Digital Twin Based on Physical

Xiao. Li(1) , Wen-Yan. Yin(2) and Qiwei. Zhan*(3)
(1) Zhejiang University, Hangzhou, 310000, e-mail: neoli@zju.edu.cn
(2) Zhejiang University, Hangzhou, 310000, e-mail: wyyin@zju.edu.cn
(3) Zhejiang University, Hangzhou, 310000, e-mail: qwzhan@zju.edu.cn

As an emerging technology, digital twin technology has attracted the attention of many fields and scholars. About digital twin, a consensus has been reached that digital twin technology can realize the interaction and integrated connection between physical space and the virtual world. By constructing digital twins, we can accurately map the physical world in the virtual environment, to effectuate the virtual debugging, operation monitoring, and intelligent decision-making of the physical world.

Digital twin is fundamentally different from the existing simulation technology in the following three aspects:

1) Real-time

The computational cost of a high fidelity model is often high, and it can not simulate the real-time state of real objects. In the real process of 1 second, the calculation cost of the high fidelity model may even exceed 1 hour. However, digital twins must be accompanied by a real-time state.

2) Connectivity

One of the main features of digital twin technology is its connectivity. This technology builds up the connection between physical components and digital components. The basis of reality is the rich sensors in physical products, which can help us collect the real data needed by digital twins.

3) Authenticity

There are no two identical snowflakes in the world, digital twin is too. Therefore, we quantify the uncertain environment and other conditions. Strive to, ensuring the mapping of twins to reality to the greatest extent.

Given these three characteristics, we introduce three key technologies based on high fidelity multi-physical field simulation:

1) Model reduction

The introduction of model reduction technology can greatly accelerate the calculation time of the physical field, which is the basis of digital twin real-time.

2) Data assimilation

Data assimilation technology can realize the integration of digital information and physical information. On the one hand, different models are selected for simulation according to the real information, on the other hand, the existing models are modified according to the new information.

3) Uncertainty Quantification.

The information that is difficult to measure is incorporated into the digital twin through uncertainty quantification to ensure the authenticity of the digital twin to a higher extent.

To sum up, we design an implementation method of digital twin based on physical equations, including four key technologies: multi-physical field high fidelity model calculation, model reduction, data assimilation, and uncertainty qualification.

1. D. Hartmann, M. Herz, and U. Wever, "Model Order Reduction a Key Technology for Digital Twins," in Reduced-Order Modeling (ROM) for Simulation and Optimization, 2018, pp. 167-179.

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