Developement of Digital Twins of Scientific Equipment and Systems for MegaScience-class Installations.

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Abstract

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1 Introduction

In the realm of MegaScience-class installations, the concept of digital twins has emerged as a transformative technology, offering unprecedented opportunities for enhancing the design, operation, and maintenance of scientific equipment and

systems. A digital twin is a virtual representation of a physical asset that enables real-time prediction, optimization, monitoring, controlling, and improved decision making in scientific equipment and systems [1]. This technology is not just a theoretical construct but a practical tool that has been increasingly applied in various fields, including manufacturing, healthcare, and now, in scientific research facilities.

The development of digital twins for scientific equipment and systems involves creating a framework that provides monitoring and evaluation capabilities for equipment involved in manufacturing and experiments [2]. This framework is crucial for MegaScience-class installations, where the complexity and scale of equipment and experiments demand precise and real-time monitoring for optimal performance and safety.

Moreover, digital twins serve as a new normal form for solving problems in a changing context, such as in the case of product quality monitoring, as highlighted by Zhang et al. (2020) in their study on a product quality monitor model with the digital twin model [3]. This adaptability is particularly valuable in the dynamic environment of MegaScience installations, where equipment and systems must consistently operate at peak efficiency under varying conditions.

The integration of computational models, sensors, learning, real-time analysis, diagnosis, and prognosis in digital twins supports engineering decisions related to specific assets [4]. This comprehensive approach is essential for the intricate and high-stakes nature of scientific research, where even minor miscalculations or malfunctions can lead to significant setbacks.

In summary, the development of digital twins for scientific equipment and systems in MegaScience-class installations represents a significant leap forward in the management and operation of complex scientific infrastructure. By leveraging the power of virtual modeling, real-time data analysis, and predictive capabilities, digital twins offer a pathway to more efficient, reliable, and advanced scientific research.

2 Literature Review

3 Research Setup

4 Methodology

5 Preliminary Results

6 Conclusion

7 References

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