Digital Twin KR3

Usecase and Application

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1 Introduction

Efforts to develop the key technologies that contribute to the three main capabilities of mirroring, shadowing and threading are underway in the DT-driven industries. [1]
Mirroring involves creating an exact virtual replica of a physical object or system in real-time. This capability is crucial for applications such as real-time monitoring and diagnostics, virtual prototyping, and testing of products before actual production. Industries like manufacturing, healthcare, and aerospace benefit greatly from precise replication and analysis to ensure quality and efficiency.
Shadowing focuses on continuously updating the digital twin with real-time data from its physical counterpart. This real-time data integration is essential for predictive maintenance, real-time performance optimization, and condition monitoring. Sectors such as energy, utilities, and smart cities utilize shadowing to ensure systems operate efficiently and to predict potential failures before they occur, thus avoiding downtime and reducing maintenance costs. [1]
Threading involves integrating and synchronizing multiple digital twins across different systems and processes. This capability is vital for complex system simulations, supply chain management, and coordinated operations across multiple locations. Industries such as logistics, large-scale manufacturing, and integrated urban infrastructure rely on threading to coordinate various elements seamlessly, ensuring smooth and efficient operations. [1]
In summary, the principles of mirroring, shadowing and threading are fundamental to the key use cases and applications of digital twin technology. These concepts enable comprehensive and integrated approaches to the monitoring, optimisation and management of complex systems across a wide range of industries.

2 Industry 4.0 and DT

In most industries, the development of Digital Twins is linked to the concept of Industry 4.0, i.e. the implementation of Digital Twin concepts , i.e. mirroring, shadowing and threading, is linked to or integrated with Industry 4.0 concepts such as the Internet of Things (IoT), cyber-physical systems (CPS), artificial intelligence (AI) and others. Today, any new implementation of digital twins should include one or more Industry 4.0 concepts. [2]

2.1 DT and CPS

Cyber-physical systems integrate cyberworld and dynamic physical worlds in a multi-dimensional and complex manner. CPS provide real-time sensing, information feedback, dynamic control and other services through the integration and collaboration of computing, communication and control, known as the "3Cs". [3]
Another concept associated with cyber-physical integration is the Digital Twin. A DT simulates real-world behaviour and provides feedback by creating high-fidelity virtual models of physical objects in virtual space. A DT reflects a bidirectional dynamic mapping process, breaking product lifecycle boundaries and providing a complete digital footprint of products. [3] This allows companies to predict physical problems earlier and with greater accuracy, to optimise the manufacturing process and to produce better products. [3]

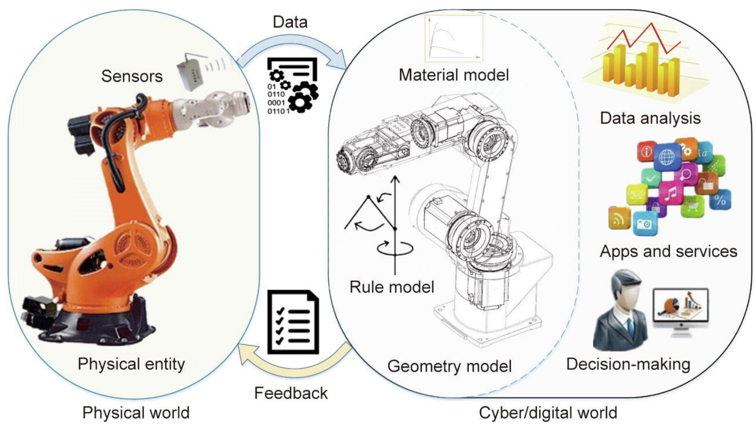

Figure 1: Integration of CPS and DTs

2.2 DT and IoT

References

[1] Y. Jiang, S. Yin, K. Li, H. Luo, and O. Kaynak, “Industrial applications of digital twins,” *Philosophical Transactions of the Royal Society A*, vol. 379, no. 2207, p. 20200360, 2021.

[2] F. Pires, A. Cachada, J. Barbosa, A. P. Moreira, and P. Leitão, “Digital twin in industry 4.0: Technologies, applications and challenges,” in *2019 IEEE 17th international conference on industrial informatics (INDIN)*, vol. 1. IEEE, 2019, pp. 721–726.

[3] K. M. Alam and A. El Saddik, “C2ps: A digital twin architecture reference model for the cloud-based cyber-physical systems,” *IEEE access*, vol. 5, pp. 2050–2062, 2017.