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Digital Twin Technology in Healthcare: A Basic Review

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Abstract: ***Throughout recent many years, our carefully extending world has encountered another critical digitalization help in light of the Coronavirus pandemic. Advanced changes are changing each part of this world. Computerized twin, one of the greatest moving innovations of ongoing years, has turned into the spotlight since the flare-up of Coronavirus 19. An advanced twin is a virtual portrayal of actual item or interaction equipped for gathering data from the genuine climate to address, approve and mimic the actual twin's present and future way of behaving. Thus, a computerized/Digital twin is a virtual form of a genuine article that might be followed, examined and gotten to the next level. Also, many new advancements and accepted methods of digitalisation are still to be incorporated in the field of medical care.***

Keywords: Digital twin, computerised twin, Healthcare, Machine learning

1. Introduction

The exemplary medical services model is overwhelmingly founded on offering clinical types of assistance through the frameworks of emergency clinics and short term centres. The nature of the wellbeing administration relies upon many factors like the capability of clinical faculty, clinic offices, and the accessibility of exceptional equipments [1]. Computerized change in medical services has a great deal of chances to further develop access and nature of care. Throughout the last 10 years, the computerized change has definitely changed a few pieces of society including healthcare [2].Among different computerized developments, one of the promising innovation that is arising as a help in the medical care industry is Digital/Computerized Twin.

A virtual imitation of an item or framework is known as a "Digital Twin" all through its life cycle. Digital twins give getting the hang of, thinking, and dynamic recalibrating for further developed dynamic utilizing ongoing information and different sources. They are mind boggling PC models that can be altered, changed, and refreshed progressively and are twins, or accurate multiplications, of genuine things. With the utilization of advanced twin innovation, clinical professionals might exhort patients on forestalling specific infections and being prepared for clinical emergencies. Advanced twins are accurate reproductions of the thing or individual they are simulating [11].

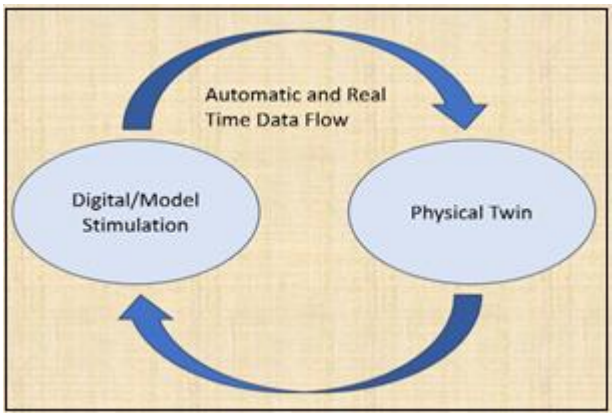

Figure 1: Digital Twin's Block Diagram

1.1 Beginning

DTs take their starting points from reflected frameworks, or recreated conditions, made by NASA during the 1970s to screen inaccessible actual spaces (e.g., rocket in mission). The most well known early use of DTs happened during the Apollo 13 mission when one of the oxygen tanks detonated two days after send off, and designs in the NASA flight control group in Houston needed to demonstrate and test potential arrangements in a reenacted climate. They guide space travellers to construct an improvised air purifier with materials accessible in the shuttle to return the Apollo 13 group once again to earth. This model is viewed as the forerunner of DTs, permitting the association among physical and virtual spaces even before the Computerized Twin (DT) idea acquired popularity [6]. In 2003 Teacher Laments of the College of Michigan presented the idea of Computerized Twins in a complete item lifecycle the executives course. It is otherwise called a computerized reflect and advanced planning. From that point forward, its definition has kept on advancing as a few researchers have given differed meanings of this innovation . Reference book

of Creation Designing states that *"The Digital Twin is a representation of an active unique "product" which can be a real device, object, machine, service, intangible asset, or a system consisting of a product and its related services"[*10].

1.2 Need of advanced twin in medical care:

Advanced innovations have been quickly embraced by the medical services industry, supporting generally speaking human encounters and rehashing how activities ought to be done. To acquire the necessary foundation and information, customary medical care suppliers are growing long haul joint efforts with innovation organizations as virtual medical care administrations gain prevalence. The worldwide medical services industry is turning out to be more strong as it conquers Coronavirus' obstacles [11].

Executions of DTs in medication have as of late begun to be accounted for in the writing. Different applications have been depicted, like in the fields of wellness, recreations of viral disease , prosperity in savvy urban areas , far off a medical procedure applications and medical services management [9]. In medical services, the actual part of the computerized twin model can be a patient. Advanced twins in medical services can supplant self-following and lead to quicker illness discovery in this way considering therapy during the beginning phases of sickness movement. Medication testing drug viability can be performed utilizing the advanced twins of patients and concentrating on the impacts of various medications on virtual twins [7]. Advanced Twin is utilized in the medical services field for purposes, for example, improving, breaking down, and creating expectations for patients, emergency clinics, and the drug industry [4].

Computerized/Digital twin in medical care is being utilized to do prescient demonstrating for different medications, checking the human body's reaction to boosts and understanding the best utilization of care and way forward for medical procedures/clinical therapies. The fundamental point behind the utilization of this innovation in medical care (and somewhere else) is to comprehend, foresee and alleviate chances/blunders. In fluctuated cases, advanced twin innovation has been combined with different advances like the Web of things (IoT), Man-made brainpower (artificial intelligence), AI (ML), fifth Era (5G) and the Cloud. Accordingly, computerized twins can quickly decrease the level of likely disappointments of medical procedures and harm to actual resources in medical care [12].

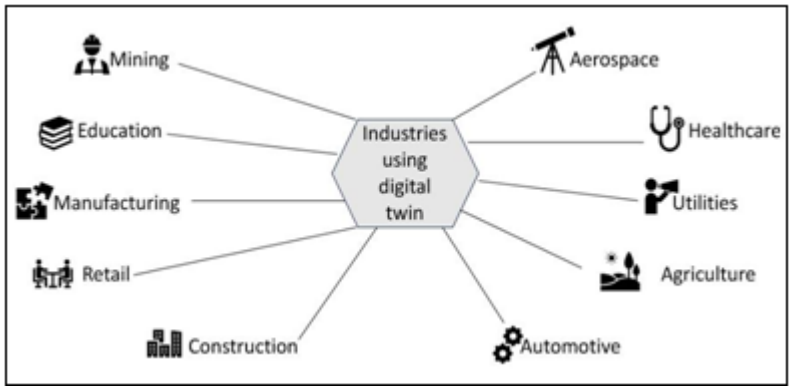

Figure 2: Industries using Digital Twins.

The digital twin index is fast approaching the peak value of 100, which indicates the highest possible search interest on Google.

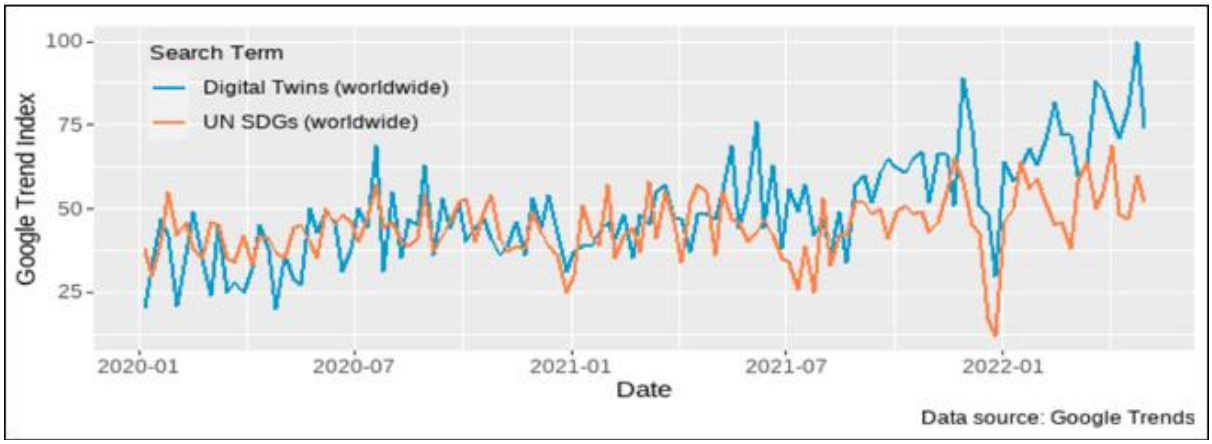

Figure 3: UN SDGs(United Nation's Sustainable Development Goals) and digital twins global Google trends since 2019 [8].

1.3 Components and Design:

1.3.1 Components: A digital twin ordinarily comprises of three parts: the actual item, the computerized item, and an association between the two. The actual item can be broke down progressively as well as the other way around. With consistent information move, the computerized twin turns into an exacting virtual duplicate of the item. Alongside

going about as a virtual resource, the computerized twin likewise stores impressive information to break down and foresee reactions to different stimuli [12].

1.3.2 Design: The three primary parts of Advanced Twins are information procurement, information demonstrating, and information application. Digital Twin purposes four innovations to gather and store ongoing information, get data to give significant bits of knowledge, and make an advanced portrayal of an actual item. These advancements incorporate the Web of Things (IoT), Man-made brainpower (simulated intelligence), Expanded Reality (XR), and Cloud (fig 4) [10].

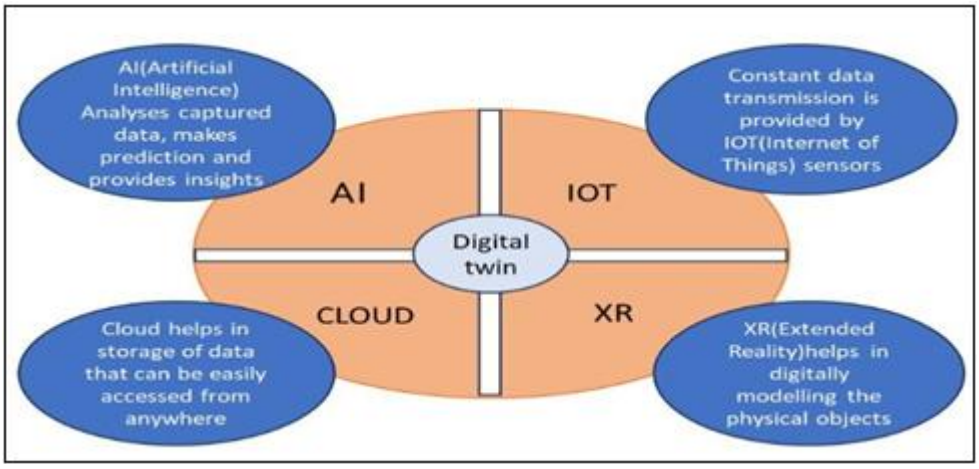

Figure 4: Technologies of Digital Twin

The design flow comprises of 6 phases, as displayed in Fig. 5.In the primary stage, ongoing, exact information will be accumulated. The information can be in any configuration (PDF, PNG, or SQL). In the following stage, the gathered information will be cleaned to eliminate copies and wrong satisfied. In the third stage, the information will be handled to separate helpful data. In the following stage, the data will be taken care of to ML strategies to produce the model. This model is utilized for perceiving designs in the handled information. In the fifth stage, a DT will be built for examination and patient consideration. At the last stage, the produced DT and models are utilized for expectation and visualisation [3].

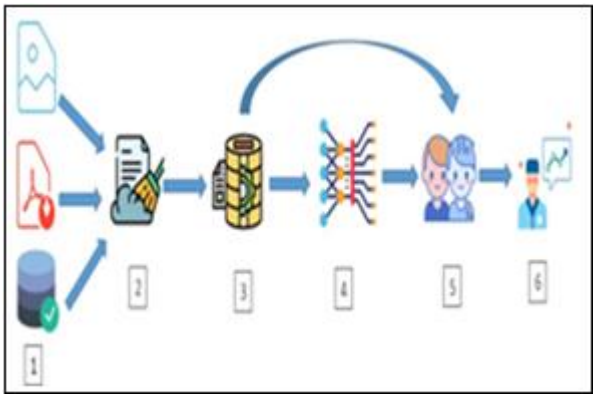

Figure 5: Six stages of design flow:1)Data Collection 2)Data Cleaning 3)Data Processing 4) ML model generation 5)Creation of DT 6)Prediction and Visualisation[3]

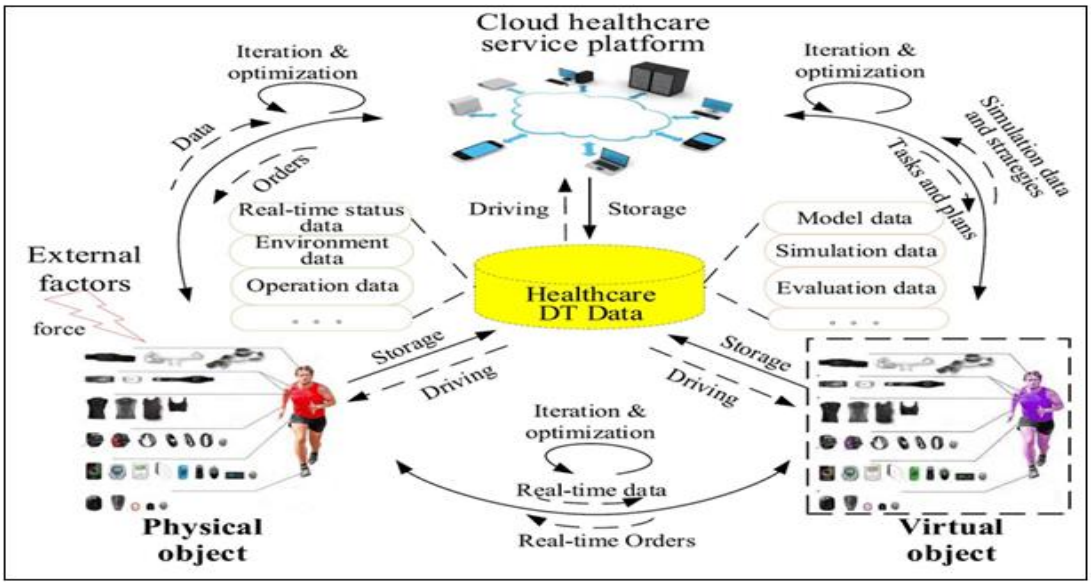

Figure 6: Framework for DT used in healthcare: data are acquired in real time from wearable sensors, and sent to models for simulation and evaluation. The historical records are recorded in the cloud to provide personalized healthcare services [9].

Figure 6: shows a representative framework for human digital twin design according to [13]

1.4Types:

Digital Twin Instance (DTI): An advanced twin occurrence is portrayed as a sort of advanced twin that addresses its actual partner all through all its lifecycle, importance there is a persistent checking of the condition of the actual twin and any progressions or development experienced by the actual twin will influence the advanced twin. In this sense, this idea goes with an item or cycle from its commencement and through its lifetime while checking and foreseeing its way of behaving.

Digital Twin Prototype (DTP): With regards to assembling and creation processes for items, an advanced twin model accumulates and stores significant data and qualities about the actual twin. A few information could incorporate PC helped plans (Creeps), bill of materials (BOM), drawings or even data that could connect the assembling system with the creation chain partners.

Performance digital twin (PDT): In additional genuine and unusual circumstances for actual twins, the PDT can screen, total and analize information from items. By collecting savvy capacities, the PDT can handle the data being observed from the actual partner and create noteworthy information that can be utilized for plan streamlining, support methodology age and reaching determinations from an item's presentation [9].

1.5 Communication model

Figure 7 delineates a communication model addressing information trade between the genuine item (heart pacemaker), interface, and computerized item. The connection goes about as a go between and a modulator wherein it codes the information got from the genuine item to such an extent that it is intelligible for the computerized item.

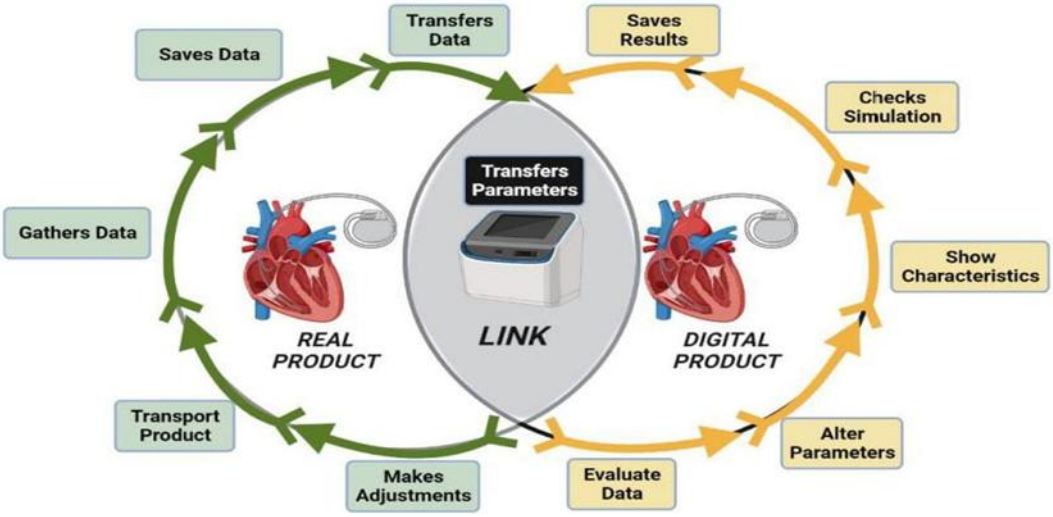

Figure 7: Communication model of a Digital Twin ,Made on biorender[12]

What's more, the model displayed in figure 7 works utilizing four significant interphases. The first is where an actual item is involved, which stores information. This should be possible by utilizing apparatuses like AutoCAD or SysML. The second is an information association that can be laid out utilizing IoT. This connection ought to be constant between the physical and computerized items. Third, the information being taken care of in the framework ought to be approved for the kind of data. At last, in the fourth step, the computerized item ought to have the option to advance as per the outcomes by the utilization of Man-made brainpower and Machine Learning [12].

2. Application of Digital Twin in medical care

A computerized twin is utilized in various ways in the medical care area, for example, patient consideration, clinical examinations, better private wellbeing results, improvement of clinic exercises, diagnostics and clinical preparation , medical services determining, better clinical exploration technique, distinguish the best therapy, upgrade clinical advancement, the best course of treatment, innovative work, expectation of the outcome, conceivable outcomes of powerful therapy and determination, recognize and report risks, crisis circumstance estimating, increment patient fulfillment, making wise tasks, distinguish patient and cycle issues, far off persistent help, remedial path, computerized checking of the human body, individualized therapy, screen medical services offices, control of patient's fundamental information[6]. Advanced twin in medical services additionally add to the wide pattern of accuracy medication to augment the proficiency and viability of medical services framework[11]. Figure 8 shows idea of computerized twin in customized medication.

Figure 8: The Digital twin concept for personalised medicine [6]

3. Objective

This article aims at providing a brief knowledge and understanding about the digital twin technology in healthcare and medical practices. It tells about the need, components and design, communication model, types and brief review on applications of digital twin in healthcare.

4. Methods and Materials

This article was written after collecting required data from secondary sources such as different websites, OpenAI chat GPT and referred journals from Pubmed , Google scholar, Frontiers in medicine, Journals of specialised medicine. The research article reviewed here includes- A review on digital twin technology in healthcare (Chugh, 2023); A systemic review: digital twin in healthcare (Shetty, 2023); Digital twin in healthcare: a survey of current methods (Ghatti,2023); Exploring the revolution in the Healthcare systems through the applications of digital twin technology (Haleem, 2023); Digital twin: benefits, use cases , challenges and opportunities(Altaran,2023); Digital twin in healthcare: Is it the beginning of a new era of evidence based medicine? (Armeni, 2022); Digital twin technology challenges and applications: A comprehensive review (Sanabria, 2022); Applications of digital twin in the healthcare industry: Case review of an IoT enabled remote technology in dentistry (Maddahi, 2022); Impactful digital twin in the healthcare revolution (Hassani, 2022); The digital twin revolution in healthcare (Erol, 2020).

5. Discussion

DTs may deliver critical worth to medical services processes. Specifically, their contribution might move accuracy medication to more significant level. They could tackle developing issues in the advancement period of new advances (engineered arms in clinical preliminaries) and assist emergency clinic administrators with advancing tasks and policymakers expect new health arrangements' ramifications. Nonetheless, while DTs application to frameworks and organizations is now deep rooted in different ventures (auto, space designing, and so on), when a person and their life and privileges are involved, the utilization of DTs should be outlined in a significantly more mind boggling climate. Numerous obstructions, to be sure, keep DTs from at present fostering their maximum capacity in medical care. Some are specialized (e.g., information computing capacities), some are social specialized (absence of interoperability of frameworks where patient information are stacked and put away), and some are connected with moral and social worries. Specialized hindrances are normal to most utilizations of DTs, likewise outside medical services, and will be step by step defeat as per innovative progressions. Social specialized obstructions are more safe since they involve a social protection from sharing information and consequently losing the eliteness of their utilization. At the point when information are gathered through various techniques by various associations, a social work is expected to make the eagerness to normalize, make uniform and offer the gathered data. We suggest that at the level of every country a focal establishment or an organization is made liable for advancing this social work, step by step moving information proprietorship towards an incorporated one, which will likewise characterize access freedoms and sharing advantages (e.g., doctors can immediately distinguish a DT for their patients in light of the data shared by all focuses in their country) [6].

A digital twin might assist with concentrating on broad emergency clinic information, for example, the timetables of medical services experts and different things. The basic availability of this information will assist with cost minimisation and patient experience upgrade. To upgrade tasks and decide the impacts of significant changes, a computerized twin mirrors genuine world settings and break down how it responds to changes. The advanced twin investigations an individual's information, survey disease side effects and differentiations them with revealed designs. To give right outcomes, it utilizes calculations and versatile analytics, which are continually refreshed to further develop information gathering and curation abilities. Present day innovation and the virtual twin of the patient assist specialists with distant patient checking. Patients will have simpler admittance to medical care, giving their families everyday confirmation and tranquility of mind [11].

Global drives are additionally encouraging, gave that the nation level social work has made adequate help. As for moral and social issues, in any case, the discussion on DTs is still in its beginning phases, and we energize researchers, organizations, policymakers, and experts to devote more space to the conversation of administrative angles,

authoritative impacts, moral worries, and social ramifications of DTs [6].

6. Conclusion

A computerized/Digital twin is a virtual form of a genuine article that might be followed, examined and gotten to the next level. At the point when something material is addressed carefully, it is "live" and "dynamic", and that implies it refreshes the crucial article changes whenever. It can likewise get information from others, machine and its environment [11]. The extending IoT and digitalization process is empowering an ever increasing number of individuals to carefully have equivalent admittance to significant data that exists. Computerized twinning cycles in medical care can elevate better admittance to medical services schooling, self medical care the board data and other distant medical services administrations without limitations related with the graphical location [8]. Computerized innovation is still in its beginning phase and arriving at its maximum capacity will require tending to huge restrictions and difficulties for a cutting edge advanced twin execution, for example, costs, data intricacy and support, an absence of principles and guidelines and issues connected with online protection and correspondence. In view of the difficulties, future examination endeavors ought to include: (1) simulation and demonstrating procedures to decrease computational intricacy: (2) 5G Correspondence: (3) IoT information handling and investigation through huge information, AI and simulated intelligence; (4) Interoperablity and (5) Cloud computing [9].

References

[1] Senbekov M, Saliev T, Bukeyeva Z, Almabayeva A, Zhanaliyeva M, Aitenova N, Toishibekov Y, Fakhradiyev I. The Recent Progress and Applications of Digital Technologies in Healthcare: A Review. Int J Telemed Appl. 2020 Dec 3;2020:8830200. doi: 10.1155/2020/8830200. PMID: 33343657; PMCID: PMC7732404.

[2] van de Vijver S, Tensen P, Asiki G, Requena-Méndez A, Heidenrijk M, Stronks K, Cobelens F, Bont J, Agyemang C. Digital health for all: How digital health could reduce inequality and increase universal health coverage. Digit Health. 2023 Jul 7;9:20552076231185434. doi: 10.1177/20552076231185434. PMID: 37434727; PMCID: PMC10331232.

[3] S, Dr. (2023). A Systematic Review: Digital Twin in Healthcare. International Journal for Research in Applied Science and Engineering Technology. 11. 4818-4825. 10.22214/ijraset.2023.52792.

[4] Erol, Tolga & Mendi, Arif & Dogan, Dilara. (2020). The Digital Twin Revolution in Healthcare. 1-7. 10.1109/ISMSIT50672.2020.92.

[5] S. Siddique, M. A. Haque, R. H. Rifat, R. George, K. Shujaee and K. D. Gupta, "Cyber Security Issues in the Industrial Applications of Digital Twins," 2023 IEEE Symposium Series on Computational Intelligence (SSCI), Mexico City, Mexico, 2023, pp. 873-878, doi: 10.1109/SSCI52147.2023.10371850.

[6] Armeni P, Polat I, De Rossi LM, Diaferia L, Meregalli S, Gatti A. Digital Twins in Healthcare: Is It the Beginning of a New Era of Evidence-Based Medicine? A Critical Review. J Pers Med. 2022 Jul 30;12(8):1255. doi: 10.3390/jpm12081255. PMID: 36013204; PMCID: PMC9410074.

[7] Maddahi, Yaser & Chen, Siqi. (2022). Applications of Digital Twins in the Healthcare Industry: Case Review of an IoT-Enabled Remote Technology in Dentistry. Virtual Worlds. 1. 20-41. 10.3390/virtualworlds1010003.

[8] Hassani, Hossein & Huang, Xu & MacFeely, Steve. (2022). Impactful Digital Twin in the Healthcare Revolution. Big Data and Cognitive Computing. 6. 10.3390/bdcc6030083.

[9] Botín-Sanabria, D.M.; Mihaita, A.-S.; Peimbert-García, R.E.; Ramírez-Moreno, M.A.; Ramírez-Mendoza, R.A.; Lozoya-Santos, J.d.J. Digital Twin Technology Challenges and Applications: A Comprehensive Review. Remote Sens. 2022, 14, 1335.

[10] Mohsen Attaran, Bilge Gokhan Celik, Digital Twin: Benefits, use cases, challenges, and opportunities, Decision Analytics Journal, Volume 6, 2023, 100165,ISSN 2772-6622, https://doi.org/10.1016/j.dajour.2023.100165.

[11] Haleem, Abid & Javaid, Mohd & Singh, Ravi & Suman, Rajiv. (2023). Exploring the revolution in healthcare systems through the applications of digital twin technology. 4. 28-38. 10.1016/j.bmt.2023.02.001.

[12] Shrivastava, Muskan & Chugh, Ritesh & Gochhait, Dr. Saikat & Jibril, Abdul Bashiru. (2023). A Review on Digital Twin Technology in Healthcare. 741-745. 10.1109/ICIDCA56705.2023.10099646.

[13] Liu, Y.; Zhang, L.; Yang, Y.; Zhou, L.; Ren, L.; Wang, F.; Liu, R.; Pang, Z.; Deen, M. A Novel Cloud-Based Framework for the Elderly Healthcare Services UsingDigital Twin. IEEE Access 2019, 7, 49088–49101.