Fall 2022

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Publication Info

Published in *ISWC: 21st International Semantic Web Conference,*, Fall 2022.

MetaverseKG: Knowledge Graph for Engineering and Design Application in Industrial Metaverse

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Abstract

While the term Metaverse was first coined by the author Neal Stephenson in 1992 in his science fiction novel "Snow Crash", today the vision of an integrated virtual world is becoming a reality across different sectors[1]. Applications in gaming and consumer products are gaining traction, industrial metaverse applications are, still in their early stages of development with one of the challenges being interoperability across various metaverse development platforms and existing software tools. In this work we propose the use of a knowledge graph based semantic data exchange layer, the Metaverse Knowledge Graph, to enable seamless transfer of information across platforms. We discuss how this approach addresses the challenge of interoperability and leads to better interactivity and synchronization across tools.

Keywords

Metaverse, Knowledge Graph, Industrial Knowledge Graph, Interoperability, Industrial Design

1. The challenge of Interoperability in Metaverse solutions

The Metaverse is a photo-realistic, real-time, and physically accurate virtual representation of the physical world with its entities, relationships, events, states, and processes. According to a Gartner, it is among the top emerging trends in technology with the potential of becoming the next stage of the internet[1]. Platforms like, e.g., Nvidia's Omniverse, Unity or Unreal, are establishing themselves as the basis for building metaverse environments. While these platforms work great for gaming applications, many industrial usecases natively use other tools stacks. For example, virtual representations of a discrete manufacturing plant could be created in Siemens' Plant Simulation and metadata about product life cycles (PLM) is commonly stored in PLM systems, e.g., Oracle's Agile or Siemens' Teamcenter. Industrial metaverse applications wanting to represent industrial objects and processes will need the ability to access data from these sources, as well as harmonize the different data models and semantic representations found in them. Interoperability across metaverse platforms is a challenge that has been recognized by the community (such as W3C and Metaverse Standard Forum[2])[2]. To interoperability there is a

ISWC: 21st International Semantic Web Conference, 23-27 October 2022, Hangzhou, China
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[1]http://www.gartner.com/en/articles/what-is-a-metaverse
[2]https://metaverse-standards.org/

need for: a) Modeling the semantics and relationships of the metaverse entities across platforms - defining the semantics of the metaverse entities which can be transferred across platforms, b) Enable real time interactivity across platforms - The edits made should be communicated across platforms, c) Enable synchronization across platforms - The virtual entities and environment can be assimilated according to the latest updates. The update should not end up requiring re-running of the development pipeline, and d) Reusability of virtual entities, and environment across the platforms - The virtual entities, and environments created for one platform can be adapted for a new platform, domain, or scenario. We propose Metaverse Knowledge Graph (MetaverseKG), a first step towards achieving the goal of interoperability and standardization for engineering design and application in the industrial metaverse.

2. MetaverseKG: Metaverse Knowledge Graph

The MetaverseKG is a semantic exchange layer of metaverse meta-data entities and their relationships, enabling representation of the physical world into the virtual metaverse. It functions as a connective platform across systems, fusing data across different tools. The MetaverseKG provides the ability for integration and interoperability across platforms in industrial engineering and design applications. The MetaverseKG a) describes the semantics and the relationships between the metaverse entities and tools, b) bridges the gaps across metaverse platforms, and c) standardizes the concepts that can be applied across the metaverse development pipeline. The seamless integration of semantic information in MetaverseKG enables synchronization across platforms. The updates made by user interactions, or design changes do not require a new design and development iteration. The updates can be seamlessly integrated into the design steps by running a few update queries to the MetaverseKG. The updates can be transferred; and the user interaction, or the design changes can be assimilated according to the new edits.

3. Discussion and Conclusion

The MetaverseKG has an advantage over the existing tool-to-tool integration platforms for solving the issue of interoperability. The development of tool-to-tool integration is a time-consuming process, requiring teams of diverse technical backgrounds to work together closely and involves several iterations of the tool before production is ready. The existing tool-to-tool integration development lacks scalability, whereas adding data from a new tool to MetaverseKG is a seamless integration process, which simply requires adding a knowledge graph linked to the new tool's data representation. The MetaverseKG is still in its early stage, it has enormous potential in addressing the issue of interoperability for industrial metaverse development.

References

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