stage – ideally before symptom onset. Fewer diseases through more prevention and a treatment reduction could be the future. Fraunhofer IESE is working on this with its extensive expertise in Digital Twins, Data Science and Data Protection.

Further information on digitalization in the healthcare sector:
www.iese.fraunhofer.de/en/trend/digital-health.html



The Digital Patient Twin can map physiological processes in the human body.

Digital Twin Hackathon

The Digital Twin Hackathon took place at Fraunhofer IESE in October 2023. Creativity was in the air and keyboards clicked to the rhythm of innovation – all in a race against time. Within 24 hours, 13 teams took up the challenge of using the Industry 4.0 middleware Eclipse BaSyx to bridge the gap between cutting-edge medical therapies and their manual production.

The winning team of the hackathon presented an approach in which Digital Twins are used to improve laboratory facilities in order to facilitate equipment management. The second-placed team used AR glasses, Digital Twins and AI models to optimise laboratory operations and increase the efficiency of experiments. The team that came third focused on creating a Digital Twin for laboratories to optimise workflows and improve data transfer. All of these innovative solutions illustrate the potential of digitalisation in the healthcare sector.

Many creative minds coded at the Digital Twin Hackathon at Fraunhofer IESE.

Here are some impressions of the Digital Twin Hackathon and further information:
https://basyxhack.iese.de/