ORIGINAL ARTICLE

Application of 3D Simulation Technology in Construction Process of Building Equipment Pipeline

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Abstract: With the continuous development of economy, people's demand for life is also increasing. Building equipment pipeline engineering should not only show artistic appreciation and practical ability, but also show economic and environmental protection and building safety. In the pipeline engineering of construction equipment pipeline construction, whether from the construction efficiency, construction quality or performance, 3D simulation technology has immeasurable role and far-reaching practical significance, and also has the intuitive nature of construction projects. In the construction equipment pipeline engineering, the problem of insufficient space gap and pipeline crossing is the most common problem in the construction equipment pipeline design industry and the actual workers in the construction. Using three-dimensional simulation technology, we can establish a relatively complete three-dimensional model of building pipeline information, and timely find the unreasonable actual situation and disadvantages in the process of building implementation. This cost can be cancelled before the actual construction, saving money, improving efficiency and shortening the construction period. With the continuous development of construction, the requirements of construction enterprises for construction efficiency have been improved, and the requirements of construction units for project quality and appearance have also been improved. In such a big environment, we put forward more requirements for the construction of building pipeline system. In order to better develop and adapt to the requirements of the times, the construction units of building pipeline should increase the application and promotion of new technologies, and use all kinds of new technologies to improve their production efficiency and quality. This article uses ICP algorithm and 3D map matching algorithm to study a series of construction equipment in the construction process of all possible profiles. In this paper, combined with the current situation of building pipeline design and construction, the application of three-dimensional simulation technology in the construction process of building equipment pipeline is described. This paper analyzes the advantages of 3D simulation technology, and deeply understands the practical application and real situation of 3D simulation software technology in the construction process of building equipment pipeline.

Keywords: Three Dimensional Simulation Technology; Construction Equipment; Pipeline Construction; Two Dimensional Plane.

With the continuous development of contemporary social economy, people's living standards are gradually getting better, the overall development of society and people's quality of life have been better improved, China's social construction engineering has also been continuously developed, and people have put forward more stringent standards for construction engineering construction and pipeline system and other construction requirements[1]. Therefore, we must introduce new technology to improve the construction quality and level of social construction engineering and pipeline engineering in our country. However, due to the complex structure of the construction pipeline engineering, the construction process involves a wide range of fields, and there are many intersections with other related disciplines. The traditional two-dimensional graphic design is not intuitive enough. Its practical application process. Therefore, in the design and construction process of building pipeline engineering, three-dimensional simulation technology must be well introduced, and vigorously promoted and applied [2]. Three dimensional simulation technology can meet the

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construction requirements of building pipeline engineering, it can feedback three-dimensional information, and then improve the construction efficiency and quality of building pipeline system [3]. In the process of the actual construction of building pipeline engineering, the traditional two-dimensional plane technology has been unable to meet the construction needs, so the efficient application of three-dimensional simulation technology can provide more information models for construction engineering, and ensure the smooth construction of building pipeline.

In recent years, with the rapid development of computer technology, three-dimensional simulation technology has become an incomparable advantage of traditional two-dimensional graphic design. At present, the development trend of engineering design is to conduct 3D simulation analysis on the whole project and all parts of the project, and integrate relevant information, such as building information modeling (BIM) information model creation configuration file[4]. 3D simulation technology refers to the combination of a normal configuration and all relevant data. Data analysis is completed by related software and 3D modeling analysis. All projects are implemented by BIM technology. Professional 3D simulation software, such as 3dmax, Maya, 3D-CAD, etc. Analyze the real situation. The project type analysis software can better solve the conflict and flow process in the project, which proves that Autodesk revamp is an ideal shape design and more suitable for pipeline design than "design standard pipeline shape" combined with experience [5]. In addition, the software can also make three-dimensional pipe model. The initial model uses the data of 3D model to complete the required data and the data after modeling. In addition, the preparation phase of all construction activities has been completed. In addition to pipeline technology, other functions related to the project. Including ventilation and air conditioning. In addition to electrical equipment and other construction methods, only by improving the work package of each part, including the construction of water supply and drainage pipeline, can the overall construction of the project achieve good construction quality [6].

Construction enterprises should pay attention to the R & D and upgrading of construction pipeline construction technology, and constantly improve the coordination and adaptability of construction pipeline construction technology. Through reasonable construction links and perfect operation technology, while ensuring the quality of pipeline construction, continuously improve the construction efficiency of construction pipeline, and better promote the development and progress of pipeline and the transformation and modernization of construction project[7]. At the same time, construction enterprises also need to attract more excellent talents, establish and improve the talent reserve system, cultivate more reserve forces, enable enterprises to master advanced technology, and constantly promote R & development of construction technology the purpose of this study is to study the construction technology, improve the quality and operation level [8]. The purpose of the project is to make the construction process of the actual test and technical indicators. Further strengthen personnel training to promote the technical progress and rapid and healthy development of the construction industry [10].

1. Algorithm establishment

1.1 ICP algorithm

The principle of ICP algorithm is as follows, assuming that there are two groups of data in the three-dimensional space R^3, namely data set p_L and p_R , respectively expressed as:

$$p_L = \{p_{l1}, p_{l2} \cdots p_{ln}, p_{li} \in R^3\} \quad (1)$$

$$p_R = \{p_{r1}, p_{r2}, \cdots, p_{rn}, p_{ri} \in R^3\} \quad (2)$$

Where n is the number of subsets in the dataset. After a series of p_L transformations in three-dimensional p_R space, each point in the point set corresponds to the data in the point set one by one

$$p_{ri} = R \cdot p_{li} + t \quad (3)$$

Where R is the three-dimensional rotation matrix and t is the translation vector.

In the ICP standard matching method, the spatial transformation data variable x is actually expressed as follows:

$$X = [q_0\ q_x\ q_y\ q_z\ t_x\ t_t\ t_z]^T \quad (4)$$

In the parameter vector of the above formula q_0、q_x、q_y、q_z are called quaternion parameters, which meet the connt conditions:

$$q_0^2 + q_x^2 + q_y^2 + q_z^2 = 1 \quad (5)$$

According to the initial value of iteration X_0, the new point p_i set is calculated by equation (1)

$$p_i = p_0(X_0) = R(X_0)P + t(X_0) \quad (6)$$

In the above formula, P represents the initial point set data, p_i the subscript i represents the initial iterative function value, and the initial value of X_0 the variable x in the formula is $X_0 = [1\ 0\ 0\ 0\ 0\ 0\ 0]^T$.

1. 2 3D image matching algorithm

The node selected in this paper is to select the system and eccentricity to describe the argument of this paper. It refers to the actual number of nodes connected by a node in a series; ε eccentricity refers to the maximum value of the probability between the node and any data node, i.e

$$\varepsilon_i = \max_{n_j \in N}(H_{n_i \to n_j}) \quad (7)$$

$$H_{A \to B} = \min_{k \in \{1,\cdots,N-1\}}(P_{A \to B}(k)) \quad (8)$$

The solution to the matrix X of node matching relation in equation (7) can be transformed into:

$$\max J_{gm}(X) = \underset{x}{vec}(X)^T K vec(X) \quad (9)$$

In the above formula, VEC means to decompose the matrix into six small matrixes, namely G_1, G_2, H_1, H_2, K_p , K_q and so on.

$$K = diag(vec(K_p)) + (G_1 \otimes G_2) diag(vex(K_q))(H_2 \otimes H_1)^T \quad (10)$$

2. Modeling method

In this paper, the three-dimensional rectangular coordinate system in the algorithm is restored to synthesize the location of the three-dimensional space of the dangerous building. The r-point is the random feature point of dangerous building after strong earthquake. K_1 and K_2 are the feature points obtained by image acquisition equipment P_1 and P_2 at r-point.

In the above formula: $(v_1,w_1,1)$ and $(v_2,w_2,1)$ are the three-dimensional coordinates of the dangerous building features obtained from the actual calculation; $(X,N,B,1)$ are the real coordinates of the dangerous building feature points in the three-dimensional coordinate system under standard conditions; k_{if}^x and k_x are the f-th element in the i-th line of the data.

By expanding the analytical expressions (1), (2), we get the following results

$$B_{d1} v_1 = k_{11}^1 X + k_{12}^1 N + k_{13}^1 B + 1 \quad (11)$$

$$B_{d1} w_1 = k_{21}^1 X + k_{22}^1 N + k_{23}^1 B + 1 \quad (12)$$

$$B_{d1} = k_{31}^1 X + k_{32}^1 N + k_{33}^1 B + 1 \quad (13)$$

Through the combination and transformation of formula (3) and formula (4), the same formula is eliminated. The results are as follows

$$(v_1 k_{31}^2 - k_{11}^2)X + (v_2 k_{32}^2 - k_{12}^2)N + (v_2 k_{33}^2 - k_{13}^2)B = 1 \quad (14)$$

Transform formula (6), filter out some of them B_{d1}, and finally carry out a series of calculations to obtain the three-dimensional measurement model of dangerous building inclination in the actual situation

$$(v_2 k_{31}^2 - k_{12}^2)X + (v_2 k_{32}^2 - k_{12}^2)N + (v_2 k_{33}^2 - k_{13}^2)B = 1 \quad (15)$$

3. Evaluation results and research

After determining the model and measurement process, the inclination of dangerous building after strong earthquake is measured. The methods proposed in this paper are used in the experiment, that is, the perception method of surface tilt angle of building pipeline design based on TLS and the perception method of surface tilt angle of building pipeline data based on Gini coefficient. After the strong vibration of the building pipeline, we can clearly feel the experience of the tilt angle of the dangerous building, so as to build the tilt angle measurement and evaluation model of the dangerous building. Because there is a certain reason for the experimental space, this paper only uses these two measurement modes to carry out the test and TLS basic building surface tilt angle perception method. After the occurrence of strong vibration, the three-dimensional data value and average error rate of dangerous buildings are in table 1 and table 2 respectively. The actual length of the building pipeline in reality is represented by X, the width is represented by Y, and the height is H.

Table1. Three dimensional data for measuring dangerous buildings

Inspection point	X/m	Y/m	H/m	Average error/%
1	940.1563	924.8863	152.7983	4.03
2	936.1685	954.1652	150.6675	1.36
3	940.1268	935.4281	149.5962	2.36
4	939.4638	926.1682	138.2654	1.18

Table 2. 3D data measured by TLS based building surface tilt detection method

Inspection point	X/m	Y/m	H/m	Average error/%
1	913.2654	897.7782	123.4127	6.47
2	916.3258	867.6357	139.6484	9.16
3	897.2646	860.9839	145.3586	8.23
4	895.3012	859.1684	150.6449	7.04

According to the data analysis in table 1 and table 2, the average existing error rate of the three-dimensional actual values of each point in the building measured by the three-dimensional building pipeline data established by the method used in this paper is less than 5%, and the minimum average error rate is only 1.18%. The results show that the average error rate of TLS building pipeline inclination detection method is more than 6%, and the minimum average error rate is 6.47%, which is significantly higher than the method used in this paper. The results show that the method used in this paper can form more accurate data when measuring the three-dimensional value of dangerous buildings after strong earthquake, which can accurately improve the accuracy of data when measuring the inclination of each dangerous building after strong earthquake.

Through the analysis of the data in figure 1 and figure 2, it can be concluded that the bikini coefficient method and TLS method in this paper need less time to measure the inclination of dangerous buildings. In the eight experiments, the average measurement time used in calculating the inclination angle of dangerous buildings is: 3.1 s for this method, 7.9 s for TLS method and 13.9 s for Gini coefficient method. The average measurement time of this method is 5.4 s shorter than the other two methods. The method used in this paper is to measure and calculate the inclination of the building after a strong earthquake, and the results show that this method is more effective. In order to improve the surveying and mapping quality of dangerous buildings after strong earthquakes, it is particularly important to measure the tilt information of dangerous buildings effectively. However, in the process of measuring the inclination of dangerous buildings after a strong earthquake, a large number of external factors will interfere with the experimental data, resulting in inaccurate data information of the final building inclination. Moving in the measurement will cause symmetry deviation of the experimental data.

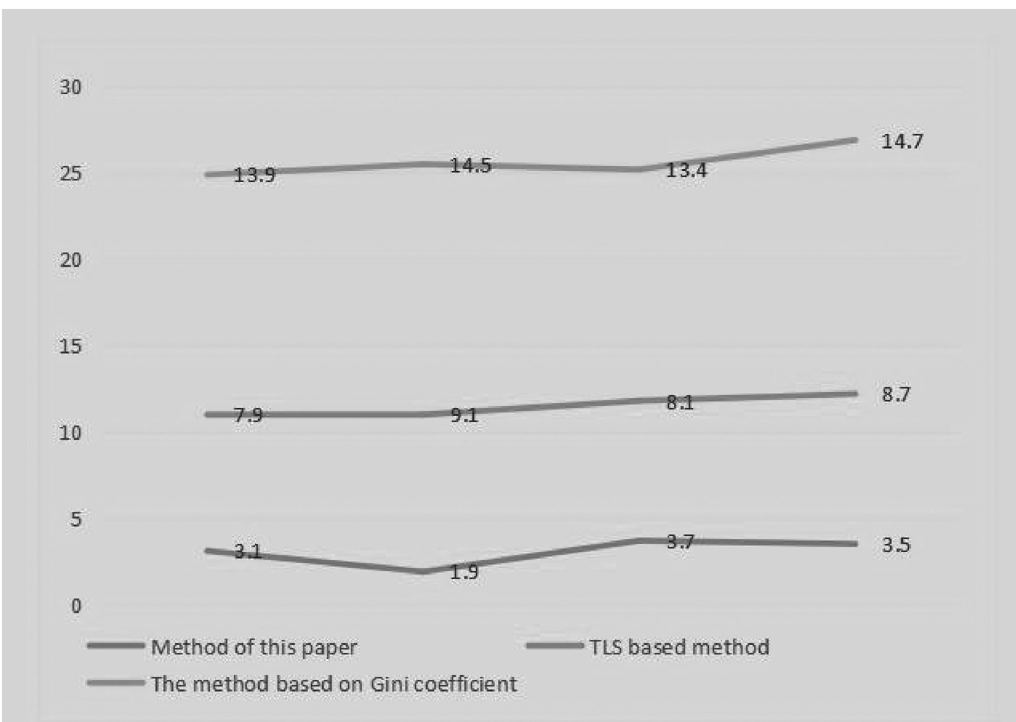

Figure 1. Measurement time data of different methods.

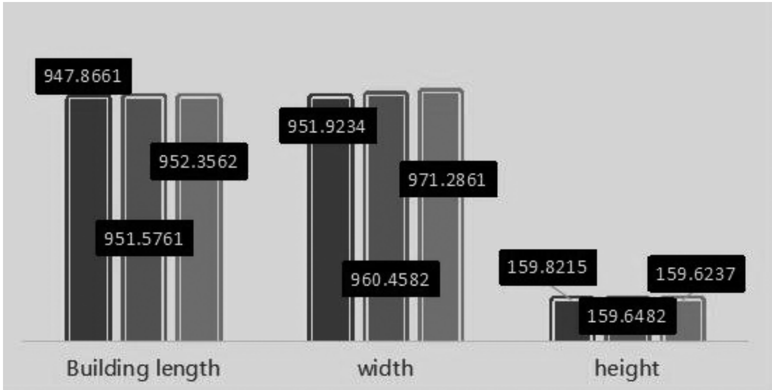

Figure 2. Actual 3D data of dangerous building.

4. Conclusion

3D simulation technology can help to improve the efficiency and quality of pipeline construction, but this new simulation technology is not widely used in China. Generally, this kind of 3D simulation technology is mainly suitable for the first urban pipeline design, but relatively speaking, it is difficult to use in medium-sized cities and relatively distant central areas in China, and the economic conditions are not developed. In addition, when 3D simulation technology is used in China, cutting-edge technology and software are often introduced. However, although this introduction method ensures advanced performance, it seems to be inconsistent with China's national conditions, which will cause difficulties in the effective design and construction of building pipelines. In order to apply 3D simulation technology to our country, we should improve the independent innovation ability of technical personnel, so as to enhance the effective promotion. At present, in our country, the application of this kind of software and technology mainly depends on the introduction of foreign software design specifications and implementation standards do not meet our national conditions. Therefore, in the process of research and application, it must be based on the actual situation of our country. In order to better publicize nationwide, improve the construction efficiency and architectural sensibility. In this paper, through the ICP algorithm and BIM building information model, a series of research and discussion are carried out in the process of building pipeline construction, and the analysis of three-dimensional simulation technology on the convenience of building pipeline construction is studied and discussed.

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