

## Informatics-Enabled Digital Watermarking for BIM Service Systems: Robustness under Geometric Attacks

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**Abstract.** Building Information Model (BIM) is an important source of measurement data and results, which is widely used in construction and urban planning. AI driven security can improve the availability of BIM and make model data easier to store. However, as more and more illegal piracy incidents become more and more urgent, the need for BIM copyright protection becomes more and more urgent. Signing security agreements or hiring professional institutions and agents can only limit people's behavior, completely rely on people's subjective activities, and is not conducive to the security of BIM data. Therefore, this paper analyzed the characteristics, application environment and problems of BIM, and analyzed the attack methods and technical characteristics of digital watermarking algorithm. Enhancing watermark robustness directly supports logistics service continuity by preventing data loss during inter-organizational handovers and protecting construction sequencing information. The improved resistance to geometric attacks ensures the reliability of shared service models among designers, contractors, and operators throughout the complex supply chain. This study grounds the evaluation in information security theory and service system reliability frameworks to address the critical need for data integrity in construction logistics. The proposed mechanism enhances the coordination reliability across urban management service systems by integrating robust reversible watermarking into the information lifecycle. According to the reversible quantization modulation, the original reference value and information availability of the BIM under the digital watermarking technology were growing with time. The average value of the original reference value of the BIM was 0.56, and the average value of the information availability of the BIM was 0.79. The robustness of BIM under digital watermark was better than the original BIM, but the watermark capacity was lower than the original BIM. Qualitative analysis indicates that the proposed approach offers superior adaptability to geometric variations compared to conventional static watermarking schemes used in similar service environments. The method specifically addresses the reversibility requirements that standard image-based watermarking techniques fail to satisfy for high-precision engineering models. On the whole, the robustness of BIM under digital watermarking was improved by 19.71%, and the watermark capacity was reduced by 39.29%. In summary, data security protocols and digital watermarking facilitate the protection of BIM data, support resistance against geometric attacks, and enhance the robustness of the model for copyright management.

**Keywords:** BIM model, digital watermark, data security, geometric attack driven security

## 1. Introduction

Digital city informatization has become the main source of scientific and technological innovation and economic growth. As noted by Alzrair et al. (2024), the creative economy drives sustainable development; therefore, securing the digital assets (BIM) of this economy against geometric attacks is a prerequisite for its long-term viability. When transmitting BIM models and data, effective technologies are needed to monitor piracy and protect copyright information. As an advanced information security technology, digital watermarking can incorporate the copyright information of the model into the BIM model and become a part of the BIM model. The establishment of small building information model is conducive to more intuitive and careful spatial search and spatial analysis, and plays a more important role in the analysis and decision-making of urban leaders. Therefore, in the process of intelligent and digital city development, obtaining BIM model is gradually becoming the core issue of digital city micro construction, and plays a vital role. Building Information Modeling functions as a critical information service infrastructure within the logistics and supply chain management of construction projects. The integration of digital watermarking into BIM service systems enhances the reliability of data sharing across the entire building lifecycle. This mechanism supports logistics coordination by ensuring the integrity of design data during transmission between diverse stakeholders and facilitates trust in collaborative service environments.

Many scholars have studied the extraction of digital watermarking. Amini Marzieh proposed a watermark decoder using vector based hidden Markov model in the wavelet domain, and the proposed decoder was superior to other decoders in terms of low bit error rate (Amini et al. 2017). In order to check the security and robustness of the proposed method against various common image processing attacks, Abdulhammed OMAR YOUNIS also calculated the peak signal to noise ratio and mean square error (Abdulhammed, 2021). Metrics defined as information availability and original reference value quantify the service quality attributes of recoverability and data accuracy essential for logistics operations. These indicators directly reflect the capability of the BIM service system to maintain operational continuity and data reliability when subjected to external geometric interferences during transmission. Islam Mohiul, based on geometric distortion correction, improved the robustness against desynchronization attacks by combining it with binary watermark detection (Islam et al. 2018). Mohanarathinam A summarized the methods of watermarking technology, and analyzed the performance of watermarked images using peak signal to noise ratio, mean square error and bit error rate (Mohanarathinam, 2020). Ma Zhaofeng proposed a trusted forensics scheme based on intelligent digital image watermarking, and proposed a technical and fair trusted forensics algorithm (Ma et al. 2020). Kapse A. S analyzed the characteristics and applications of digital watermarking, and studied the digital image security using digital watermarking (Kapse, 2018). Liu Shuai developed a digital watermarking algorithm based on fractal coding method and discrete cosine transform, which combined fractal coding method and discrete cosine transform method for double encryption (Liu et al. 2017). The above studies all describe the extraction methods of digital watermarking, but there are still some shortcomings in geometric attacks.

Many scholars have studied the restoration of digital watermarking based on geometric attack BIM model. Jin and Jongweon (2022) proposed a blind watermarking method for urban geographic markup language model based on group coordinate quantization transformation algorithm to ensure data loading and keeping imperceptible. Nishimaki Ryo (2019) introduced the concept of watermarking of cryptographic functions and proposed a watermarking scheme based on a lossy trapdoor function of the decision bilinear problem. Feng Bin designed and implemented a semi fragile watermark based on digital transformation, which was mainly used to tamper and restore the converted image and pure image (Feng, 2020). Ying (2019) proposed a new robust digital watermarking framework for color images using the combined embedding technology of discrete Fourier transform and dual tree complex wavelet transform. All the above researches have described the methods of digital watermark recovery under BIM, but there are still some deficiencies in resisting geometric attacks.

Embedding the information into the watermark by using the difference value can effectively resist the shearing attack, and the remaining quantifiable distortion can be used to create a mechanism to synchronize with the watermark information. In addition, by deleting information from the watermark, data can be stored more accurately, and the requirements for BIM model transmission and sharing can be met. The research of digital watermarking and BIM model can provide theoretical support for the zero watermarking and reverse watermarking algorithms of BIM model. This study advances the field of informatics by adapting reversible watermarking to the high-precision and low-redundancy requirements of BIM service environments. It establishes a necessary link between algorithmic robustness and the continuity of service in collaborative design platforms. The proposed approach addresses the specific data consistency challenges inherent in lifecycle management which distinguishes it from generic multimedia security algorithms. Therefore, this paper provides a theoretical basis for future research on BIM model watermarking algorithm by studying BIM model digital watermarking.

## 2. Evaluation of BIM Model Problems

### (1) Characteristics of BIM model

Before designing the digital watermarking algorithm of BIM model, it must be combined with the characteristics of BIM model and possible attacks on BIM model in actual production and use. The characteristics of BIM model mainly include the following five types, as shown in Figure 1. The first is the substantiality of the model. Different from the surface type of 3D point cloud model or mesh model, the structure of the model is the most important feature and essence of the BIM model. The internal elements of BIM model have their own spatial positions, communication conditions between elements and the complete topology of the watermark algorithm, which are the basic elements of the digital watermark algorithm. Second, the requirements for precision are very high. The spatial location information of cells is represented by the information coordinates of datum points. The adjacent cells can establish strict topological relationships and the restrictions commonly used in projects for engineering design. Therefore, BIM model has higher spatial accuracy and close relationship, and the spatial location changes related to charts are closely related to them. Even if they change little, their spatial location would also change accordingly. The third is low repeatability. The 3D object model is composed of single elements and elements. Other information can be stored on the platform as separate files. There is no more information in the 3D host model. Compared with a digital watermarking method based on NSCT transform and neural network hybrid evolutionary algorithm, the data storage accuracy of BIM model reaches 13 decimal places (Amiri and Sattar, 2020). The information must change the data within the required range and combine some display precision with the application scenario. The fourth is data classification. BIM model can be divided into three types of system structure data, depending on data content, application scenarios and functions. In the process of data transmission and storage, different types of elements are stored in different categories, and different categories are stored in the corresponding element and component types. The BIM model also includes a variety of file formats for physical transmission and application. The fifth is data consistency. The BIM data sequence can be changed according to the modified parameters or spatial location information to change the information about meta parameters and related elements. This would automatically change the relationship between BIM model elements, and change the information about the elements, so that multiple images of the BIM model can be displayed at the same time, thus ensuring the consistency of data and views in the model. In addition, BIM model also has many original and complex file structures and other data characteristics.

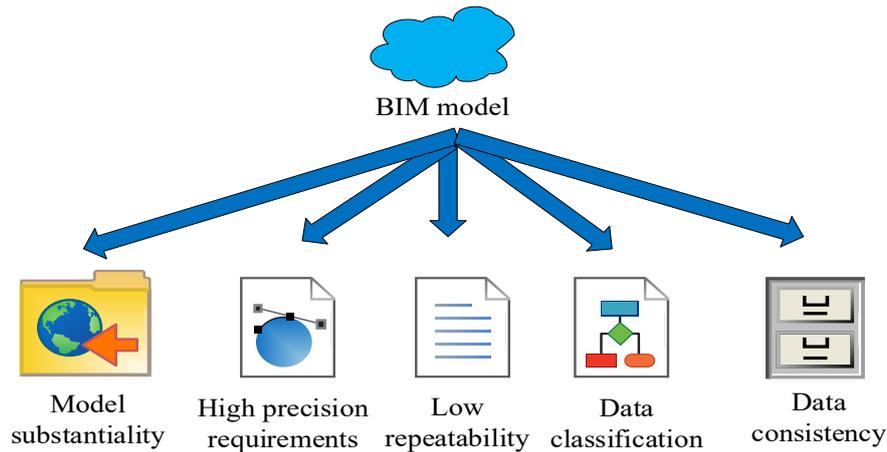


Fig 1: Features of BIM model

### (2) Application environment of BIM model

Because the use of digital watermarking technology can protect data copyright, the use of digital watermarking technology in BIM models can promote the data sharing process of BIM models in the entire building life cycle (Nagai, 2018). BIM model is based on 3D geometric model, integrating specific geometric data, attribute information, topology information and semantic information into all main instances of the model (Herr and Thomas, 2019). The core application environment of BIM model consists of three dimensions: cloud environment, enterprise class and personal privacy. Cloud environment usually refers to the joint review, editing and modification of BIM models between designers, owners and operators, which is the result of the participation and cooperation of all interested parties. Watermarking serves as a pivotal component of the informatics architecture governing the information lifecycle from creation to recovery. It acts as a data governance mechanism within BIM-based service platforms to track model provenance during collaborative editing and versioning. This integration ensures that the security protocol evolves alongside the dynamic stages of data upload, modification, and auditing in cloud-based logistics environments. The enterprise class is a platform, which is responsible for the comprehensive management of enterprises using BIM models and parameters. All users of the platform can download BIM models to a platform through the local work platform through the network, and private BIM models can only be viewed, edited and commented in the personal environment. Effective knowledge transfer in logistics chains relies on trusted frameworks, a requirement that our proposed watermarking mechanism directly addresses by securing the model's provenance (Noof et al. 2026).

### (3) Problems of BIM model

Considering the diversity of integration and application environments in different application scenarios, the security problems that may exist in BIM model data transmission and organization data structure management include two aspects. On the one hand, the security foundation of the BIM model is weak, and users have a weak sense of security. Although a large number of BIM models can be obtained in some model management platforms, the practical effect is very small. If there is no appropriate security protocol or unified security mechanism, users have a low understanding of BIM model security; on the other hand, the BIM model lacks security. In enterprise and cloud environments, most traditional integrated model sharing and transmission platforms protect data through control or encryption methods authorized by users, and only protect the data security of models in the deployment phase. In view of the weak security foundation of BIM, users' security awareness can be improved by publicizing and implementing relevant laws and regulations. Moreover, the BIM model has no security function, so the security of the BIM model can be further improved through data security technology.

## 3. Evaluation of BIM Model Digital Watermarking Technology

(1) Characteristics of BIM model digital watermarking technology

There are four main features of BIM model, as shown in Figure 2. The first is strong robustness. For various geometric attacks on BIM model during transmission and propagation, robustness is an important indicator to measure the characteristics of BIM model digital watermarking algorithm, and also an important basis to measure the quality of watermarking algorithm. Therefore, these attacks must be taken into account when developing digital watermarking algorithms, so that BIM models can still correctly extract watermarks after geometric attacks. The second is imperceptibility. High precision and low redundancy are important signs of the difference between BIM model and traditional 3D digital watermarking, which means that the development of BIM algorithm requires higher visibility. Robust watermark includes watermark information by changing the characteristics or attributes of BIM model. Zero watermark or reversible watermark would not affect the accuracy of the model. The third is high watermark volume. The larger the volume of the watermark, the greater the impact of its accuracy on the BIM model. Because BIM model needs high precision, it is inappropriate to only mention the volume of watermark. Therefore, in order to increase the volume of the data watermark, the watermark volume of each starting point must be considered when designing the watermark algorithm. In addition, considering the low redundancy of BIM model, it is necessary to improve the utilization of small data and make full use of the information in BIM model to create a watermark insertion and extraction mechanism. The fourth is high efficiency. In order to improve the efficiency of data exchange, BIM model also puts forward higher requirements for the development of watermarking algorithm. Only by ensuring the stability of the watermark algorithm, reducing the complexity of the algorithm, and improving the efficiency of watermark embedding and extraction, can the BIM model meet the needs of data exchange.

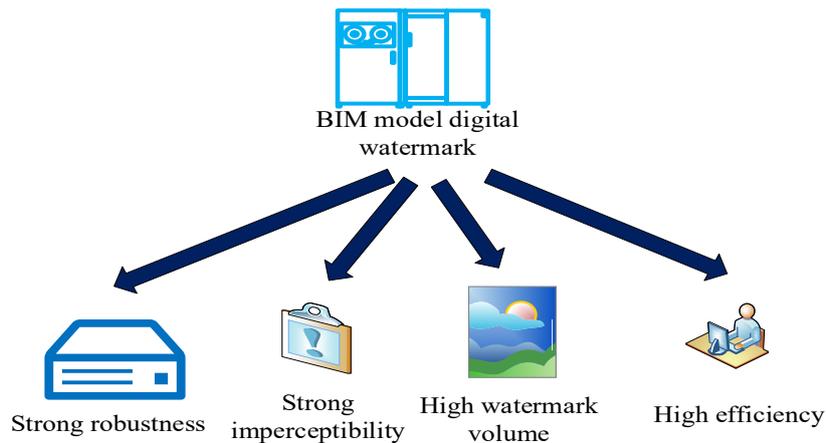


Fig. 2: Features of BIM model digital watermarking technology

(2) Digital watermarking attacks of BIM model

BIM model is faced with various deployment situations and various forms of attacks. In the watermark impact test, the stability of the watermark algorithm must be evaluated, rather than completely destroying its content. There are five main watermark attacks, as shown in Figure 3.

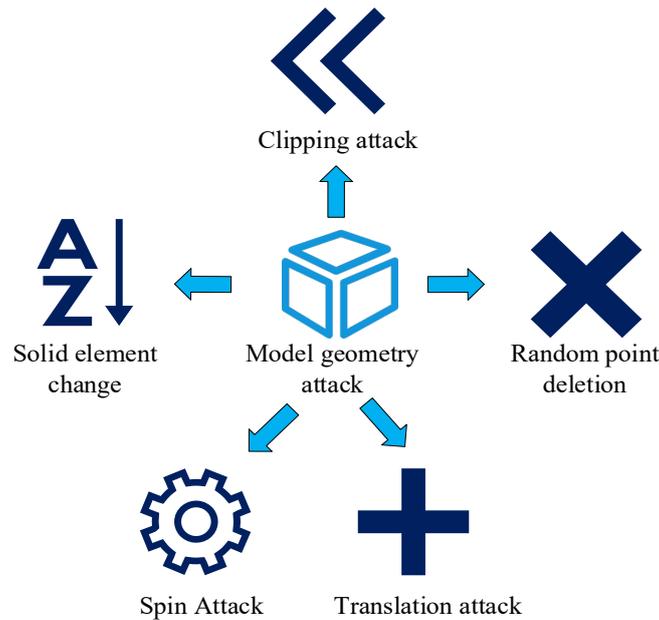


Fig. 3: Digital watermark attack mode of BIM model

#### 1) Translation

The most common geometric attack is model transformation attack, and translation transformation operation is a routine operation of BIM model. Therefore, in order to effectively deal with the changes of geometric attacks, it is necessary to develop a digital watermarking algorithm that matches the 3D model. For translation changes, the model can convert them into a constant frequency range, thereby developing a watermarking algorithm, which can also be more resistant to attack combinations.

#### 2) Rotation

The rotation operation in the BIM model is usually used to modify the project model, which is also a normal operation. In the process of rotating the model, the model can be easily deleted and added due to data restrictions and topological coupling conditions. Therefore, in order to effectively resist the attack of geometric changes, it is necessary to develop a digital hydrological algorithm that matches the 3D model. In order to change the rotation, people can use the rotation frequency within the attack frequency range to obtain strong randomness to counter the rotation attack.

#### 3) Solid element change

Each structure of the BIM model contains substantive information, including points, lines, regions, and other information. The changed details of the model would be added to the diagram and other information. These attacks are simple, but they affect the retrieval of watermark information by changing the model. To change entity elements, people can select feature extraction of attribute information, and use non element size to organize built-in and verified watermark detection mechanisms.

#### 4) Random point deletion

When exchanging the data of each element of the BIM model, a single element or multiple element models may be randomly deleted, but illegal users can still obtain high-precision residual models (Oraee, 2019). These changes would not only affect the visual effect and quality of the model, but also destroy its topological connection and boundary. In this case, the information with watermark still exists, but it cannot be recognized correctly. In order to deal with random deletion, online information, surface information and other basic information are added to the deleted watermark information, which can effectively resist accidental deletion attacks.

#### 5) Cropping

Geometric attack interception would significantly affect the loss of model information, especially

the loss of elements, topological links and attribute data. Although this type of attack is simple, it seriously damages the watermark information, resulting in a serious loss of model quality. However, due to the high precision data of the cut model, the copyright information of other models still needs to be protected. In order to ensure that the watermark of the new sampled data is displayed correctly, it is necessary to make changes that can be reprocessed to facilitate the model to cope with cropping changes.

### (3) Security defense of BIM digital watermarking under data security

At present, there are several security mechanisms for data security, as shown in Figure 4. The first is to formulate security agreements. The data distribution organization must propose technical requirements and data security commitments to ensure the data security of the entire BIM model. The development of security protocols can limit the behavior of users in the data management and distribution phase to ensure the security of data. The second is the user block. BIM data structure model is a special file model, whose data security and user block can be used to save data in the protection formula (Lee et al. 2021). The copyright information in the model is saved to the data structure by using user blocks and keys, and the file format is not changed. The third is to trust professional managers. Data managers and distributors shall jointly entrust professional agents for unified management and use, and professional agents shall have user rights to allocate data according to resource levels and requests. Therefore, data security depends on the rules and technologies of professional agent management. In order to solve many security problems in the BIM model, people can use multiple security protocols to add their own blocks and instruct professional agents to protect data publishing rights. However, adding user blocks is only applicable to the data structure and the confidential format of a single file. If the data structure is exported or destroyed in other formats, it is not available. In addition, the development of security protocols or the use of professional agents depends on the subjective activities and business technologies of individuals, making them more relevant, but targeted protection cannot be achieved. Therefore, the combination of digital watermarking technology and BIM model can better protect the copyright of BIM model at the technical level, and track and correct the consequences of leakage, regardless of the personal security protocols and secret data structures (Rehman et al. 2025).

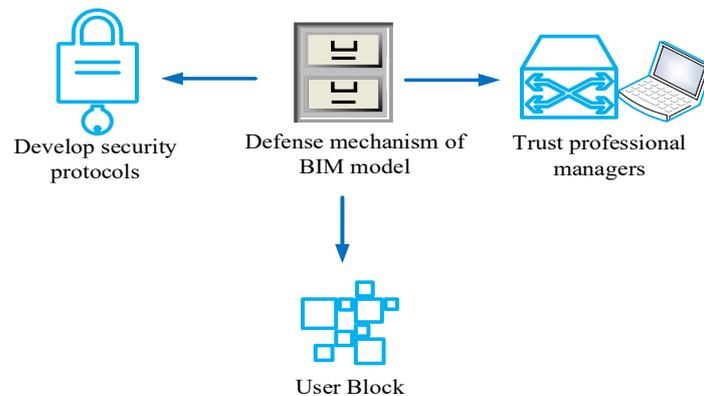


Fig. 4: Security defense mode of BIM digital watermark under data security

## 4. Reversible Watermarking Algorithm for BIM Model under Reversible Quantization Modulation

In order to study the specific practical effect of the digital watermarking algorithm of geometric attack BIM model under data security, this paper analyzes the watermark detection and quantization interval of the BIM model through reversible quantization modulation technology, and then improves the algorithm and optimizes its parameters through reversible quantization modulation. This mathematical formulation establishes the basis for preserving BIM data integrity during collaborative service exchanges. The quantization steps ensure that the watermark embedding process maintains the high precision required for downstream logistics and engineering applications while enabling the recoverability of original data after security verification. In the process of digital watermark

optimization, it is necessary to extract the watermark information of BIM model and recover the BIM model reversibly through data recovery and key. First, the BIM model is read and the changed element  $A$  through displacement change is obtained:

$$A = (A_1, A_2, A_3, \dots, A_n) \quad (1)$$

Among them,  $n$  is the total number of primitives, and then feature point  $A_o$  is selected to obtain the difference sequence of BIM model as follows:

$$A_o = (R_o, S_o, T_o) \quad (2)$$

$$x_r = (x_1, x_2, \dots, x_{rn}), x_t = (x_1, x_2, \dots, x_{tn}) \quad (3)$$

$$x_{ir} = R_i - R_r, x_{is} = R_i - R_s \quad (4)$$

Among them,  $rn$  and  $tn$  both represent the total difference of available recovered data;  $R_o, S_o, T_o$  represents the coordinate system of the spatial coordinate axis;  $x_{rn}, x_{tn}$  represents the difference between the primitive and the feature point in the  $R$  and  $T$  directions respectively. Then, the data precision is used for iterative replacement. Among thme, the iterative replacement condition is:

$$5 \cdot 2^a \cdot 10^{-q-1} \leq g \leq 2^a \cdot (\Delta - 5 \cdot 10^{-q-1}) \quad (5)$$

Among them,  $\Delta$  is the value of the quantization step of the watermark;  $q$  is the data precision;  $g$  is the quantization length of the quantization interval of the BIM model;  $a$  is the insertable watermark of a single difference. Then, the remainder  $x$  obtained from Formula (4) is used to judge the position of the watermark information, and the synchronization mechanism between the watermark information and the feature points is established as follows:

$$W = N \left( \frac{x}{2^a} \times 10^6 \right) \cdot e(0, V) \quad (6)$$

Among them,  $N$  is a random sequence, and the reversible quantization modulation formula after watermark embedding is analyzed as follows:

$$X' = f \cdot m + p[W] \Delta + \frac{x}{2^x} \quad (7)$$

Among them,  $X'$  is the quantized watermark difference;  $\Delta$  is the quantized length;  $x$  is the number of insertable watermarks;  $m$  and  $p$  are the interval index value and remainder of the BIM model under quantized coefficients respectively. Then the original reference values of the BIM model are obtained as follows:

$$R'_i = x'_{ir} + R_h \quad (8)$$

$$S'_i = x'_{is} + S_h \quad (9)$$

Among them,  $R_h, S_h$  is the abscissa and ordinate of the feature point. Finally, the availability of extracting and restoring digital watermark information using BIM model is as follows:

$$c = 2^a \cdot (m_2 / 2^a) \cdot \Delta + 2^a \cdot x_2 \quad (10)$$

## 5. Experimental Evalaution of BIM Model Digital Watermarking under Data Security

In order to study the anti geometric attack effect of BIM model digital watermark, this paper analyzed the original reference value of BIM model and the availability of digital watermark information through reversible quantization modulation. Then the specific security performance of BIM model under data security was studied according to the attack mode of digital watermark, and the corresponding defense mechanism was built according to the problems of the model, so as to improve the practicability of BIM model. This paper first investigated the satisfaction of three construction enterprises with the BIM model under digital watermarking. The survey aims to assess the perceived service reliability and trust of users in the watermarked BIM environment rather than providing a technical validation of the algorithm. These exploratory results demonstrate the acceptance of the proposed mechanism among industry practitioners and validate the service utility of the system in real-world logistics scenarios. Each enterprise surveyed 100 people, as shown in Table 1.

Table 1. Satisfaction of three construction enterprises with BIM model under digital watermark

	Satisfied	Commonly	Dissatisfied
Construction enterprise 1	85	7	8
Construction enterprise 2	88	8	4
Construction enterprise 3	84	10	6
Total	257	25	18

According to the data surveyed in Table 1, the overall satisfaction of the three construction enterprises was relatively high. The number of personnel satisfied in construction Enterprise 1 was 85, accounting for 85% of the total number of the enterprise; 7 people were generally satisfied, accounting for 7% of the total number of the enterprise; 8 people were dissatisfied, accounting for 8% of the total number of the enterprise. The number of personnel satisfied in construction Enterprise 2 was 88, accounting for 88% of the total number of the enterprise; 8 people were generally satisfied, accounting for 8% of the total number of the enterprise; 4 people were dissatisfied, accounting for 4% of the total number of the enterprise. The number of personnel satisfied in construction Enterprise 3 was 84, accounting for 84% of the total number of the enterprise; 10 people were generally satisfied, accounting for 10% of the total number of the enterprise; 6 people were dissatisfied, accounting for 6% of the total number of the enterprise. In general, the number of satisfied people accounted for 85.7% of the total number of the three construction enterprises; the number of generally satisfied people accounted for 8.3% of the total number; the number of dissatisfied people accounts for 6% of the total number. Satisfied personnel believed that digital watermarking technology can improve the robustness of BIM model and the watermark capacity, thereby improving the security of BIM. High satisfaction levels reflect a strong trust in the BIM service platform and indicate that the watermarking mechanism meets the data sharing reliability expectations of enterprise users. This correlation suggests that perceptible security measures contribute to the user confidence necessary for the adoption of collaborative service systems. Moreover, digital watermarking technology can also improve the identification accuracy of BIM model, which can effectively ensure the communication function of BIM model. Those who were not satisfied thought that the digital watermark is not safe enough to build BIM model. This paper then analyzes the changes of BIM model deformation and imperceptibility under digital watermarking, and investigates their changes within a week, as shown in Figure 5.

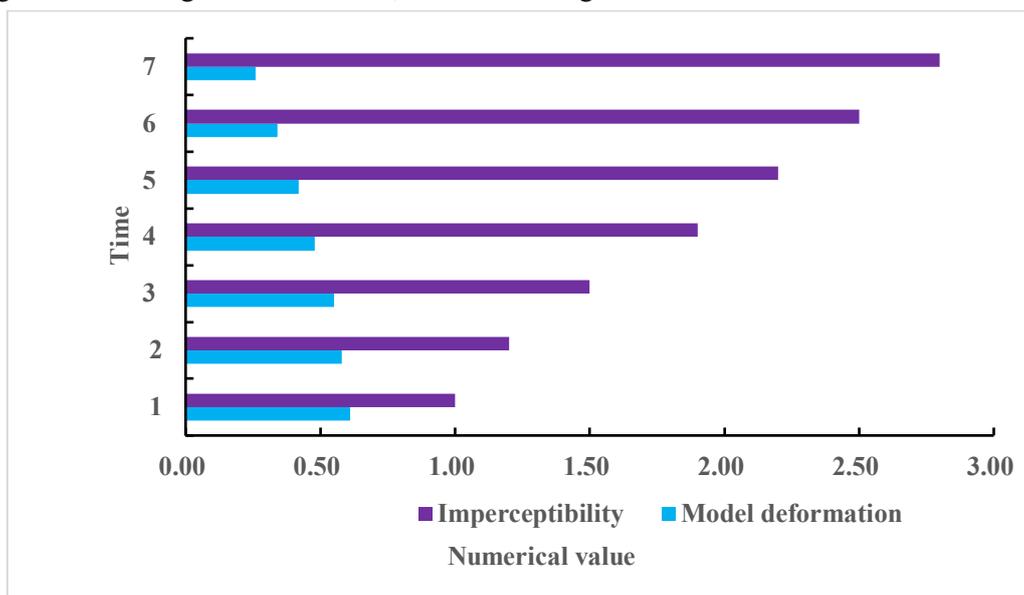


Fig. 5: Deformation of BIM model and change of imperceptibility under digital watermarking

According to the histogram depicted in Figure 5, the deformation of the BIM model under the digital watermark decreased with time, and the imperceptibility of the BIM model increased with time. This trend illustrates the stability of the informatics service over prolonged operational periods and indicates improved data integrity maintenance. The reduction in deformation signifies that the watermarking algorithm successfully minimizes disruptions to the geometric precision required for logistics planning and facility management services. The average deformation of the BIM model under the digital watermark was about 0.46, and the average imperceptibility was about 1.87. On the whole, the initial deformation value of BIM model under digital watermarking was 0.61, which decreased to 0.26 on the seventh day, and the whole process decreased by 0.35; the initial value of imperceptibility of BIM model was 1.00, which increased to 2.80 on the seventh day, and 1.80 in the whole process. The reduction of BIM model deformation indicated that the BIM model is more stable, while the increase of model imperceptibility indicated that the digital watermarking technology of BIM model can improve the management function of the model and model security, and ensure the copyright security of BIM model and the convenience of subsequent accountability. This paper then uses reversible quantization modulation to analyze the original reference value of BIM model and the availability of information. The specific changes are shown in Figure 6.

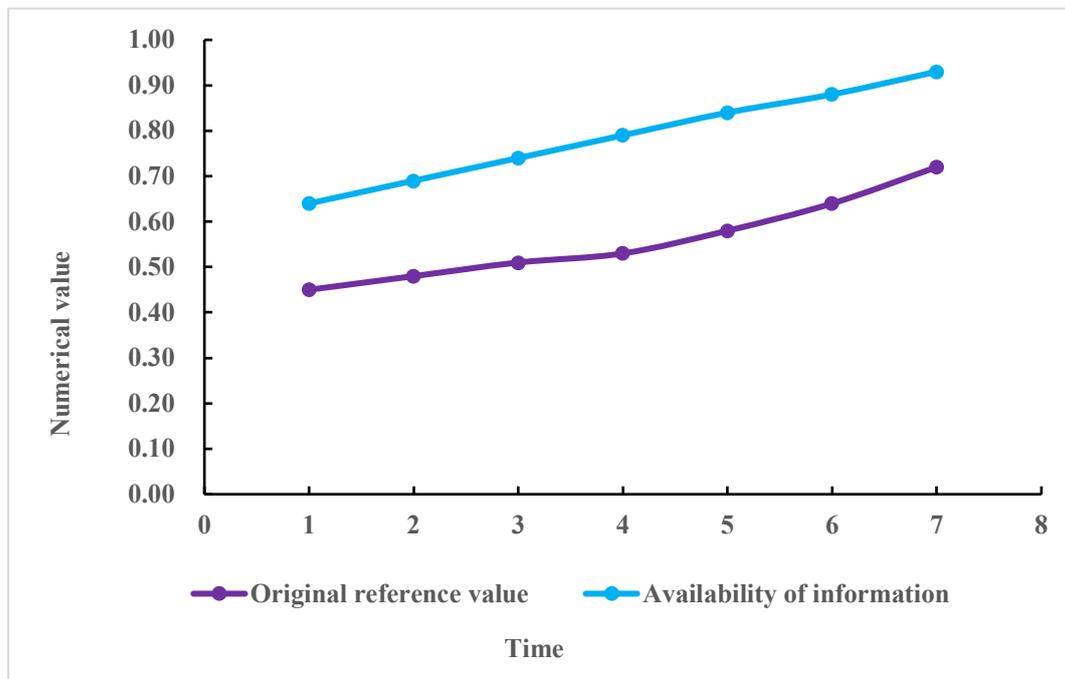


Fig. 6: Original reference value of BIM model and availability of information

According to the curve depicted in Figure 6, the original reference value and information availability of the BIM model under digital watermarking technology were growing with time. The average value of the original reference value of the BIM model was 0.56, and the average value of the information availability of the BIM model was 0.79. On the whole, the initial value of the original reference value of the BIM model was 0.45, which increased to 0.72 on the seventh day, and the whole process increased by 0.27; the initial value of information availability of BIM model was 0.64, which increased to 0.93 on the seventh day, with an increase of 0.29 in the whole process. The increase of the original benchmark value of the BIM model and information availability showed that digital watermarking can improve the stability of the BIM model algorithm, and also can more effectively protect the model from external geometric attacks, which not only guaranteed the copyright of the BIM model, but also improved the security of the model. Later, this paper analyzes the robustness and watermark capacity of the BIM model under the digital watermark, and compares them with the original BIM model, as shown in Figure 7.

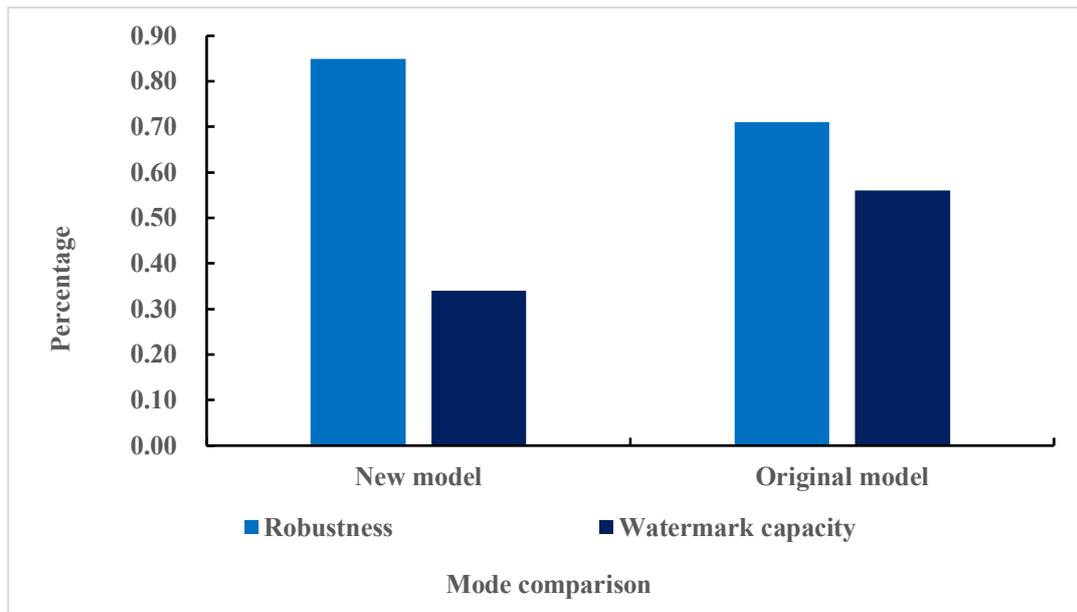


Fig. 7: Robustness of BIM model and watermark capacity under digital watermark

According to the data investigated in Figure 7, the robustness of the BIM model under the digital watermark was better than the original BIM model, while the watermark capacity was lower than the original BIM model. On the whole, the robustness of BIM model under digital watermarking was improved by 19.71%, and the watermark capacity was reduced by 39.29%. The robustness improvement of BIM model of digital watermark showed that digital watermark technology improved the stability of BIM model and made BIM model more stable and accurate. The decrease of the watermark capacity of the digital watermark showed that the BIM model was getting more and more accurate, because the increase of the watermark capacity would damage the precision of the BIM model, and the watermark capacity would drop significantly under the data security. It showed that the precision of BIM model was getting higher and higher. By improving the efficiency of watermark embedding and extraction, BIM model can meet the needs of data exchange.

## 6. Conclusions

The zero watermark algorithm of BIM model is difficult to identify, which requires the authentication of other institutions and the representation of reversible watermark algorithm, and this algorithm would not affect the accuracy of BIM model and its communication. AI driving can improve the robustness and imperceptibility of BIM model. By selecting the points that can be quantized, the closed-loop synchronization mechanism, watermark insertion and data recovery mechanism were established, which is very important to improve the visibility of BIM model and protect the copyright of BIM model. This paper only considered common geometric attacks on BIM models. In order to further improve the stability of the algorithm and adapt to different scenarios and application models, future research can consider different types of attacks in model integration, partial drag models, file conversion and network transmission.

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