Chapter 1
Unveiling the Essence of Digital Twins:
A Comprehensive Study on Digital Twins for Future Innovation

Hirak Mondal
Department of Computer Science and Engineering, North Western University, Bangladesh

Saima Siddika
Department of Computer Science and Engineering, North Western University, Bangladesh

Anindya Nag
Computer Science and Engineering Discipline, Khulna University, Bangladesh

Riya Sil
https://orcid.org/0000-0003-4158-9301
Department of Computer Science, Kristu Jayanti College, India

ABSTRACT

A digital twin (DT) can be seen as a tool that speeds up the process of innovation. DT provides numerous advantages by generating a real-time replica of tangible systems. These benefits include faster business processes, higher productivity, and more innovative ideas at lower costs. It is one of the most exciting new digital technologies being worked upon to provide assistance to different types of businesses to go digital and make decisions. The idea of a DT has been around for almost 20 years, but it is still changing as it is used in various fields. This chapter looks at 46 different definitions and research work of DT that have been written in the last 10 years and comes up with a single, more general definition that includes all of them. It also gives a detailed description of the DT and how it differs from other digital technologies. A case study is provided on how DT works and how it can be used, along with discussions on future opportunities of DT.

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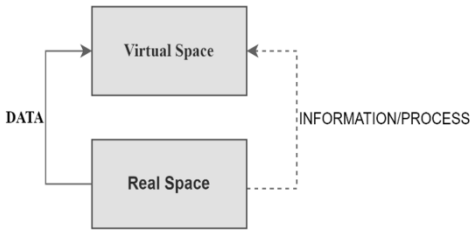
1. INTRODUCTION

Digital Twin (DT) technology drives digital transformation, enabling innovative business models and decision tools. Companies are integrating data, analytics, and services, or are in the process of doing so (Delen et al., 2013). DT is a digital replica of a physical product, originating from product life cycle management. Grieves identifies three key elements: the physical product, its digital representation, and two-way data connections for information exchange (Grieves et al., 2014). This process, shown in Figure 1, involves transferring data from the physical to the virtual world through twinning and vice versa. Twinning syncs real and virtual environments, with virtual spaces supporting functions like modeling, testing, and optimization.

Figure 1. Twining Real and Virtual Environments



DT, along with cloud computing, augmented reality, ML, AI, and IoT, has gained popularity in academia and industry in recent years. This growth is evident in Figure 2, which shows increasing DT adoption in maintenance research. Publications, including journals, books, and articles, highlight this trend. The article volume in 2019 indicates a rise compared to 2018, with no output between 2014-2015, possibly due to phased digitalization, IoT integration, or ML data analysis preceding DT adoption for maintenance (Errandonea et al., 2020).

Figure 2. Search Results per Year