Dependability of systems

Fraunhofer IESE utilizes Digital Twin technology to ensure the dependability of systems

Interview with Dr. Daniel Schneider, Division Manager Dependable Systems at Fraunhofer IESE

An important research area at Fraunhofer IESE deals with the dependability of systems. Particular focus is on safety and security with two dedicated departments. When ensuring safety and security in next generation system of systems, digital twins can be of great use. In this interview, Dr. Daniel Schneider explains how the Digital Twin is used and what role it plays in making systems more dependable.

Dr. Daniel Schneider
Division Manager
Dependable Systems

How can Digital Twins help to ensure dependability of systems?

In general, Digital Twins are digital representations of systems that describe certain aspects of the systems – but which can be updated dynamically and continuously. Current data from a running process, the system, and the environment are always incorporated, creating an accurate representation for a specific aspect of the system in the Digital Twin. To a certain extent, we have been working on this topic for over 15 years – longer than the term Digital Twins has actually existed. We used to call it Models@Runtime. This means creating models of systems and utilize them at runtime in order to support aspects such as dynamic adaptation or the guarantee of safety and security. In terms of guaranteeing safety and security, the aim is often to monitor and evaluate dynamic changes in the system or context in order to be able to react appropriately at runtime.

In recent years, we have increasingly been looking at the dependability of systems with Artificial Intelligence and, in particular, with neural networks. One specific approach is our Uncertainty Wrapper, which is a kind of Digital Twin that continuously makes statements about the uncertainty of the AI output at runtime.

What are the advantages of Digital Twins for dependability?

This depends heavily on the application. Ideally, runtime models enable that the performance of a system can be significantly improved. Instead of acting on the basis of worst-case estimates, systems can now monitor and evaluate the actual situation and then only do what is really necessary to ensure dependability.

Another positive example comes from pharmaceutical production. As part of the RNAuto flagship project, we are using the Digital Twin for quality assurance of pharmaceuticals. Each device in the production process was equipped with a modular Digital Twin in order to comprehensively monitor the production process and dynamically incorporate all relevant parameters. If the quality deviates, it is possible to intervene to minimise this. Automatic quality documentation can also be created, as all relevant data is already stored in the Digital Twins.

What other use cases are there?

We are currently increasingly dealing with dynamic systems that integrate at runtime. If this is the case, the systems often come from different manufacturers and are supposed to come together and work together ad hoc. According to our approach, each of these individual systems has its own Digital Twin that describes all the key characteristics of dependability. This allows automated analyses of dependability properties of the integrated overall system, which can then be continuously monitored and controlled.

Apart from that, we deal with systems at development time and their supply chains. It is often the case that various suppliers deliver components to an OEM, the original equipment manufacturer, and the OEM has the task of integration. Here we have the challenge of correctly integrating the models and work products for the dependability properties, which are often quite extensive and complicated. On the basis of our Digital Twins for dependability – so-called digital dependability identities – such integration scenarios can be partially automated supported by dedicated modeling tools such as our own modeling tool – safeTbox.

Is the Digital Twin becoming increasingly important for dependability – even in industry?

The term "Digital Twin" has clearly experienced a hype, especially in the area of production. But there are indeed promising ideas with plenty of potential here. The term is also increasingly being used in other domains. For example, we are currently researching various applications of Digital Twins in the healthcare sector, such as Digital Patient Twins to improve preventive care.