# A Blockchain Based System for Healthcare Digital Twin

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**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.

## 1.INTRODUCTION

According to the latest statistics from the World Health Organization, about 930 million people worldwide are at risk of falling into poverty due to out-of-pocket health spending of 10% or more of their household budget. Currently, there is a surge in improving the healthcare situation and a myriad of developments are ongoing in the healthcare sector with respect to Artificial Intelligence Big data and in other spectrum. Though, it is not something that can be assuaged outright, whereas the real problem is not in the slow advancement of the technology, rather the mishaps in real life, e.g., adverse events, late diagnosis, etc. DT can bring an immediate alteration in the healthcare sector from its root by incorporating analysis, predictive measurements, decision making paradigm, and data collection.

There are some notable developments in the healthcare sector incorporating DT. Martinez-Velazquez *et al.* have developed a cardio twin based on the heart that can mitigate the risk of any Ischemic heart disease. Barbiero *et al.* have proposed a

general framework to provide a panoramicview over current and future physiological conditions. However, the recent developments in DT for the healthcare sector, have some drawbacks from the perspective of data sharing, storage, and access control. Also, without any proper framework, collecting a large amount of data haphazardly will cause a disarray which will perpetuate when involving other data transformation techniques. For these reasons, it is a prominent task to decide in which way DT will perceive which healthcare data from which dimensions. To solve these problems, we propose a structured mathematical data model to collect the patients' data in a systematic and prede _ned way so that a cluster of acute information about a physical patient and its surrounding environments can be accumulated while they are at the hospital. With the proposed data model the patient can be individually identified as well as the patient portfolio can be concocted with the clinical data.

It is often reported that people show a lack of concern regarding the security of the health data which leads to integrity and confidentiality breaches. Around 881 breach reports have been recorded within the last 24 months and are under investigation by the U.S. Department of Health & Human Services. Therefore, to effectively solve this problem, a system is needed that can store and keep data securely with proper structure. Moreover, around 60% of the counties in the world have the capacity to review the progress and performance of the healthcare systems and around 59% can use data to drive policies and planning for the health sectors. To cover these wide distributed nationwide healthcare sectors, having the mentioned potentials, a distributed network can be implemented by enforcing a distributed storage facility without any central governing authority. For this reasons, the block chain technology can be integrated with DT to accumulate this insurmountable health data in a structured and distributed way with adequate security properties. In a block chain based DT system for healthcare, block chain renders the services of collecting intricate and diverse data immutably with proper access and sharing mechanism, on the other hand, DT provides proper data analysis, aggregation, prognosis, and representation services which are conducive to build a proper healthcare DT. To mitigate these issues, in this article, we present a concrete mathematical model for patients' clinical data and then propose a block chain based Healthcare Digital Twin system based on the presented data model.

## 2.LITERATURE SURVEY

### 2.1 F. Alshehri and G. Muhammad, ``A comprehensive survey of the Internet of Things (IoT) and AI-based smart healthcare,'' *IEEE Access*, vol. 9, pp. 3660_3678, 2021.

Smart health care is an important aspect of connected living. Health care is one of the basic pillars of human need, and smart health care is projected to produce several billion dollars in revenue in the near future. There are several components of smart health care, including the Internet of Things (IoT), the Internet of Medical Things (IoMT), medical sensors, artificial intelligence (AI), edge computing, cloud computing, and next-generation wireless communication technology. Many papers in the literature deal with smart health care

or health care in general. Here, we present a comprehensive survey of IoT- and IoMT-based edge-intelligent smart health care, mainly focusing on journal articles published between 2014 and 2020. We survey this literature by answering several research areas on IoT and IoMT, AI, edge and cloud computing, security, and medical signals fusion. We also address current research challenges and offer some future research directions.

**2.2 A. N. Navaz, M. A. Serhani, H. T. El Kassabi, N. Al-Qirim, and H. Ismail, ``Trends, technologies, and key challenges in smart and connected healthcare,'' *IEEE Access*, vol. 9, pp. 74044_74067, 2021.**

Cardio Vascular Diseases (CVD) is the leading cause of death globally and is increasing at an alarming rate, according to the American Heart Association's Heart Attack and Stroke Statistics-2021. This increase has been further exacerbated because of the current coronavirus (COVID-19) pandemic, thereby increasing the pressure on existing healthcare resources. Smart and Connected Health (SCH) is a viable solution for the prevalent healthcare challenges. It can reshape the course of healthcare to be more strategic, preventive, and custom-designed, making it more effective with value-added services. This research endeavors to classify state-of-the-art SCH technologies via a thorough literature review and analysis to comprehensively define SCH features and identify the enabling technology-related challenges in SCH adoption. We also propose an architectural model that captures the technological aspect of the SCH solution, its environment, and its primary involved stakeholders. It serves as a reference model for SCH acceptance and implementation. We reflected the COVID-19 case study illustrating how some countries have tackled the pandemic differently in terms of leveraging the power of different SCH technologies, such as big data, cloud computing, Internet of Things, artificial intelligence, robotics, blockchain, and mobile applications. In combating the pandemic, SCH has been used efficiently at different stages such as disease diagnosis, virus detection, individual monitoring, tracking, controlling, and resource allocation. Furthermore, this review highlights the challenges to SCH acceptance, as well as the potential research directions for better patient-centric healthcare.

**2.3 U. Bharti, D. Bajaj, H. Batra, S. Lalit, S. Lalit, and A. Gangwani, ``Medbot: Conversational arti_cial intelligence powered chatbot for delivering telehealth after COVID-19,'' in *Proc. 5th Int. Conf. Commun. Electron. Syst. (ICCES)*, Jun. 2020, pp. 870_875.**

Telemedicine can be used by medical practitioners to connect with their patients during the recent Coronavirus outbreak, whilst attempting to reduce COVID-19 transmission among patients and clinicians. Amidst the pandemic, Telemedicine has the potential to help by permitting patients to receive supportive care without having to physically visit a hospital by using a conversational artificial intelligence-based application for their treatment. Thus, telehealth will rapidly and radically transform in-person care to remote consultation of patients. Because of this, it developed a Multilingual Conversational Bot based on Natural Language Processing (NLP) to provide free primary healthcare education, information, advice to chronic patients. The study introduces a novel

computer application acting as a personal virtual doctor that has been opportunely designed and extensively trained to interact with patients like human beings. This application is based upon a serverless architecture and it aggregates the services of a doctor by providing preventive measures, homeremedies, interactive counseling sessions, healthcare tips, and symptoms covering the most prevalent diseases in rural India. The paper proposes a conversational bot "Aapka Chikitsak" on Google Cloud Platform (GCP) for delivering telehealth in India to increase the patient's access to healthcare knowledge and leverage the potentials of artificial intelligence to bridge the gap of demand and supply of human healthcare providers. This conversational application has resulted in reducing the barriers for access to healthcare facilities and procures intelligent consultations remotely to allow timely care and quality treatment, there by effectively assisting the society.

## 3.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 rea 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.

### 3.1 IMPLEMENTTAION

**Hospital**

In this module, the Admin has to login by using valid user name and password. After login successful he can do some operations such as Login, View Physicians, View Brad Details, View All Patient Records, Views All Medication Transactions, Generate Disease Hash Code, Views All Disease Records By Block chain, View Disease Results.

**Physician**

In this module, there are n numbers of users are present. User should register with group option before doing some operations. After registration successful he has to wait for admin to authorize him and after admin authorized him. He can login by using authorized user name and password. Login successful he will do some operations like Register and Login, View Patient Records, View Patient Records With Solution, Views All Medication Transactions.

**Brad**

In this module, there are n numbers of users are present. Transport Company user should register with group option before doing some operations. After registration successful he has to wait for admin to authorize him and after admin authorized

him. He can login by using authorized user name and password. Login successful he will do some operations like Register and Login, View Patient Records, View Patient Records With Solution, Views All Medication Transactions.

## 5.CONCLUSION

At present, many developments are going on in order to subside the uncertain health mishaps. Artificial Intelligence, Big data, and many more techniques are being used without any due consideration of how this vast and diverse data can be accumulated from the real world conveniently and store them securely. The digital twin technology can enable an effective way for collecting data and generating insight through analysis. But this data, being generated through numerous processes, needs to be systematically stored with proper security and handled by a compact system, which can also render all the requirements to create a digital twin in the healthcare sector. With these motivations in mind, our article presents a concrete mathematical model of Digital Twin for healthcare, proposes the Healthcare Digital Twin (*HDT*) system and provides the protocol flow for the system to coincide with the mathematical model.

The main contributions of this article are the following. The *HDT* is proposed with the incentive of remedying the segregated data collection process by incorporating a defined mathematical data model with which patient relevant data can be collected in a regulated way. The model has emphasized three core stages: Pre-Hospital Admit, Patient Disease Diagnose, and Surgical Operative Procedure, as these stages present the three most important stages for a patient. Next, the architecture of the system, being integrated with block chain, is constructed with the defined data model in consideration, so that users can use the data for other purposes without any conflicts. With proper protocol flows, there are some
illustrations of how the system can be used for different use cases.

It is understandable that, even with the state-of-the-art technologies, a digital twin of a full patient body is still out of reach because of the extant nuances in the human body. There are a raft of opportunities to decrease this gap. We strongly believe that the proposed model and system in this article will be a step towards fulfilling this goal. In future, we will develop the proposed system and examine its applicability and performance.

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