

Chapter 2

Bridging AI, Healthcare, and Industry Using Digital Twins for Transformative Solutions

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ABSTRACT

The integration of Artificial Intelligence (AI), healthcare, and industry is undergoing a revolutionary transformation with the advent of digital twin technology. Digital twins are virtual replicas of physical systems that serve as the bridge that connects these domains, enabling real-time data analysis, predictive modeling, and personalized solutions. Digital twins facilitate a seamless flow of information across AI-powered healthcare systems and industrial frameworks. On the industrial front, digital twins are revolutionizing healthcare manufacturing, drug development, and medical device innovation. However, implementing these solutions comes with challenges, including data privacy, interoperability, and computational complexity. Despite these challenges, the use of AI-driven digital twins holds immense promise

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in shaping a future. By bridging AI, healthcare, and industry, digital twins pave the way for transformative solutions that improve lives and redefine possibilities.

1 DIGITAL TWINS AND ITS EVOLUTION IN HEALTHCARE AND INDUSTRY

The digital twin with regard to the creation of a virtual replica of a physical asset has become a disrupter across multiple domains, such as the healthcare sector and production lines. The idea of using a virtual model to mimic a tangible subject or object in terms of action and productivity has spiked from rudimentary simulation models involving mechanical and mathematical algorithms, to complex, data-based systems supported by developments in AI, IoT, and big data (Hassani et al., 2022). Originally developed for the aerospace industry, today's digital twins cover a broad range of industries and industries – their main purpose is predictive analytics, optimization, and improvement.

In the field of healthcare, digital twins are now paving the way for a new type of focused diagnostics and prognosis. From the genetics, the medical history and real-time data procured from wearable devices, the digital twin offers an all-rounded view of the health status of a patient. Such models allow clinics and physicians to forecast different outcomes of treatment and estimate the results of treatment (De Benedictis et al., 2022). For instance, thanks to digital twinning of the nervous system, it is possible to simulate organ surgery, including the heart or lungs, to avoid possible complications or to study the effectiveness of a medical intervention before applying it in practice. Also, they enable the perfect fitting and implant fabrication done in accordance with the patient's anatomy, optimizing comfort and functionality.

In industries, digital twins mainly assist in improving processes, identification of potential problem areas for maintenance, and increasing operational productivity (Kshetri et al., 2021). In manufacturing, they offer visibility into manufacturing lines, making it easier for organizations to discover bottlenecks, make improvements in productivity, and improve product quality. Through developing Digital Twins of specific machinery or overall facilities, different situations may be tested and studied to recognize possible difficulties and overcome them ultra-early. In the energy domain, the digital twin of the power grid helps to sustain the stability and reliability of power systems and the operators can easily plan the fluctuating demand and supply of power (Sahal et al., 2022). This synergy fosters innovation, enhances decision-making, and delivers transformative solutions to some of the most pressing challenges in healthcare and industry.

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