# Chapter 9
# Geospatial Information Based Digital Twins for Healthcare

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## ABSTRACT

*A digital twin refers to a virtual model of a process, product, or service. It is a bridge between the physical world and digital world. Due to its obvious benefits, more organizations are adopting it, particularly in medicines and healthcare. The big data can be collected through wearable sensors, GPS, images, and IoT, and analysed with AI and machine learning that can be very helpful in various aspects of health sector. The GIS improves data capture and integration, leads to better real-time visualisation, offers detailed analysis and automation of future projections, and facilitates communication and cooperation. Digital twins are very helpful in personalised healthcare, monitoring the treatment. There are, however, many challenges associated with the digital data of patients, such as digitization of health records, security of data, and real-time analysis and predication to provide efficient and economical healthcare services.*

## INTRODUCTION

Our world is changing very fast and becoming high-tech. It is anticipated that by 2050, 2/3rd of the world's population would be living in the major cities. As the technology grows, it has the potential to improve the comfort and quality of lives of people living in the cities. The 4th Industrial Revolution (IR) is rapidly changing the way we live, we think, we work and we interact; creating a visible impact on our cities. This dramatic change is possible only through the adoption of latest digital technologies, such as the digital twin, internet of things (IoT), sensors, artificial intelligence (AI), machine learning (ML), autonomous vehicles, big data analytics, cloud computing, blockchain, virtual reality (VR), augmented reality (AR), building information modeling (BIM), and many others. Geospatial technology is considered as a powerful tool for transformation of digital information into actions (Garg, et.al., 2022).

A digital twin is called a virtual model which replicates the 3-D framework, physical properties and environmental conditions of a process, product or service. It works as a bridge between the physical

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world and the digital world. The digital twin model allows us to examine the input-output factors, and thus it enhances the learning which then can be applied to its physical counterpart. Digital twins can represent current, past, or even future states of assets that may not exactly represent what exists in the real-world (Mostak, 2021). The state of art digital twins provide information beyond the current state of Earth and its objects and infrastructure.

Since 1960s, the concept of digital twins is being used. The NASA has been creating digital twins of its physical space mission systems to test the equipment in a complete virtual environment. In 1990s, the idea of digital twins emerged in David Gelernter's book (Gelernter, 1993). The digital twin idea has originally emerged in the product manufacturing sector (Arun, 2017). Since then, the digital twin technology has received much attention both in industry and research, and is being used in a large number of industrial applications (Kamel Boulos & Zhang, 2021). For example, precise digital models of complex structures, e.g., aeroplanes, can used for testing their performances. With digital twins, integration of additional layers is possible; each incrementally improving the representation and analysis (Mostak, 2021). In recent years, the integration of geospatial technology, BIM, and interactive 3D model have enhanced the use of digital twins. Digital twins deploy automated techniques to enhance the business processes, reduce the risk involved, maximise the output, and fasten the decision-making by predicting outcomes. geographic information system (GIS) technology provide the basic framework for the creation of any digital twin model.

Digital twins are already being developed in engineering and manufacturing, but researchers are now exploring the same principles to apply to the medical world to improve the clinical and public health outcomes. Earlier, it was not common to see digital twins beyond industrial manufacturing because they were very expensive to build. Today, digital twins can help researchers and doctors to detect the diseases and study the effects of medicines through simulation. Affordable new technologies have now given the flexibility in making digital twins more accessible and applicable. The digital twin technology is creating a revolution in the healthcare and biotechnology to create a revolution in the lives of the people. It can help identifying useful symptoms for chronic diseases, and make a comparison of various treatment methods of similar types of patients. This kind of analysis will be very useful for medical doctors to actually perform the tests with the patients (Ghazanfari, 2022). Digital twin has the capabilities to enhance the processes of clinical treatments, as it can be used to ask questions and get possible answers, and use these answers to derive into actions without actually experimenting straightaway on patients.

## ELEMENTS OF A DIGITAL TWIN

There are four broad elements as given below:

1. **Data Capture:** Digital twins are providing opportunities to organizations to devise approaches for capturing and visualizing the data. In addition, it is important to use the techniques to integrate the data and analyze information, such as data modelling, feature creation & extraction, and workflow & business systems
2. **Real-Time Analysis:** It helps selecting the right decisions, discovering the new patterns, and revealing the future trends with real-time information. It includes dashboards, reporting, real-time IoT integration, analytics, and visualization of data.