Towards a Mining Metaverse: Spatial Computing Meets Digital Twins for Remote Operations

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ABSTRACT

Digital Twins (DTs) are transforming business operations across many industries through their accurate representations of physical entities enabled by IoT technologies. By integrating real-time data analytics and artificial intelligence, DTs can provide valuable insights for decision making, such as predicting failures before they occur, optimising processes, and enhancing performance which in turn, deliver tangible values to businesses around the world. DTs have been successfully applied in various sectors, such as manufacturing, aerospace, and the building industry, to transform their business operations and create competitive advantages in the face of the fourth industrial revolution. However, the minerals industry has not fully embraced the potential of digital twins, especially in terms of incorporating effective visualisation and intuitive user interaction designs to maximise the fidelity, usability, and scalability of cyber-physical systems. One promising way to address this gap is to leverage Extended Reality (XR) technologies, which enable immersive and interactive experiences in a virtual environment. XR can also facilitate the creation of an industrial metaverse for mining-related applications, where users can collaborate and perform real-world tasks in a shared, persistent virtual space from different locations. To demonstrate the feasibility and benefits of this approach, this work presents a proof of concept by developing and deploying a digital twin with real-time monitoring and control capabilities for a legacy ball mill operation, a common type of processing equipment used in the minerals industry. The paper also shows how XR can be used to guide the creation of a cyber-physical system for remote operation and crisis management using software platforms that are widely used in serious game developments.