Building Construction Information Real-Time Sharing Method Based on 3D Scanning Technology and Social Network Analysis

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Abstract. In order to reasonably improve the management effect of the construction personnel, and reduce the construction costs, arrange the progress of the construction project scientifically and reasonably to ensure the overall construction quality, a real-time sharing method of building construction information is proposed, which combines 3D scanning, augmented reality, intelligent wearable equipment, Internet of Things, regional network communication and RFID.

Keywords: 3D scanning · Social network · Construction · Information sharing

1 Introduction

With the rapid development of the urban construction industry, the construction process and completion safety management problems are gradually highlighted. In particular, the construction problems encountered are complex and diverse, such as real-time sharing of construction information collection, construction progress coordination, construction personnel behavior management, etc. In order to solve the above construction problems, improve the construction management effect, reduce the construction costs, and ensure the smooth progress of the construction, use the scientific and effective 3D scanning technology and network information processing technology in the real-time sharing management of construction information. The scheduling of construction projects is scientific and appropriate, that can ensure the whole construction quality, and the use of information collection and analysis can promote the optimization of resource allocation, which can effectively reduce the waste of resources in each construction link. The application of 3D scanning technology has a great promoting effect on construction management [1]. Three-dimensional scanning is a kind of technology that can fully display the computer simulation environment and make the user feel immersive. Three-dimensional scanning technology builds on augmented reality technology by adding a virtual and real-world nexus that allows workers to more realistically perceive the real world [2]. Therefore, the application of 3D scanning technology to building construction will not only greatly improve the safety and reliability of the construction phase, but also lay a solid foundation for the follow-up construction industry.

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In the process of real-time sharing and processing of construction project information, the construction party is the main body of the project construction, and an information-based safety management system for construction shall be established in light of the safety management problems of the construction party in the construction phase, and three closed-loop information sharing management systems, including the collection system of construction information in the intelligent era, the pre-prevention safety management system based on three-dimensional scanning technology and the safety management system for construction process based on three-dimensional scanning technology, shall be formed [3]. It is used to standardize and guide the actual construction process, ensure the safety performance coefficient of the construction process, and achieve the goal of guaranteeing the intrinsic safety of the construction system.

2 Method of Real-Time Sharing of Construction Information

2.1 Building Construction Information Processing Algorithm Based on 3D Scanning Technology

The building information model based on 3D scanning technology can integrate all kinds of effective information, realize collaborative operation and management of the whole life cycle of building, effectively grasp the information of each stage and ensure that this information can be shared in the whole stage. Combining the latest research results, a 3D scanning system based on machine vision, we establish the information transmission path to guide the final data processing method. The photo-type three-dimensional scanning system includes a photo-type 3D scanner, optical projector, CDD camera, stability bracket, 3D point cloud data processing methods, power supply and other accessories. CCtrlDevice, ClmageProcess, CRenderOpenGL, CDataManager four software module systems are embedded in the 3 D scanner and CCD and internal control calibration systems are integrated [4]. Based on the principle of laser ranging, the three-dimensional coordinate value in space is measured instantaneously by a high-speed laser transmitter [5].

In the process of building construction information real-time sharing, the camera coordinate system is used as the coordinate system (x, y, z) of 3D sensor, and the imaging mode of 2D camera can be seen:

$$\begin{cases} X_{ax} = \frac{(x_m - x_0 + \Delta x)}{c} Z_{aw} \\ Y_{an} = \frac{(y_m - y_n + \Delta y)}{c} Z_{av} \end{cases} \tag{1}$$

Where: (x_m, y_m, z_m) is the three-dimensional coordinate of the measured point m in the camera coordinate system, (x_m, y_m) is the image coordinate of the imaging point of the measured point on the camera; C is the effective focal length of the camera, (x_0, y_0) is the center of the image plane, and $(\Delta x, \Delta y)$ is the comprehensive distortion, which can be expressed by the following formula:

$$\begin{cases} \Delta x = x_c r^2 k_1 + x_c r^4 k_2 + x_c r^6 k_3 + \left(2x_c^2 + r^2\right) p_1 + 2p_2 x_c y_c + b_1 x_c + b_2 y_c \\ \Delta y = y_c r^2 k_1 + y_c r^4 k_2 + y_c r^6 k_3 + 2p_1 x_c y_c + \left(2y_c^2 + r^2\right) p_2 \end{cases} \tag{2}$$

Where:

$$\begin{cases} x_c = \Delta x x_m - x_0 \\ y_c = \Delta y y_m - y_0 \end{cases} \tag{3}$$

$$r = \sqrt{Y_{an} x_c^2 + X_{ax} y_c^2} \tag{4}$$

Among them, $c, x_0, y_0, k_1, k_2, k_3, p_1, p_2, b_1, b_2$ is the model parameter of camera coordinate system, which can be obtained by camera calibration technology [6]. Taking the plane structured light as an example, the plane of structured light has a definite mathematical description in the reference coordinate system. The specific form is determined by the mode of structured light

$$Z_r = f(X_r, Y_r) \tag{5}$$

The transformation relationship between reference coordinate systems can be described by rotation matrix R and translation matrix T. As shown in the formula, R and T can be obtained by sensor calibration technology:

$$\begin{pmatrix} X_c \\ Y_c \\ Z_c \end{pmatrix} = Z_r R \begin{pmatrix} X_r \\ Y_r \\ Z_r \end{pmatrix} + T \tag{6}$$

$$R = \begin{pmatrix} r_{11} & r_{12} & r_{13} \\ r_{21} & r_{22} & r_{23} \\ r_{31} & r_{32} & r_{33} \end{pmatrix} \tag{7}$$

$$T = \begin{bmatrix} T_1 \\ T_2 \\ T_3 \end{bmatrix} \tag{8}$$

The equation of structured light plane in 3D sensor camera coordinate system can be solved by the above formula

$$Z_c = Tf(X_c, Y_c) \tag{9}$$

The mathematical model of structured light vision sensor is obtained

$$\begin{cases} X_c = \frac{(x - x_0 + \Delta x)}{c} Z_c \\ Y_c = \frac{(y - x_0 + \Delta y)}{c} Z_c \\ Z_c = f(X_c, Y_c) \end{cases} \tag{10}$$

By introducing the structured light plane, the relationship between the light plane and the camera coordinate system is obtained by using the pre calibration technique. As a supplementary constraint, the ambiguity of the inverse mapping from the two-dimensional image space to the three-dimensional space is eliminated [7]. Further initialize the information, and then check whether it is in a sleep state under the sharing method. If not, send the information to the management module. After the successful transmission, they

Table 1. Construction initialization information

Initialization information	Information acquisition		Information management	
	a	b	a	b
1000	27.8	24.7	25.2	23.7
10000	27.6	25.4	170.9	28.0
100000	29.1	237.3	145.5	25.4

receive the information and process it. The data is analyzed as shown in the table (Table 1).

Three dimensional scanning is convenient to detect the contour data of the working environment. All kinds of monitoring devices arranged in the construction workplace can be transmitted to the technicians through the network, and then the three-dimensional modeling can be integrated into the BIM method, and the risk identification can be carried out in advance on the BIM method, so as to reduce the information asymmetry of all parties in the initial stage of the system construction, which is convenient for better management In order to avoid the construction safety problems that may occur in the construction process, we should coordinate all parties effectively. Based on this, the construction information processing steps are optimized, as shown in the following Fig. 1:

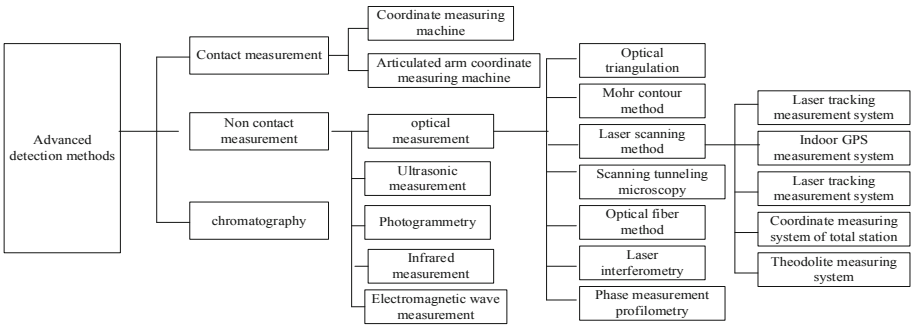

Fig. 1. Construction information processing steps

As shown in the figure, the most advanced heterodyne multi frequency phase-shifting three-dimensional optical measurement technology is used for single measurement format, measurement accuracy, measurement speed and other performance. Compared with the traditional gray code plus phase-shifting method, it has reached the world's most advanced level, with higher measurement accuracy, larger single measurement range, strong anti-interference ability, and little impact on the measured data, so as to scan and measure objects from several millimeters to tens of meters Volume information [8, 9].

The products represented by surface scanning equipment are especially suitable for the modeling of large plane, super large surface and complex surface parts.

2.2 Building Construction Information Sharing Model Based on Social Network

Social network related equipment can be divided into three categories according to its measurement methods. Compared with the traditional risk analysis mode, this risk identification method will be more scientific, reasonable and effective. Based on such practical problems, we should establish an information collection and modeling system in the early stage of social network construction, which is convenient for the follow-up work [10]. The effective construction information collected is integrated into the social network BIM integrated information management method, which is convenient for the later engineering modeling and real-time information sharing in the whole process. The whole information collection system is shown in Fig. 2

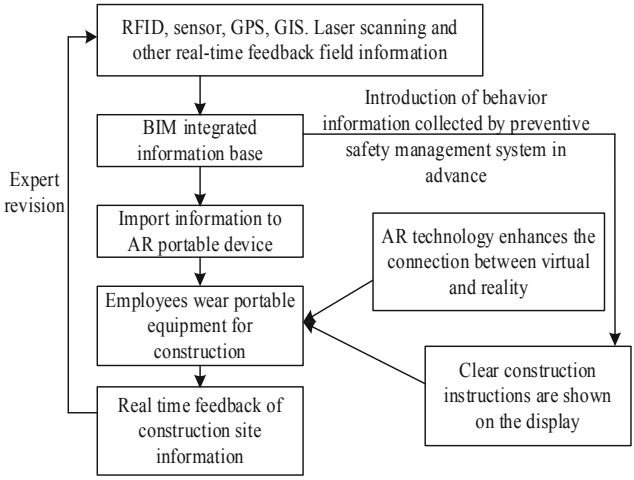

Fig. 2. Information collection system at the initial stage of construction

In the early stage of construction, fine information collection and three-dimensional modeling will greatly reduce the sudden accidents that may occur in the whole life stage. Integrating all kinds of building information, simulating the corresponding construction environment, and relying on BIM information method for all aspects and multi-level management will improve the safety and reliability in the actual construction process. BIM can store all geometric information and engineering technical information in engineering design scheme [11, 12]. On the basis of building construction information collection in the early stage, it is applied to BIM method and combined with digital network technology for 3D modeling. In the process of modeling, the design planning problems are discussed and analyzed to find the optimal solution. So as to better adapt to the technical development of the current digital era, and constantly introduce new science and technology to enhance the operation safety of the current facilities. Based on this,

the informatization safety management system before construction is optimized, and the specific structure is shown in Fig. 3.

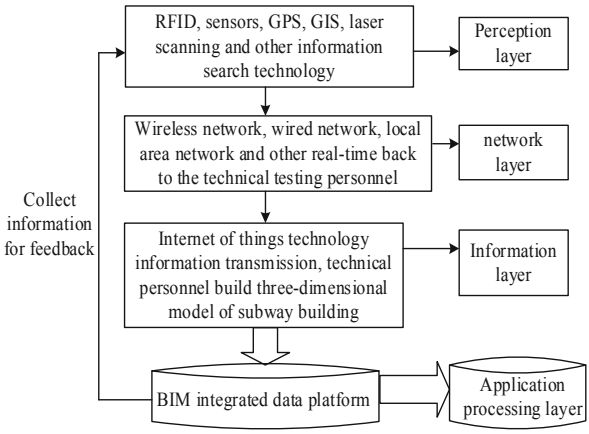

Fig. 3. Information sharing prevention safety management system

In the early stage of construction, the information collection system has been able to ensure technicians to establish a relatively complete project model based on BIM method, so as to find the design conflicts in the process of information integration modeling. The complete BIM model is connected with 3D scanning technology, the project model is imported into the virtual technology, and then the model is optimized. The 3D technology is used to integrate the virtual reality environment and BIM model seamlessly, and all the information collected is verified and corrected before the actual construction.

2.3 Realization of Real-Time Sharing of Construction Information

In the established three-dimensional model, VR technology is used to import. The main construction personnel wear a head mounted display and immerse themselves in the virtual construction environment for relevant construction operations. The safety management personnel will track and record their behavior, and finally feed back to the BIM information integration method to form a dynamic and real-time updated safety behavior log. The main personnel of intelligent construction method can also continuously improve their own reliability through the application of scientific information technology. The emergence of 3D scanning technology and its application equipment HMD makes virtual construction possible. The significance of building construction is great. The objective risk factors can be identified before the actual construction, and then the corresponding preventive measures can be formulated The implementation of man who will present these steps to prevent potential hazards and accidents on HMD equipment, increase the safety and reliability of construction, and then reduce the risk probability of people in the whole safety system, so as to achieve the intrinsic safety of system construction. Based on this, the construction information security management model is constructed to avoid all kinds of emergencies and improve the intrinsic safety

of construction. The specific construction information security management model is shown in Fig. 4.

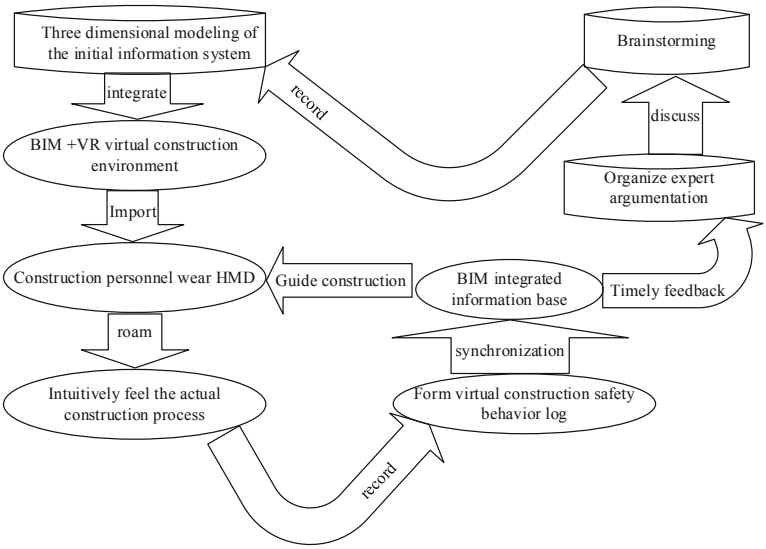

Fig. 4. Construction information security management model

According to the BIM target, the specific plan of building construction is planned. The implementation of real-time information sharing technology will change the production process of building construction. Through the establishment of real-time information sharing scheme, it can realize the smooth migration, sharing and checking of information, such as document management, query prevention authority, folder maintenance and notification. According to the technical ability of building construction, the technical framework is established by analyzing BIM tools, hardware and software requirements. For employees, including training system, number of trainees, time, expert selection, etc.; BIM application organization structure design. In the social network, the browser server architecture is adopted, which is based on the secondary development of scalable data collector. With network data as the technical support, the design and development of building construction information sharing method under the background of big data is realized. As shown in the figure is the overall architecture of the construction information sharing method (Fig. 5).

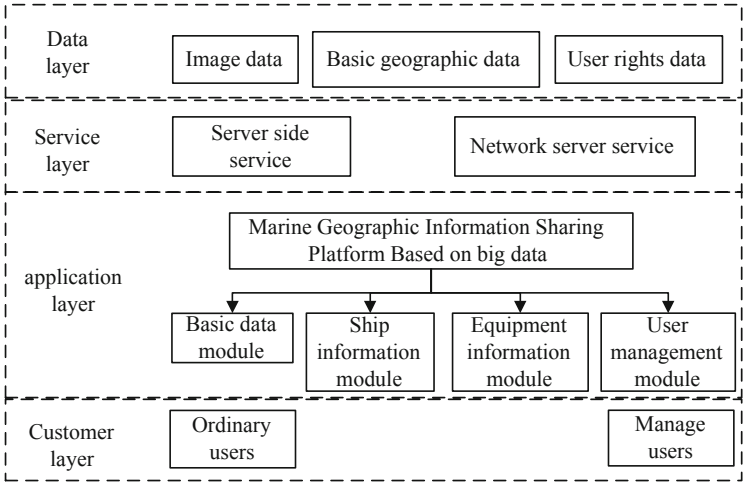

Fig. 5. Overall framework of construction information sharing method

The organizational structure includes the new department and new post specially responsible for managing BIM Technology and services, the division of work interface and the responsibilities of relevant parties. The final foothold of project BIM implementation and construction BIM Technology implementation is the construction project. At the project level, the implementation content of BIM includes project BIM implementation preparation, construction information model creation, model application, BIM results output; project BIM implementation preparation. BIM implementation preparation includes setting BIM implementation objectives, BIM implementation plan, BIM team and BIM facility environment. Construction information model creation. Based on the CAD drawings or BIM design model provided by the design unit, the construction model is constructed, and specific information is added according to the types of BIM application. Taking the BIM application of construction organization simulation as an example, the construction information model should include the contents of construction drawing, construction organization design, construction schedule, resource organization and plane layout; project BIM application. The BIM model is used in the management of construction process, such as schedule management, cost management, multi-party collaboration, etc. BIM output. Through the BIM application, the targeted solutions are obtained. Taking the BIM application of concrete prefabricated components as an example, through the BIM implementation in the above stages, the resource allocation plan, process instruction, processing drawing, report list, etc. Required for component production can be formed. Based on this, the architecture construction information management framework is optimized, as follows (Fig. 6):

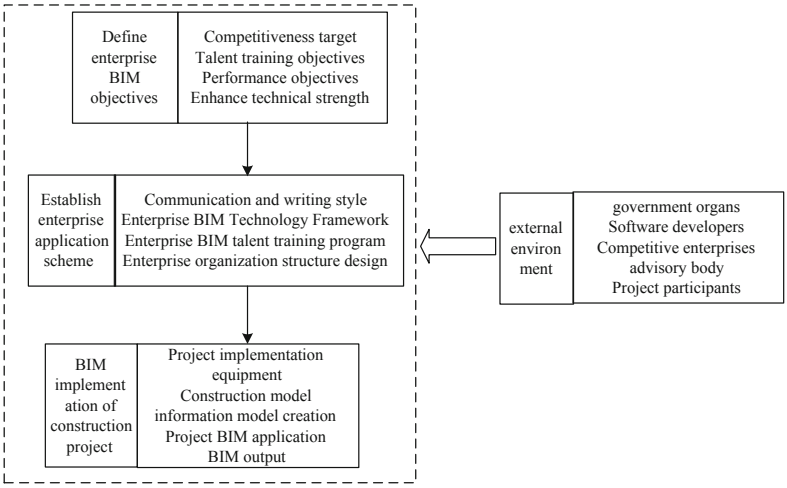

Fig. 6. Construction information management framework

The purpose of information sharing development of BIM Technology in construction building is to preliminarily determine the framework of success factors and define the scope for subsequent analysis of key success factors. The following figure describes the development steps of information sharing list processing (Fig. 7).

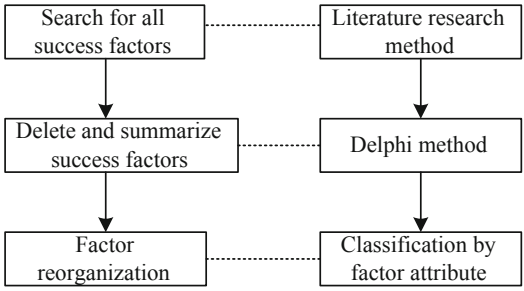

Fig. 7. Processing steps of information sharing list

According to the application layer of the overall framework of the above building construction information sharing method, the overall functions of the development and construction of the sharing method under the background of big data are designed, as shown in the Fig. 8.

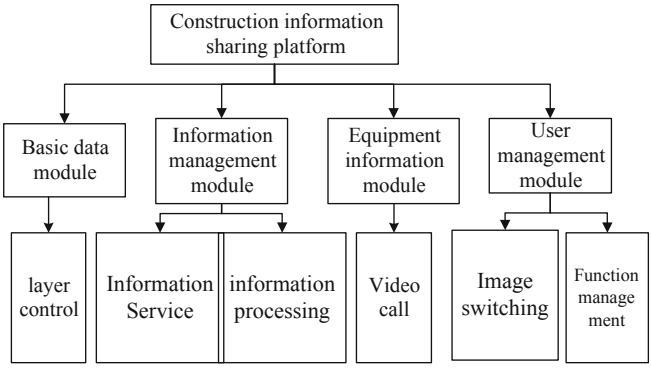

Fig. 8. Overall function design of information sharing model

It can be seen from the figure that the functional part of the building construction information sharing method based on 3D scanning technology and social network analysis is composed of basic data, building information, information and user management modules in the overall framework, in which the basic data module can realize image hierarchical control, the building information module can realize information query and processing, and the information module can realize video adjustment The user management module can realize image switching and function management. BIM direct cost control should be paid attention to in construction. Excessive purchase of BIM related software and hardware facilities will not only confuse the application objectives of BIM, but also cause the risk of construction operation. At the same time, due to the uncertainty in the process of BIM implementation, such as the change of design and business content, the potential cost of BIM Technology should be controlled to improve the economic benefits of BIM.

3 Analysis of Experimental Results

In view of the practical application of the real-time sharing method of building construction information based on 3D scanning technology and social network analysis, the design is verified by experiments. The experimental parameters were optimized as shown in Table 2.

Table 2. Parameter setting of experimental data acquisition

Unit number	Acquisition node	Parameter setting
1	A1	60
2	A2	75
3	A3	55
4	A4	80

The traditional method and the information sharing method in this paper are compared. Under the noise interference, the construction information sharing situation is compared and analyzed. Set the information sharing time as 20 s, select 8 building construction information as the experimental object, respectively view the two methods information sharing situation, and the comparison results are shown in the Fig. 9.

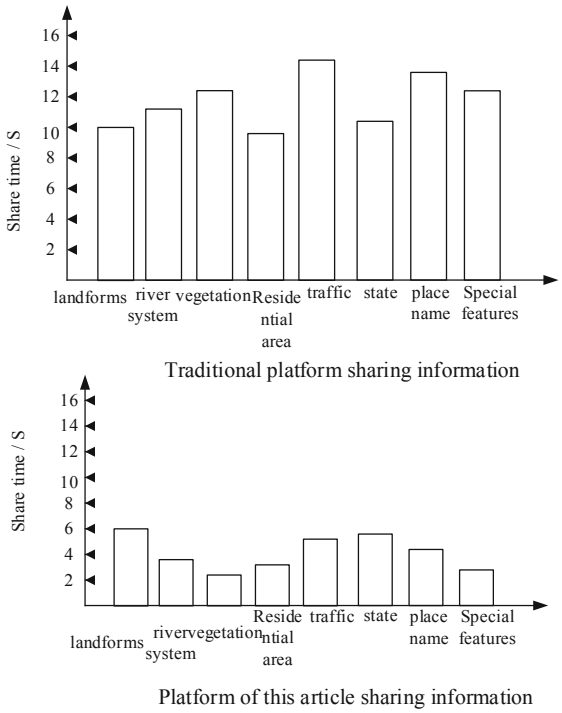

Fig. 9. Time consumption of information sharing between the two methods

It can be seen from the Fig. 9 that the information sharing time of the traditional method is longer than that of the data sharing method in this paper. Therefore, the real-time information sharing method of the three-dimensional scanning technology combined with social network analysis proposed in this paper has significantly shorter time-consume and lower time-consume in the practical application process, which fully meets the research requirements.

Furthermore, the two methods share the differences in time may be due to noise interference. Therefore the sharing effect of the two methods is compared under noise interference, and the results are shown in Fig. 10.

It can be seen from the Fig. 10 that the traditional method is more disturbed by noise and has a longer time, building construction information real-time sharing method based on 3D scanning technology and social network analysis is less disturbed by noise, and the performance of sharing information has remained stable. Therefore, the design method is better.

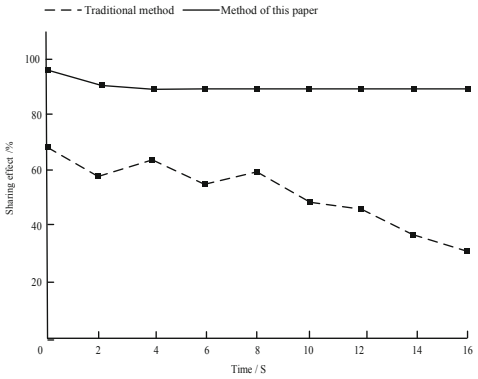

Fig. 10. Comparison of sharing effect of two methods under noise interference

4 Conclusion and Outlook

This paper briefly discusses the significance of information management for construction projects and the strategy of realizing information management. At present, society has entered information society, and it has become inevitable for all walks of life to be included in information management. As a basic industry of development, construction project shoulder a heavy list of responsibilities. In order to effectively improve the efficiency and safety of its work, it will be built It is an inevitable choice to include the informatization of construction project management, which can lay a solid foundation for the long-term development of China's construction projects. With the rapid development of information technology, the construction process is inseparable from the application of information technology. Construction management is closely related to construction quality and construction cost control. Computer network technology is also widely used in construction management, which effectively improves the level of construction management. Therefore, the analysis of information technology application in construction management plays a great role in promoting the development of the domestic construction industry. This paper deeply analyzes the application of computer in construction project management, and probes into the application status of information technology in construction management. Based on this, this paper puts forward the application strategy of information technology in construction management, in order to improve the application level of information technology in domestic construction management. With the continuous development of the economy and society, project construction is more and more strict, with higher requirements for information management technology. The role of real-time sharing of construction information is increasingly important in the construction industry and information technology application. In the future, information sharing methods with higher sharing accuracy and shorter sharing time will remain the main focus of research in this field, and ultimately promote the development of information sharing technology to a higher level.

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