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Building a Digital Resource Platform for Cultural Heritage Using Digital Twin Technology

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Abstract

The author suggests a strategy for digital building of the cultural heritage of the Great Wall based on digital twin in order to preserve and inherit material cultural heritage. This approach discusses the implications of the Great Wall digital twin's entire life cycle, suggests a research direction and content for the cultural heritage of the Great Wall's digital twin construction, and carries out an application of the Great Wall digital twin to assess the effectiveness of the application. The evaluation's findings demonstrate that consumers are generally satisfied with Great Wall's digital twin application, with an average score of each indicator over 4, and a marginally subpar functional experience. For the digital archiving, use, and decision-making of the Great Wall's cultural legacy, this method can offer full life cycle visualisation services. It can also give theoretical and methodological references for the preservation and transmission of tangible cultural property.

Keywords: Digital twins; Smart city; Sustainable city design; Data value extension; urban rail transit; Future cities

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Introduction

Early digital displays were widely utilised in the realm of cinema art and were thought to be a display method that combined projection technology with transmission technology, with significant and practical distribution benefits [1-5]. The idea of digital display has been given richer connotations and expansions as a result of the widespread application of numerous new technologies, including Internet technology, multimedia technology, and virtual reality technology. Using digital technology as the method of manifestation, the so-called "digital display" will present the content as the primary component. The digital presentation of the display content is accomplished by a variety of new media and digital media technologies. A new display technique and methods of expression for digital display are provided by the application of new media technologies. It integrates and innovate multiple media information to establish a new platform for information transmission and is not constrained by national borders, regions, time, or space [6].

According to the features of various categories of cultural heritage, the digital display method of material heritage classifies and stores information using a variety of digital technologies, and employs a variety of new media technologies to achieve digital display. It not only fully activates the body's many sense organs but also enables viewers to comprehend the presented material in a more organised and thorough manner [4].

Prior to this, countries used digital technology to conserve cultural assets and the corresponding theoretical study was fairly developed. The majority of research content focuses on the theoretical framework of digital protection, the creation of important technologies, or the use of digital technology in the dissemination and exhibition of cultural assets. According to Singh et al., new technologies like VR and AR have the potential to be effective and affordable tools to conserve and spread cultural information. Assessed the usability of the cultural relics enhanced display system using AR and 3D computer graphics technology. Analysed the cultural heritage movement and the acceptance of augmented reality applications using a technology acceptance model. Presented an interactive virtual guide for exploring ancient sites that uses augmented reality. in their PhD dissertation the utilisation of computer-supported collaborative learning and augmented and virtual reality technology in museum teaching. Outlined the motion recovery structure technology for precisely creating 3D data and presented the findings of the research on the archaeological demonstration of Bodward Fortress utilising airborne laser scanning technology [7].

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Digital technology development has exploded in recent years. There are still some restrictions even though China's research on its application in cultural heritage protection is expanding. Particularly, the majority of studies concentrate on intangible cultural legacy, whereas tangible cultural heritage is the subject of very few studies. The creation and construction of museums, as well as the preservation of intangible cultural assets, are the main focuses of the research. Research on the preservation of intangible cultural heritage concentrates on the digital transmission and inheritance of intangible cultural heritage, whereas research on the advancement of museums concentrates more on the development and design of derivative cultural and creative products as well as the enhancement of the museum's guide system. Research on cultural legacy as a whole or on cultural organisations like museums is numerous, but there are few studies on user experience and public perception [8].

Research on digital twins is currently more prevalent in the domains of aerospace, machinery production and other industries than it is in the humanities, social sciences, and other humanities combined. Additionally, there is a paucity of research and application in the area of digital twins for the digital construction of the Great Wall cultural heritage. There are many single-level researches about the Chinese Great Wall's digital construction, including 3D models, platform R&D, and AR/VR multiterminal displays, but less studies that integrate "lightweight modelling, IoT communication, data processing, and application services." There have been significant advances in "picture recording, partial restoration, and archaeological demonstration" as a result of the current digital research on China's Great Wall cultural property. Research on "complete life cycle" material, such as the progression of historical processes and simulation of future construction, is, nevertheless, lacking. The use of digital twins is suggested for the Great Wall National Cultural Park, with theoretical and practical implications for the digital construction of the Great Wall cultural heritage. This paper analyses the research status of digital twin theory and technology in various countries and the digital construction of the Great Wall cultural heritage [9].

Material and Methods

A technique called Digital Twin (DT) makes it simple to access any user-defined application. For a specific on-demand application, this emerging technology combines software and hardware implementation; this is a unique feature of the technology. Additionally, DT utilises the Internet of Things and a variety of sensors needed for the identification of the required material (IoT). Thus, it will be the best technology in the future. On the other side, building information modelling is a similarly popular technique (BIM). The distinguishing feature of this BIM technology is that it offers a visual depiction of the structure along with a sophisticated illustration of the physical and functional properties of the specified location or structure. With their cutting-edge qualities, these two technologies will make building construction simpler. The Digital Twin-Building Information Modelling (DT-BIM) hybrid model of these two technologies is subsequently proposed in this study work, and the findings are reviewed [10-12].

The Great Wall's significance is primarily seen in its contribution to the growth of the Chinese people. The Great Wall's significance to human civilisation serves as a primary indicator of its historical and cultural importance. As a result, the Great Wall's numerous cultural artefacts have a tremendously high cultural and historical worth. However, because to natural wind erosion, numerous conflicts, the fast urbanisation of China in recent years, and the grave lack of knowledge of the Great Wall's cultural legacy, the Great Wall's defence system has been critically challenged [13].

The Great Wall's digital twin may digitally recreate the structure's historic construction process, significant historical time and space, and current state of affairs, offering trustworthy digital resources and solid data support for the Great Wall's preservation, restoration, and presentation. A visual intelligent simulation of the Great Wall's future construction is produced concurrently by AI computing on the Great Wall and its surroundings using vast amounts of data. Therefore, the development of the Great Wall cultural heritage's digital twin is not only a fresh investigation of digital twin technology in the field of cultural heritage, but also a creative addition to the already-existing theoretical framework for the development of the Great Wall cultural heritage's digital twin. After incorporating and subtracting the pertinent study findings from China and other nations, it is assumed that the digital twin and material cultural heritage digitization share a shared theoretical framework and common characteristics [14, 15].

Discussion

In general, the process of transforming 3D scanning point clouds from data building structures into a BIM model is referred to as scan-to-BIM. Academically, the use of bitmap image technology in building is still in its infancy and there is no established standard or method of execution. Data collection quality is assessed using the scan-to-BIM scanner settings for precision (15 mm), positional accuracy (15 mm), and coverage (85 percent). Once the scanned building satisfies the scanning accuracy and resolution satellite requirements, coverage is determined.

A digital twin is important for evaluating the AI technology retrofitting plan for existing buildings since it can increase energy efficiency and lower carbon emissions from structures. The impact of photovoltaic solar module configuration angle on building energy use and photovoltaic device electricity output is thoroughly examined in this paper, the representation of the performance study of energy consumption using several methods.

Conclusions

An original study of cutting-edge digital technology in the field of cultural heritage protection and inheritance, the research on the creation of the Great Wall's digital twin is of significant importance to the digital building of the Great Wall National Cultural Park in China.

The development of the Great Wall digital twin covers five dimensions for the overall system structure. The Great Wall's physical dimensions are made up of both tangible and intangible cultural heritage information. The Great Wall's virtual entity

dimension consists of many types and levels of virtual simulations of the Great Wall. Multiterminal application service scenarios make up the Great Wall twin application dimension. Data connection and processing are part of the dual communication connection dimension. The core data centres are part of the twin platform dimension.

From a research standpoint, it can offer full life cycle visualisation services for the digital archiving, use, and decision-making of the Great Wall cultural heritage and can offer a fresh perspective and a new route for the digital construction of the Great Wall National Cultural Park. This innovation in research is what this project aims to achieve. In terms of research content, it creatively proposes a thorough study on the closed-loop application of the physical entity, virtual entity, and twin application scenarios of the Great Wall in light of the shortcomings of the research status of various countries in China combined with the features of digital twin technology. It combines art and technology in a unique way that offers fresh research opportunities.

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