Semantic Digital Twins: Trends and Shortcomings (Keynote)

Evgeny Kharlamov

Bosch Center for Artificial Intelligence, Germany
SIRIUS Research Center, University of Oslo, Norway

Abstract

During the last decade the concept of Digital Twins, as digital representation of a physical object or system, has become one of the key building blocks towards digitalization and automation in the whole production value chain. In particular, Digital Twins are popular in manufacturing since they allow to seamlessly capture the entire manufacturing environment including facilities, processes, materials, personnel, etc. In the keynote talk we discuss the current practices and trends in the development and use of Digital Twins in smart manufacturing with a particular focus on approaches that are rooted in semantic technologies, that is, ontologies, constraints, knowledge graphs. We also discuss what are the limitations of existing solutions and requirements for the next-generation Semantic Digital Twins.

First, we discuss the vision of the concept of a digital twin will be analyzed based on the perspective from the industry. In this scenario, the main challenge still remains to have isolated information silos, and digital twins can support the aggregation of information from such silos. This goes beyond conceptual modelling, i.e. just interlinking the physical and digital conceptual models, but also connecting information across the project life cycle and solving the particular needs from industry.

Then, we deep dive into the analysis of the digital twin-powered industry 4.0, from vision to the main trends and current practices. Industry 4.0 can be enhanced with semantic digital twins and industrial knowledge graphs, which will enable applications to be built on top of such digital twins and the underlying knowledge graph they expose. The existing digital twin solutions provide flexible linking and integration of heterogeneous data across information silos, and having ontology-based solutions simplifies data access. The digital twin concept enables heterogeneous industrial asset data to be discoverable, presented in a homogeneous language, and understood by domain experts. Furthermore, diagnosis and analytics require specialised semantic languages to enable native analyses over semantic data models and combine data extraction and data analysis.

Finally, in the keynote we present different research directions for Semantic Digital Twins. The research community has a good room for improvement on topics such as the combination of ontologies and constraints, the use of modelling patterns and standards, the provision of quality management mechanisms, the construction of user-orientated solutions, and the enhancement of Digital Twins with machine learning, analytics, and simulation. Addressing these topics will give us the next generation of Semantic Digital Twins that are enhanced with modelling patterns, constraints, reasoning, quality metrics and user-oriented tools.

Keywords

Digital Twin, Ontology, Semantics

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0000-0003-3247-4166 (E. Kharlamov)