Research on Computational Mechanics Construction of Bridge Civil Engineering Construction Based on Computer Big Data Technology

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Abstract. In this paper, a 3D visualization system for bridge construction management is established based on VRP virtual platform. The bridge construction monitoring data management system is designed on the platform of Access database and the object processing technology of VRP. Starting from the basic theory of construction monitoring of cable-stayed bridge, the system realizes the problem of construction error identification in the monitoring process and using the recognition results to compensate and modify the finite element model. The system mainly realizes the functions of data editing, query, data analysis, data visualization, bridge information introduction and so on. It solves the key problem of using relational database to form various reports quickly and intelligently.

Keywords: Computer, big data, bridge construction, mechanical analysis, construction monitoring, database.

1. Introduction

High-speed railway bridge construction is a complex system engineering, in order to implement the quality, safety, construction period, investment benefits, environmental protection, technology innovation "six in one" management requirements, it is urgent to improve the efficiency and quality of construction schedule management, optimization and dynamic control. At present, the display and management of bridge construction progress mainly use reports and two-dimensional graphics, which are not intuitive and cannot fully show the patio-temporal characteristics of the construction process. The traditional construction management is mainly based on experience management, mainly the project manager responsibility system, whose main work is completed by the project manager, and the management means adopted by the project manager will reflect different management methods depending on different people. In the practical stage, the main method is to use systematic management through construction drawings, construction plans, materials and equipment consumption, and to perform performance through the two-dimensional "work-time" cross chart based on the critical line method. In the era of scientific management, the traditional means of modern large-scale engineering management cannot reflect the scientific management [1]. The construction stress test is to measure the elastic stress variable caused by the load of the observed part under different working conditions, so as to obtain the actual stress state of the bridge. In order to improve the test accuracy, vibrating string stress-strain measurement is often used to measure the stress and strain of reinforcement or concrete in recent years. The vibrating string stress-strain gauge reflects the stress and strain through the vibration frequency of the steel string. It has the advantages that the resistance differential strain gauge cannot compare with. Since there is no simple functional relationship between frequency and stress-strain, the calculation of stress-strain from frequency is a tedious process, which is obtained by interpolating the calibrated frequency and stress-strain curves which vary with the stress-strain meter and deducting installation strain, other non-load strain, temperature drift and zero drift. The construction of long span bridge is a series of complicated construction procedures and system conversion process. Before and after each working condition in the construction process, the frequency of the buried sensor must be measured to obtain the corresponding stress and strain, and then the corresponding control theory is analyzed to obtain the measures and control quantity that should be taken for the subsequent construction steps. In the whole process of construction monitoring, the data of stress and strain gauge need to be processed and

managed in real time is very large. In addition, bridge engineers need to quickly and easily understand the various construction conditions, the stress of each section and its change law, that is, according to various rules to query data, in addition to meet the requirements of the report and the requirements of data exchange with structural analysis software and construction control software [2]. These work such as the use of manual calculation is quite tedious and error-prone, and the use of database system to deal with can be easily completed.

In this paper, virtual reality technology is applied to bridge construction management to provide a visual way for construction. While completing virtual construction, VR platform is used to reflect the completion of the project [3]. This system can greatly improve the scientific management of construction projects, ensure the quality of bridge construction, increase construction efficiency, save funds, avoid risks and so on.

2. Design of railway bridge construction mechanics monitoring system

2.1. System Architecture

In order to meet the above requirements, the system is divided into four modules: database management module; Three-dimensional modeling module; Image progress expression module; Interactive query module. The architecture is shown in Figure 1.

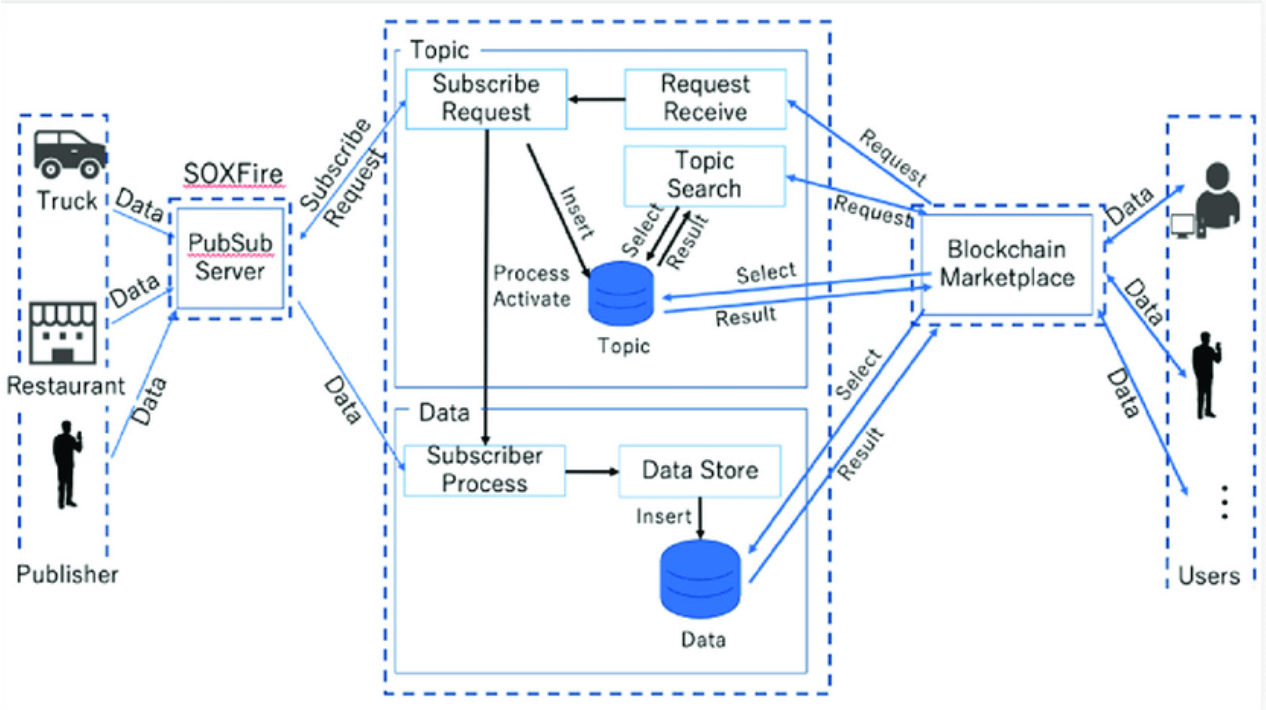


Figure 1. System architecture

2.2. System function design

According to the decomposition structure (WBS) of the bridge construction process project, the system can be divided into foundation engineering, pier engineering, beam and plate engineering, bridge deck pavement and guardrail waterproof bridge deck auxiliary engineering. The management mode of the bridge project is: the project manager manages the construction of the whole bridge project, the project department directly manages the construction team, and the construction team directly manages and controls the team [4]. In other words, the whole project adopts the hierarchical management mode. The research of the bridge construction management 3D visualization system is used as the management level of the project department, so the project decomposition structure (WBS) does not need to be detailed to each construction team.

1) This software adopts multi-document interface (MDI), which mainly includes three functions: data input, data query and report. To set SubMain () as the launch object, add the following code to open similar to the data source, you can also add delete, modify, refresh, and other functions to the form. Thus, an easy-to-use connection with data computation, editing, and establishment of record sets.

2) Create MDI sub-form 'Data Input Form ', and the interface is shown in Figure 2. Users can enter, modify and delete data in this form, and the calculation work is automatically completed by the program. Data is presented in the form of primary and minor tables, and the primary and minor tables are consistent through code. The form mainly includes ADO Data controls. The data is attached to the grid control DB Grid and some text boxes where the user enters the data. Add the following code to create the data set and display the data with the DB Grid control:

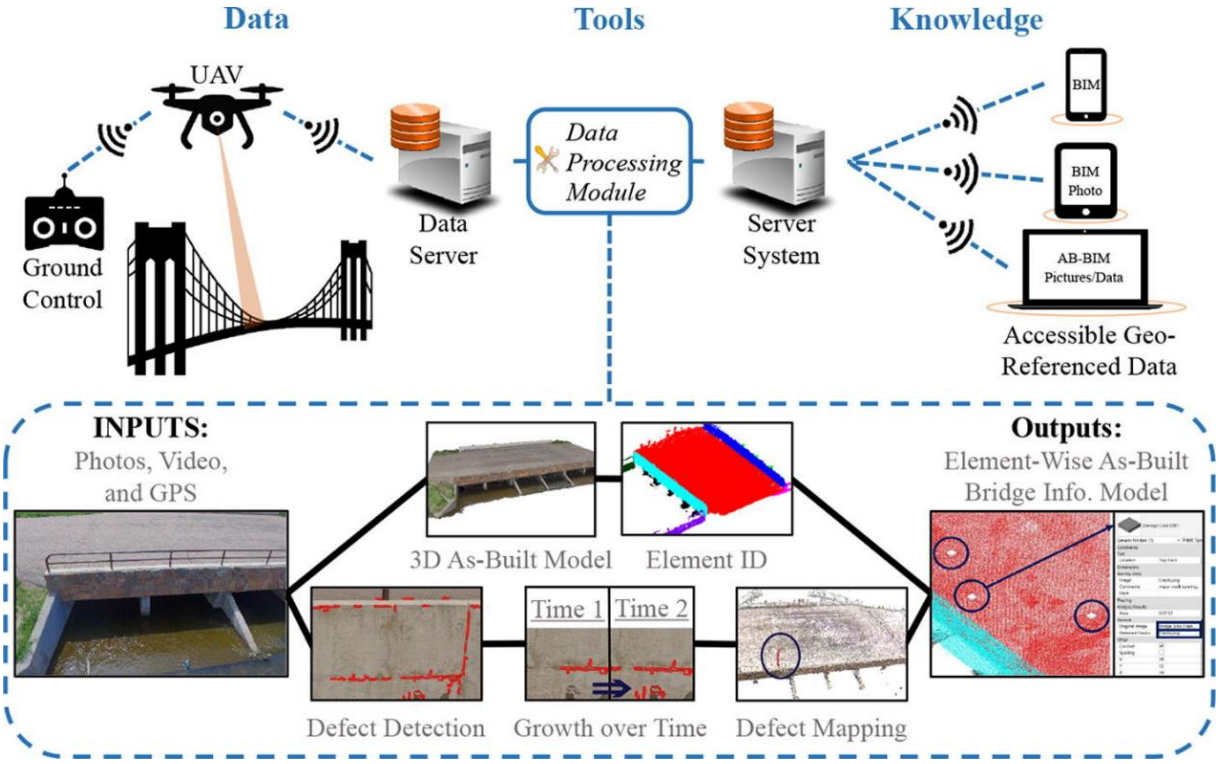


Figure 2. Function of 3D visualization system for bridge construction management

3) Create a data query form. In order to make bridge engineers quickly and conveniently understand each construction condition, the stress of each section and its change rule, it provides a variety of powerful query browsing methods: record browsing (can be sorted by any field such as time, stress, position, etc.), main fine table browsing, hierarchical browsing, etc.

2.3. Database structure design

2.3.1 Importing database Data

The data of bridge construction management system is mainly obtained from CAD drawings and Excel. After a detailed understanding of bridge design and construction drawings, the two-dimensional drawing information is converted into two-dimensional table information by manual input method for the data in CAD drawings. The WBS decomposition structure is used to build the model, and the information is still transformed in accordance with the WBS decomposition structure by piecewise means. In the transformation process, the name of the model and the name of the data information are strictly unified, so as to provide accurate data and simplify the connection between the model data when they are imported into the VR platform [5]. The data in the Excel data table can be imported into the database system Access by programming. Excel data is imported to the database by program input means. Import method: A method named Exceeds is defined in the class first, which is used to fill the data in Excel tables into the Dataset.

2.3.2 Database Links

After the completion of the bridge model and the database, the first problem to be realized is the connection between the bridge model and the database. This system can realize the direct connection between them according to the characteristics of the VR system and the advantages of the access database table structure. Moreover, the connection between them can be updated and interactive in real time, that is, the changes of data sources can be realized in real time on the interface platform. This advantage also ensures that the construction management personnel can update the database structure in real time, and the database can feed back to the system in real time through the connection between them. Thus, it can be presented to managers in the form of 3D models on VRP platform. And for the bridge of the overall detailed information plan (including in the VRP platform cannot realize the connection), can be designed by VB system program directly from the access database, for example, on the construction process of visualization needs to be through VB program directly from the database data or from other channels to obtain the VRP platform required data, so as to realize the function of the whole bridge construction management visual management system [6]. The realization process is in the VRP platform, the establishment of a visual procedure, through this procedure to call VB program to achieve the combination of two procedures and a database. Because most of the data of the bridge is stored in the database, and the VRP platform and data can be combined with some limitations, so in order to improve the function of the construction management visualization system, must use other programming design, by calling the database, bridge design data to achieve. The above database connection structure of the example reflects the VRP platform, database and VB program three combination. Figure 3 shows the construction management visualization system database.

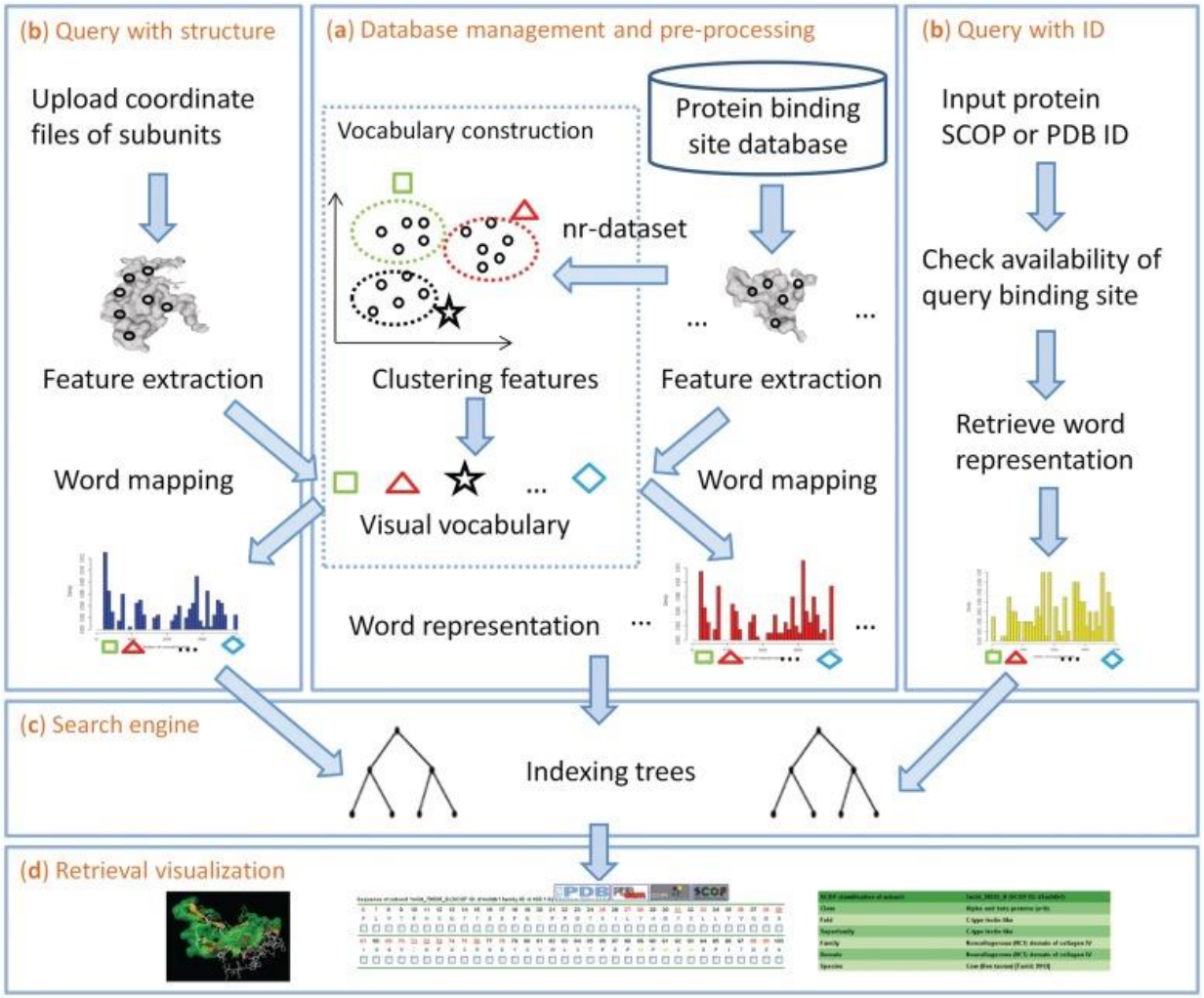


Figure 3. Construction management visualization system database

3. BccAss construction error analysis method

3.1. Identification of structural parameters and construction errors

Firstly, the monitoring engineer should model the bridge according to the actual boundary conditions, which is the basis of the finite element calculation of monitoring. There are many kinds of loads repeatedly acted on the bridge deck in the construction stage, such as the weight of the bridge deck crane, the weight of the bridge panel, the weight of the steel beam and so on. Some loads can be weighed or calculated very accurately, such as the weight of bridge panels and the weight of steel beam segments. Using these determined loads, the stiffness error of the finite element model can be identified [7]. Under the condition of small deformation, the stiffness and external load of the structure satisfy the following equation:

$$[K]\{\delta_f\} = \Delta\{f\} \tag{1}$$

Where, $[K]$ is structural stiffness; $\{\delta_f\}$ is structural deformation; $\Delta\{f\}$ is the variation of external load. The bridge deck elevation can be measured once each before and after the change of external load to identify whether the stiffness parameters of the bridge are correct. The stiffness data can be checked repeatedly with the load data [8]. For example, when the deflection of the main beam caused by the self-weight of the bridge panel is determined, the weight of the crane can be calculated by using the structural deformation caused by the movement of the crane, or whether the tension change of the stay cable is correct according to the following formula:

$$[K]\{\delta_N\} = \Delta\{N_i\} \tag{2}$$

Where, $\Delta\{N_i\}$ is the change of the stay cable force; $\{\delta_N\}$ is the structural deformation caused by cable tension, $i = 1, \cdots, n$. According to the concept of stress-free linear shape and stress-free curvature in stress-free state method, the internal force of the structure in a certain state can be released to obtain the manufacturing linear shape:

$$H_f = H_i + [K_i]^{-1} \,|\, (-\{f_i\}) \tag{3}$$

Where, H_f is the stress-free installation line of the steel beam; H_i is the current measured linear shape; The other symbols are the same as before [9]. After the high-strength bolt of steel beam is finally screwed, the change of structural load $\{f_i\}$ is completely caused by the self-weight of the structure. Therefore, the identification and correction of structural stiffness $[K_i]$ can be used to identify the errors generated in the process of steel beam manufacturing and installation.

3.2. Error correction and compensation

In order to ensure the safety of bridge construction and the realization of other monitoring objectives, construction errors can be found and corrected in time. According to the formation principle of finite element stiffness matrix, structural stiffness

$$[K] = \sum \{K^e[E, v, R, N(x, y, z)]\} \tag{4}$$

Where, $[K^e]$ is the element stiffness matrix; E is the elastic modulus of materials; v is Poisson's ratio of materials; R is the cumulative error of the previous stage; $N(x, y, z)$ is the node coordinate; The other symbols are the same as before. It is not easy to accurately measure the cable force of parallel strand cable. After identifying the cable force error through multiple parameter identification, the compensation and correction of cable force should be careful. Cable force compensation is expressed in the form of pulling amount:

$$\Delta L_i = L_i - L(T, D, F, N) \tag{5}$$

Where, ΔL_i is the pull out amount of current error correction; L_i is the target cable length of the current stage; L is the cable length when there is an error in cable force; D is the current structural displacement.

4. System simulation analysis

The progress expression of bridge three-dimensional image is divided into two steps, namely construction information query and dynamic display of image progress. Construction progress inquiry is divided into historical progress inquiry and daily progress inquiry. The historical progress query first queries the progress update table according to the work point ID, and then lists all the points in time for that work point in the history progress TAB for the user to select. The steps of daily progress query are as follows: (1) According to the station ID, query the pier and beam ID and basic information corresponding to the station in the pier table and beam table; (2) Query the nearest progress in pier schedule and beam schedule according to the date selected by users and pier and beam segment ID; (3) Analyze the basic information and progress information obtained from the query, judge the validity of the data, and generate progress reports. The dynamic display of image progress first converts the progress report into executable dynamic display command, and then calls the rendering function to eliminate and cut each entity. The corresponding relationship between construction progress and display command is shown in Table 1.

Table 1. Schedule and display command mapping table

Progress	Deal with	Command
Single pile foundation completed	Named mapping	Pile foundation display
Single cap completed	Named mapping	Cap display
Completion of pier	Named mapping	Pier display
Pier construction	Named mapping	The pier is cut vertically
	Casting height is converted to cutting parameters	
	Named mapping	
	Beam calculation based on mileage and centerline	
Beam section under construction or completed	Cutting segment set, beam cutting segment set conversion	Multi-section horizontal cutting of beam
	Is cutting parameter	

5. Conclusion

The three-dimensional construction schedule management system of high-speed railway bridge has been preliminarily applied in the construction management, which vividly and intuitively shows the construction process of the bridge in the line, so that the project manager can browse the bridge construction situation in the virtual environment, and improve the efficiency of construction management. The technology of database management, parametric modeling, image progress expression and interactive information query involved in the development process can be applied to the construction progress management of roadbed, tunnel and other projects.

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