

Retraction Retracted: Construction of Heritage Digital Resource Platform Based on Digital Twin Technology

Mathematical Problems in Engineering

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

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Research Article Construction of Heritage Digital Resource Platform Based on Digital Twin Technology

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In order to preserve and inherit material cultural heritage, the author proposes a method for digital construction of the Great Wall's cultural heritage based on digital twin. This method discusses the connotation of the whole life cycle of the Great Wall digital twin, proposes the research path and content of the digital twin construction of the Great Wall cultural heritage, and conducts the application of the Great Wall digital twin to evaluate the application effect. The evaluation results show that users' overall satisfaction with Great Wall's digital twin application is relatively high, and the average score of each indicator is above 4, and the functional experience is slightly poor. *Conclusion*. This method can provide full life cycle visualization services for the digital archiving, application, and decision-making of the Great Wall cultural heritage and provide theoretical and methodological references for the preservation and inheritance of material cultural heritage.

1. Introduction

The early digital display was widely used in the field of film art and was considered to be a display method including projection technology and transmission technology, with extensive and convenient dissemination advantages [1]. With the wide application of many new technologies such as Internet technology, multimedia technology, and virtual reality technology, the concept of digital display has been endowed with richer connotations and extensions. The socalled "digital display" is to display the content as the main body, with digital technology as the means of realization. Through various new media and digital media technologies, the digital presentation of the display content is realized [2]. The application of new media technology provides a new display method and means of expression for digital display. It is not limited by national borders, regions, time, and space and integrates and innovates various media information to form a new platform for information dissemination.

The digital display method of material cultural heritage, according to the characteristics of different types of heritage,

classifies and stores information through various digital technologies and uses various new media technologies to achieve digital display. It not only fully mobilizes the various sense organs of the human body but also lets the audience have a more systematic and comprehensive understanding of the displayed content.

2. Literature Review

Countries applied digital technology to cultural heritage protection earlier, and the related theoretical research was relatively mature. Most of the research content revolves around the theoretical construction of digital protection, the development of key technologies, or the application and practice of digital technology in the display and dissemination of cultural heritage. Singh et al. pointed out that emerging technologies such as VR and AR have the potential and advantages of efficient and low-cost ways to preserve and disseminate cultural information [3]; Rhee et al. applied AR and 3D computer graphics technology to the cultural relics enhanced display system and analyzed its usability [4]; Jahanger et al. used a technology acceptance model to analyze the cultural heritage movement and the acceptance of augmented reality applications [5]; Karimi et al. proposed an augmented reality-based interactive virtual guide for visiting archaeological sites [6]; Karmakar et al. explored in their doctoral dissertation the application of augmented and virtual reality technology in museum education through computer-supported collaborative learning [7]. In the "double wall dialogue," Dy et al. introduced the research results of the archaeological demonstration of Bodward Fortress using airborne laser scanning technology and described the motion recovery structure technology for accurately generating 3D data [8].

In recent years, the development of digital technology has been booming. Although China's research on its application in cultural heritage protection is booming, there are still certain limitations. Specifically, intangible cultural heritage is the main focus of most researches, and there is relatively little research on tangible cultural heritage. The research purposes are mostly based on the protection of intangible cultural heritage and the development and construction of museums. Research related to the protection of intangible cultural heritage focuses on the digital preservation and inheritance of intangible cultural heritage, and research related to the development of museums more focuses on the improvement of the guide system in the museum and the development and design of derivative cultural and creative products. There are many studies on cultural heritage itself or cultural institutions such as museums, and there are few studies on public cognition and user experience.

At present, there is much digital twin research in various countries in aerospace, machinery manufacturing, and other fields, and less research in cultural heritage, other humanities, and social sciences. At the same time, the digital construction of the Great Wall cultural heritage also lacks research and application in the field of digital twins. The digital construction of the Great Wall in China has more single-level studies such as 3D models, platform R&D, and AR/VR multiterminal displays, but there are fewer closedloop comprehensive studies integrating "lightweight modeling, IoT communication, data processing, and application services" [9-10]. The existing digital research of the Great Wall cultural heritage in China has made great breakthroughs in "image recording, partial restoration, and archaeological demonstration." However, there is a lack of research on "full life cycle" content such as historical process evolution and future construction simulation. This paper analyzes the research status of digital twin theory and technology in various countries and the digital construction of the Great Wall cultural heritage and proposes that digital twins should be used in the Great Wall National Cultural Park, with theoretical and practical significance for the digital construction of the Great Wall cultural heritage.

3. Research Methods

3.1. Significance of Digital Twin for the Construction of Great Wall National Cultural Park. The significance of the Great Wall is mainly manifested in promoting the development of the Chinese nation. The historical and cultural value of the Great Wall is mainly reflected in its contribution to human civilization. Therefore, the rich cultural relics of the Great Wall have extremely high cultural and historical value. However, with natural wind erosion, several wars, the rapid development of China's urbanization in recent years, and the serious lack of awareness of the cultural heritage of the Great Wall, as a result, the defense system of the Great Wall has been seriously threatened. According to the 2009 National Cultural Relics Directorate City Resources Survey and Identification Results, only 8.2% of the Ming Great Wall artificial walls are well-preserved, nearly three-quarters of the walls are in poor condition, and even no relics exist [11].

The Great Wall digital twin can digitally restore its historical construction process, important historical time and space, and real-time status quo, providing reliable digital resources and strong data support for the protection, restoration, and display of the Great Wall. At the same time, AI computing is performed on the Great Wall and its surrounding environment through massive data, providing a visual intelligent simulation for the future construction of the Great Wall [12]. Therefore, the construction of the digital twin of the Great Wall cultural heritage is not only a new exploration of digital twin technology in the field of cultural heritage but also an innovative supplement to the existing theoretical system of digital construction of the Great Wall cultural heritage. After inducting and deducting the relevant research results from China and other countries, it is believed that the common theoretical system and common characteristics of digital twin and material cultural heritage digitization are shown in Figure 1 [13].

3.2. Research on the Connotation of the Whole Life Cycle of the Great Wall Digital Twin. Virtual simulation is a simulation technology that simulates the physical world by converting physical models into software. The characteristics and parameters of the physical world are reflected through 3D high-fidelity modeling [14, 15]. A digital twin is based on virtual simulation, real-time perception, diagnosis, and prediction of the state of physical objects through actual measurement, simulation, and data analysis; regulation of the behavior of physical objects through optimization and instructions; and self-evolution through mutual learning between related digital models. This enables simultaneous improvement in stakeholder decision-making during the life cycle of physical entity objects. It can be said that virtual simulation is part of many key technologies for realizing digital twins. In addition, the formation of digital twins also requires various IoT and Internet technologies such as sensors, data transmission, data analysis, drives, and cloud platforms.

In recent years, under the background of vigorously promoting the development of scientific and technological innovation industries and advocating the protection of cultural heritage, the digital research and practice of China's tangible and intangible heritage have made great progress. Virtual simulation is the first generation of digital simulation technology with high-reduction 3D models as the core technical feature, from manual modeling using 3D Max,



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FIGURE 1: Analysis of common theory and common characteristics.

Unity, and other software to intelligent modeling using scanned point cloud data to generate models. From the physical display using 3D printing molding technology to the virtual display using VR/AR/XR technology, different concepts and technologies have created different application scenarios and interaction methods [16].

With the development of information technology and the advent of the Internet of everything era, digital twin, as the second generation of digital simulation technology with the whole life cycle as the core feature, highly integrates virtual simulation with the new generation of Internet of things, Internet, blockchain, artificial intelligence, etc. Electronics and Information technology: its application fields have gradually shifted from aerospace, military, and other fields to modeling and processing, design and manufacturing, smart city management, and other fields. With forward-looking concepts and technical advantages, digital twins will provide new methods and new tools for cultural heritage in various application scenarios such as digital protection, monitoring, simulation development, and display.

As a key technology to realize intelligent construction, digital twin can realize information fusion and interaction between virtual space and physical space. Therefore, combining with the characteristics of complex construction projects and many-elements information, referring to the five-dimensional model of digital twin, a multidimensional model of intelligent construction based on digital twin is proposed, as shown in the following equation [17]:

$$M_{\rm BDT} = (B_{\rm PE}, B_{\rm VE}, B_{\rm Ss}, B_{\rm DD}, B_{\rm CN}). \tag{1}$$

In the formula, $B_{\rm PE}$ represents the physical construction entity, $B_{\rm VE}$ represents the virtual construction model, B_{Ss} represents the intelligent construction service for the whole life cycle of the building, $B_{\rm DD}$ represents the data of the whole life cycle of the construction object, and $B_{\rm CN}$ represents the connection between the modules.

In terms of the entire life cycle, digital twins in the fields of aerospace, machinery production, and smart city management are iteratively updated in the process of physical entity simulation; the starting point of its life cycle is the present state of the physical entity. Material cultural heritage is different from the former. As an important material cultural heritage in China, the Great Wall is a large-scale military defense project built in different historical periods. Therefore, the digital twin of the Great Wall should be composed of three parts: history, current situation, and future in terms of twin structure (see Figure 2).

The first part is a retro-twin to the Great Wall's defense system. Through the review and demonstration of a large number of documents, combined with virtual simulation technology and artificial intelligence algorithm simulation technology, we can really restore the construction process of the Great Wall defense system and the changes in different historical periods. Its purpose is to sort out and digitize the construction history and war history of the Great Wall defense system. The second part is the twin management of the status quo of the Great Wall and its surrounding environment [18]. On the basis of BIM, GIS, and other model data, through the application of multitype distributed sensing equipment and safe and high-speed network transmission, the purpose is to restore the 1:1 status of the Great Wall, not only the visual 1:1 restoration but also a 1:1 restoration of changes in the real world such as climate, human flow, and geological changes, so that the inside and outside are the same, holographic mirroring. The third part is the future development twin of the Great Wall that contains AI calculation predictions and manual design changes. AI calculation prediction is a simulation of the environmental changes of the Great Wall by computer through data collection and operation of the real physical world. Artificial design changes can be redesigned through artificial digital models, which change and present the Great Wall and its surrounding environment. The purpose is to "trial and error" through the simulation of the digital environment and provide more reasonable countermeasures for the environmental protection construction of the Great Wall

Therefore, the digital twin of the Great Wall is to recreate a corresponding "virtual Great Wall" in cyberspace, forming a physical Great Wall in the physical dimension and a digital Great Wall in the information dimension (historical information, status quo information) and coexisting and blending the virtual and the real pattern, through real-time



FIGURE 2: The twin structure of the Great Wall digital twin in the full life cycle.

feedback of multiple types of sensors to the digital world, intelligent, consistent, and complete visual mapping, and simulation can be realized [19].

4. Analysis of Results

The construction path of the Great Wall digital twin consists of three parts, namely, literature and data research, framework and key technology research, and visual terminal and application research, and the structural relationship is shown in Figure 3 [20].

4.1. Literature and Data Research on Multitype Great Wall Cultural Heritage. By arranging and analyzing the material and intangible cultural heritage, the construction process, change process, and important historical temporal and spatial data of the Great Wall can be demonstrated. It is a technical data study on the construction of the digital twin of the Great Wall cultural heritage. The data research on the material cultural heritage of the Great Wall includes the content of the documents and data of the Great Wall ontology buildings, military settlements, public buildings, and relics in different historical periods. The data research on the intangible cultural heritage of the Great Wall includes the content of the documents and data of the defense of the Great Wall in different historical periods, folk culture, and major historical events. Zhang et al. mentioned the tangible heritage of the Great Wall cultural heritage in the construction of the Ming Great Wall cultural heritage database, including the Great Wall body building, military settlements, public buildings, related relics, and all the tools and utensils contained in it. Among them, the main buildings include the walls, enemy towers, wall towers, beacon towers, piers, and battle towers of the Great Wall; military settlements include towns, road cities, acropolis, Suocheng, Baocheng, Guancheng, posts, and outposts; public buildings include official residences, storage pastures, temples and ancestral halls, school academies, archways, and towers; relics include water kilns, residential sites, smoke stoves, fire pools, and other relics.

4.2. Research on the Great Wall Digital Twin Framework and Key Technologies. First, research is conducted on the theoretical framework of the Great Wall digital twin system. We research on the application strategy of digital twin technology in tangible and intangible cultural heritage and propose the theoretical concept, construction connotation, and technical framework, as well as the contents and functions of each part of the digital twin of the Great Wall cultural heritage. Second, we research on the construction of the Great Wall lightweight virtual entity library and the construction methods of the Great Wall virtual entity with different precision levels and realize the construction of the Great Wall virtual entity library based on this. It includes the restoration of construction in different historical stages; the reproduction of special historical node scenarios; the real mapping of the current environment; and the base of the future development model. Third is the application research of multitype sensors in the data interaction layer. We research on the network architecture and perception acquisition methods of different types of distributed sensors and study the near real-time data flow method between the digital domain and the physical domain based on Firefly [21], and based on this, the methods and paths of real-time data acquisition of the Great Wall and its surrounding environment are studied. Fourth, we research on the transmission and processing methods of the Great Wall's multitype data. We research on the transmission methods of data of the Great Wall cultural heritage, geology, ecological environment, social economy, and human environment, including communication protocols, data fusion, interface services, and other research contents.

4.3. Research on the Visualization of the Great Wall Cultural Heritage and the Multiterminal Application of Digital Twin. The visualization of the Great Wall cultural heritage consists of three-dimensional digital visualization, information and data visualization, and other contents. The former is mainly aimed at the Great Wall virtual entity, and the latter is mainly aimed at the visual design of information and data in system association, functional interaction, interface

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FIGURE 3: Research path for the construction of the Great Wall digital twin.

experience, structural navigation, media communication, and technical aesthetics. At the same time, based on the research on the spirit and cultural symbols of the Great Wall, the application method and content of the cultural heritage of the Great Wall in the national cultural park online platform, offline exhibition hall, various management platforms, and other multiterminal scenarios are studied. A multidimensional interactive approach to culture, art and technology has also been explored.

4.4. Test Results and Analysis. In order to evaluate the usability, functionality, and acceptability of the overall interactive system of the Great Wall digital twin application and to verify the user experience satisfaction and dissemination effect based on the digital display and dissemination strategy of cultural heritage, for target users, two evaluation items, namely, task test and filling in subjective evaluation scale, were carried out, respectively. The description of the indicators is shown in Table 1.

The user task test is divided into two parts: interface operation and functional actual experience. The task design revolves around the core functions of the application, the specific task design is shown in Table 2.

After sorting through the task test results, it is found that the users have completed various tasks well; most

users can complete all tasks independently, and some users can also successfully complete the tasks after being briefly prompted by the main test staff. In terms of the specific operations of the application, it has been observed that during the test of task 2, the number of misoperations by users is high, and it generally occurs when switching between the functions of floor plan navigation and realscene navigation, which one is the live tour function. In addition, it was also observed that during the completion of task 4, it is a common practice of the user to click the "More" button to display the hidden menu instead of swiping right on the screen. Based on the above observations, the design of ambiguous icons should be optimized in subsequent application iterations until it is convenient for users to understand, and various gestureguided designs should be improved before users use them for the first time.

Figure 4 shows the average scores of each index in the user's subjective evaluation scale. From the data, it can be seen that the user's overall satisfaction with the Great Wall digital twin application is relatively high, and the average score of each index is above 4 points. Among them, the interactive operation scores are more prominent, and users are more satisfied with various gesture designs, which are in line with daily usage habits. About lower functional scores, the reason is mainly limited by its own

First-level indicator	Se	condary dicators	Indicators	Indicator score			
	Vi	sual style	The overall style is harmonious and unified, beautiful, and applicable Icons are well-designed and easy to understand	5 5	4 3 4 3	3 2 3 2	1
Interface usability	In	teraction	The function level is clear and the operation process is reasonable Gesture operation conforms to daily usage habits	5 5	43	32 32	$\frac{1}{2}$
	Emotional experience		I am satisfied with the overall experience	5	4 3	3 2	1
Experiential	l Av F	Feature vailability Pleasure	I can see the details of the artifacts clearly, as expected Easy to operate, can get started quickly I enjoyed the experience, it was immersive	5 5 5	4 3 4 3 4 3	; 2 ; 2 ; 2	1 1 1
	Cognition		The content presented is informative, interesting, and easy to understand Novel and interesting display of cultural relics	5 5 5	4 3	3 2 3 2	1
Digital communication	Mer	ntality and attitude	I think such a form has artistic appeal and has a positive effect on cultural dissemination	5	4 3	3 2	1
	В	ehavior	I think this form has a strong sense of participation I would like to take the initiative to pay attention to relevant information	5 5	4 3 4 3	3 2 3 2	1
			TABLE 2: User testing tasks,				
Task theme	Serial number		Detailed description of the task				
Interface usability	Task 1		Task description: reserve museum tickets Task start status: go to the home page and look for the appointment entry Task end status: complete the appointment, return to the home page				
	Task 2	Task descri	ription: choose a theme route of interest to start the tour and experience the A cask start status: enter the navigation page and operate according to the promy Mission end status: open AR real-world tour or plan route diagram	AR ots	live	tou	1r the
	Task 3	Mis Task descrip	town hall town hall sion start status: enter the AR camera page and look for the treasure hunt ent Task end status: complete collection and return to AR camera page ption: learn about the specific introduction of a collection of cultural relics and	ran d li	ce	to	ite
	Task 4	audio commentary Task start status: enter the home page and click on more entries			sten	10	115
	Task 5	W	Then the task is over, enter the audio commentary page to complete the listen Task description: enter my page to see which exhibitions have participated Task start status: go to my page Task end status: complete the search and return to the home page	ing			
AR experience	Task 6	Task descrip	otion: use the camera to scan the identification map of the terracotta beast-shaped the cultural relic model Mission start status: turn on the AR camera, ready to scan Mission end status: artifact models appear on the screen	po	t an	d vi	ew
	Task 7	Task descrij	ption: open the AR application, generate the cultural relic model, place it on the plane, and appreciate the details Task start state: open AR app and try to tap the screen	e re	cog	niti	ion
	Task 8	Mission end status: after the model is successfully generated, use two fingers/single finger to ro move the cultural relic Mission description: pick a fun cultural relic sticker and complete a selfie Mission start status: open AB camera and select a sticker					nd
	IASK O		Mission start status: open Ale calification selfee				

TABLE 1: User's subjective evaluation scale.

technical level, the functional experience cannot be combined with the interactive prototype of the application interface, and the display method is relatively simple. On the whole, the Great Wall digital twin application basically meets the user's expectations and visually achieves a beautiful atmosphere while satisfying the basic display of cultural relics in terms of functions. The user experience has been improved to a certain extent with pleasure and immersion through technology, and the digital display and dissemination of cultural resources in the collection have been better achieved. However, the richness of functions and the accuracy of icon recognition remain to be improved. In terms of performance, it still needs to be further optimized.



FIGURE 4: The average score of each index of the subjective evaluation scale.

5. Conclusion

The research on the construction of the digital twin of the Great Wall is an innovative study of forward-looking digital technology in the field of cultural heritage protection and inheritance, which is of great significance to the digital construction of the Great Wall National Cultural Park in China.

For the overall system structure, the establishment of the Great Wall digital twin includes five dimensions. They are the physical entity dimensions of the Great Wall, composed of material and intangible cultural heritage data. The virtual entity dimension of the Great Wall is composed of multitype and multilevel virtual simulation models of the Great Wall. The Great Wall twin application dimension consists of multiterminal application service scenarios. The twin communication connection dimension consists of data connection and processing. The twin platform dimension consists of core data centers.

Aiming at the innovation of research, from the perspective of research, it can provide full life cycle visualization services for the digital archiving, application, and decisionmaking of the Great Wall cultural heritage and provide a new vision and new path for the digital construction of the Great Wall National Cultural Park. In terms of research content, in view of the shortcomings of the research status of various countries in China, combined with the characteristics of digital twin technology, it innovatively proposes a comprehensive research on the closed-loop application of the physical entity, virtual entity, and twin application scenarios of the Great Wall. At the same time, it is a combination of art and technology, providing new research directions and footholds.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

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References

- P. Tichá, M. Domonkos, J. Trejbal, P. Demo, and Z. Prošek, "Electrospun sio2 nanotextiles for preservation of a tangible cultural heritage," *Key Engineering Materials*, vol. 868, pp. 86–91, 2020.
- [2] L. Lisienkova, T. Shindina, and T. Lisienkova, "Development of a methodology for assessing the technical level of cultural heritage objects in construction," *Civil Engineering Journal*, vol. 7, no. 4, pp. 662–675, 2021.
- [3] R. K. Singh, A. Singh, L. Ksherchokpa et al., "Grassroots approaches for sustaining biocultural diversity and livelihood security: insights from indian eastern himalaya," *Environmental Management*, vol. 68, no. 1, pp. 17–37, 2021.
- [4] B. Rhee, F. Pianzola, N. Oh, G. Choi, and J. Kim, "Remediating tradition with technology: a case study of from tangible to intangible: a media showcase of kisa chin p'yori chinch'an uigwe," *Digital Creativity*, vol. 32, no. 1, pp. 56–70, 2021.
- [5] Q. K. Jahanger, J. Louis, C. Pestana, and D. Trejo, "Potential positive impacts of digitalization of construction-phase information management for project owners," *Journal of Information Technology in Construction*, vol. 26, pp. 1–22, 2021.
- [6] S. Karimi and I. Iordanova, "Integration of bim and gis for construction automation, a systematic literature review (slr) combining bibliometric and qualitative analysis," *Archives of Computational Methods in Engineering*, vol. 28, no. 7, pp. 4573–4594, 2021.
- [7] A. Karmakar and V. S. K. Delhi, "Construction 4.0: what we know and where we are headed?" *Journal of Information Technology in Construction*, vol. 26, pp. 526–545, 2021.
- [8] A. Dy, A. Dw, A. Hz, W. A. Ye, B. Ssa, and A. Qd, "A novel application integration architecture for the education industry - sciencedirect," *Procedia Computer Science*, vol. 176, pp. 1813–1822, 2020.
- [9] A. Sharma and R. Kumar, "A framework for pre-computated multi- constrained quickest QoS path algorithm," *Journal of Telecommunication, Electronic and Computer Engineering*, vol. 9, no. 3-6, p. 897, 2017.
- [10] T. Marcher, G. H. Erharter, and M. Winkler, "Machine learning in tunnelling - capabilities and challenges," *Geomechanics and Tunnelling*, vol. 13, no. 2, pp. 191–198, 2020.
- [11] G. Uggla and M. Horemuz, "Identifying roadside objects in mobile laser scanning data using image-based point cloud segmentation," *Journal of Information Technology in Con*struction, vol. 25, pp. 545–560, 2020.
- [12] J. Jayakumar, B. Nagaraj, S. Chacko, and P. Ajay, "Conceptual implementation of artificial intelligent based E-mobility controller in smart city environment," *Wireless Communications and Mobile Computing*, vol. 2021, Article ID 5325116, 8 pages, 2021.
- [13] A. Zarinwall, T. Waniek, R. Saadat, U. Braun, H. Sturm, and G. Garnweitner, "Comprehensive characterization of aptes

surface modifications of hydrous boehmite nanoparticles," *Langmuir*, vol. 37, no. 1, pp. 171–179, 2021.

- [14] J. Wang, Z. Tian, X. Yang, and M. Zhou, "Twpalo: throughthe-wall passive localization of moving human with wi-fi," *Computer Communications*, vol. 157, pp. 284–297, 2020.
- [15] L., Y. Diao and X. Liu, "Ce-Mn mixed oxides supported on glass-fiber for low-temperature selective catalytic reduction of NO with NH3," *Journal of Rare Earths*, vol. 32, no. 5, pp. 409–415, 2014.
- [16] K. T. Park, S. H. Lee, and S. D. Noh, "Information fusion and systematic logic library-generation methods for self-configuration of autonomous digital twin," *Journal of Intelligent Manufacturing*, pp. 1–31, 2021.
- [17] R. Huang, S. Zhang, W. Zhang, and X. Yang, "Progress of zinc oxide-based nanocomposites in the textile industry," *IET Collaborative Intelligent Manufacturing*, vol. 3, no. 3, pp. 281–289, 2021.
- [18] N. Wang, X. Li, P. Wang, and Y. M. Zhang, "Secure synchronization control for a class of cyber-physical systems with unknown dynamics," *IEEE/CAA Journal of Automatica Sinica*, vol. 7, no. 99, pp. 1–10, 2020.
- [19] R. Zeng and L. Wang, "Tightly-secure two-pass authenticated key exchange protocol using twin Diffie-Hellman problem," *IET Information Security*, vol. 14, no. 6, pp. 764–772, 2020.
- [20] E. Wernerová, S. Endel, and D. Kutá, "Implementation of the BIM method at the VSB - technical university of ostrava," *International Journal of Engineering Research in Africa*, vol. 47, pp. 133–138, 2020.
- [21] Q. Liu, W. Zhang, M. W. Bhatt, and A. Kumar, "Seismic nonlinear vibration control algorithm for high-rise buildings," *Nonlinear Engineering*, vol. 10, no. 1, pp. 574–582, 2021.