A Blockchain Based System for Healthcare Digital Twin

ABSTRACT

Digital Twin (DT) is an emerging technology that replicates any physical phenomenon from a physical space to a digital space in congruence with the physical state. However, devising a Healthcare DT model for patient care is seen as a challenging task as the lack of adequate data collection structure. There are also security and privacy concerns as healthcare data is very sensitive and can be used in malicious ways. Because of these current research gaps, the proper way of acquiring the structured data and managing them in a secure way is very important. In this article, we present a mathematical data model to accumulate the patient relevant data in a structured and predefined way with proper delineation. Additionally, the provided data model is described in harmony with real life contexts. Then, we have used the patient centric mathematical data model to formally dene the semantic and scope of our proposed Healthcare Digital Twin (HDT) system based on Blockchain. Accordingly, the proposed system is described with all the key components as well as with detailed protocol flows and an analysis of its different aspects. Finally, the feasibility of the proposed model with a critical comparison with other relevant research works have been provided.

**EXISTING SYSTEM**

Peng *et al.* [53], in their article have presented a construction case on hospital DT in China, which had already been built. The authors have delineated how the hospital twin has been developed based on Continuous Lifecycle Integration method. A lot of sensors, for acquiring real time data of the hospital, have been planted during construction and the whole system can be controlled from a single point through DT. However, there is nothing mentioned about access control and encryption mechanisms for the collected data.

Liu *et al.* [54] have proposed a cloud based framework with healthcare DT. The reason behind the project is that there are elder people who hardly take medical services because of their indifference toward diseases. The authors have developed the system comprising of 4 parts: Physical object, Virtual object, Cloud healthcare service platform, and healthcare data. Although, some important aspects have been described, however, no algorithm has been mentioned for the predictive measures.

Shamanna *et al.* [55], introducing Precision Nutrition to DT. The paper is about Twin Precision Nutrition (TPN) which monitors a group of 64 years old type 2 diabetic patients to reduce HbA1c in blood. The platform collects data from body sensors and a mobile app (TPN) to track and analyze the body health signals in order to personalize the patients' treatment. Although the system is devising results based on real time data, the authors have not provided any mechanism by which they have conducted the analysis.

Barbiero *et al.* [56], in their article have proposed an architecture combining the qualities of a generative model with a graph-based representation of pathophysiological conditions.

In [57], Petrova *et al.* have proposed a DT platform for exploring the behavioral changes in patients with proven cognitive disorders with a focus on multiple sclerosis. One of the primary components of this platform is functionality for collecting data for the DT.

**Disadvantages**

* The system is not implemented public blockchain and only implemented private blockchain in which security is very less.
* The data is not accumulated while patient goes through disease assessment phase.

Proposed System

1) A patient centric mathematical data model to represent the patient data in a defined and structured way.

2) The proper delineation of the clinical data with real life contexts which will be perceived by DT while the patient is on the treatment phase.

3) A blockchain integrated Healthcare Digital Twin System architecture based on the proposed data model with proper threat modeling and requirement analysis.

4) A number of protocol flows utilizing the blockchain based system which showcases how the system can be utilized in different scenarios.

5) A detailed analysis of the proposed system covering its feasibility, advantages/disadvantages, comparisons with Health Insurance Portability and Accountability Act (*HIPAA*) [18] and the General Data Protection Regulation (*GDPR*) [19] as well as with other existing research works.

6) Finally, the limitations and the future scopes of the presented system.

**Advantages**

* The system is implemented DT which stands for the representation of the anatomy of a digital asset in a digital space which is the depiction of a physical

phenomena from a physical space.

* In the proposed system, the system is implemented DIGITAL TWIN FOR DEVELOPING A PRODUCT and DIGITAL TWIN FOR AN INDIVIDUAL INSTANCE which are more secure and safe.

**SYSTEM REQUIREMENTS**

➢ **H/W System Configuration:-**

➢ Processor - Pentium –IV

➢ RAM - 4 GB (min)

➢ Hard Disk - 20 GB

➢ Key Board - Standard Windows Keyboard

➢ Mouse - Two or Three Button Mouse

➢ Monitor - SVGA

**Software Requirements:**

* Operating System - Windows XP
* Coding Language - Java/J2EE(JSP,Servlet)
* Front End - J2EE
* Back End - MySQL