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Application of Virtual Simulation Technology in Road and Wooden Bridge Design

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Abstract:

Wood structure plays an important role in the construction of steel-concrete bridges. In view of the current situation of highway bridge construction, this paper puts forward the method of using virtual reality technology to simulate the construction process. This method uses the virtual prototype of bridge instead of the model of bridge to simulate the effect of bridge construction, so as to provide a new means for design evaluation. Through the programming language to create an integrated operating system platform, the virtual reality technology, database technology, image animation and other organic combination, introduced to the steel bridge engineering. At the same time, this paper deeply studies the application of virtual reality technology in the whole construction process of large complex steel structure bridge, and establishes a platform with strong operability, convenient human-computer interaction and friendly operation interface. The experimental results show that the proposed method can shorten the design cycle and improve the design quality.

Keywords*:* *Wooden Bridge, Bridge construction, virtual reality, virtual prototype, data fusion.*

I. INTRODUCTION

With the rapid development of computer technology, the popularization and application of various professional software in engineering field, the calculation of structural internal force and drawing of construction drawing have been computerized step by step, which greatly improves the production efficiency [1-2]. However, the structural construction drawings in plane mode, because of their limitations in expression form, can only be adapted to professional

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engineers and technicians [3]. Because of their complicated lines, text marks and tables, it is easy to make mistakes in drawing recognition, for example, the dimensions of thousands of bars in different parts of the bridge structure [4]. The application of AUTODESK.CIVIL3D, 3D Max and other software can realize the representation of 3D model and the description of the internal structure of engineering structural components, but only one angle or one side of the structure can be displayed on the display [5-6].

In-depth observation of the internal structure of components can be realized by browsing animation, but this animation has poor operability and human-computer interaction. It is difficult to describe the details of components intuitively, and it is even more difficult to express the complex organization and scheduling of construction process. Therefore, it has become a new topic to simulate the actual construction process of large-scale structures with the expression of three-dimensional building structures [7]. In 1990s, virtual reality technology created a new research field for the development of human-computer interaction interface, and provided a new description method for the visualization of large-scale data of various projects [8]. Applying virtual reality technology to large-scale bridge engineering can freely interact with scenes and objects in virtual environment, which provides visual decision-making tools for designers, constructors and decision managers.

II. AN INTRODUCTION TO PSEUDO REALITY

2.1 Key features of virtual reality

(1) Immersion

Also known as telepresence, it refers to the degree of reality that users feel as the protagonist in the simulation environment. The ideal simulation environment should make it difficult for users to distinguish the true from the false, and enable users to devote themselves to the three-dimensional virtual environment created by the computer. The highest level is: everything in the environment looks true, sounds true, moves true, even smells and tastes true, just like the feeling in the real world.

(2) Interactivity

It refers to the user's operability of objects in the simulated environment and the natural degree (including real-time) of getting feedback from the environment. For example, the user can directly grasp the virtual object in the simulated environment with his hand. At this time, the hand has the feeling of holding something, and can feel the weight of the object. The object in the field of vision can also move immediately with the movement of the hand.

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(3) Imagination

It is emphasized that the virtual reality technology should have a wide imaginable space and broaden the scope of human cognition. It can not only reproduce the real environment, but also arbitrarily conceive the objective environment that does not exist or even is impossible to occur.

2.2 The classification of pseudo reality

(1) Passive virtual reality. In the three-dimensional environment, it provides a closed process for users, and the travel distance and observation object are strictly and independently controlled by the software. The user has no control except to exit the session.

(2) Query based virtual reality. Provide a three-dimensional environment for users to point out the topographic map; Participants can choose the distance and observation, but there can be no other interaction with the 3D scene.

(3) Interactive virtual reality. Provide a three-dimensional environment for users to point out the journey. In addition, 3D environment is also the participant of virtual entity reaction and action to behavior.

2.3 Advantages of Virtual Reality Modeling Language (VRML)

VRML space is not only the establishment of the scene, but also the definition of the attributes and behaviors of the objects in the environment, and even the expressions and actions of the objects can be reflected. New technologies are constantly improving its functions.

(1) Platform independence. The advantage of VRML language based on 3D virtual experiment scene is that it can easily generate 3D geometric entities, and also has the characteristics of platform independence.

(2) C / S mode. The access mode of VRML is based on the client and server mode. The server provides the resources (image, video, sound, etc.) supported by VRML files. The client downloads the desired files through the network, and interactively accesses the virtual realm of the files through the VRML browser on the local platform.

(3) Real time 3D graphics rendering. Real time 3D rendering engine is better embodied in VRML. This feature makes VRML modeling and real-time access more clearly separated. VRML is different from other 3D modeling animation, it has interactivity.

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(4) Network transmission is easy. VRML is suitable for the transmission of computer network, it does not require a high network transmission bandwidth, and the work of graphics generation is put on the client computer with low requirements. Because VRML can transmit 3D information and receive remote instructions in low bandwidth heterogeneous network environment in real time, and it does not require high performance of 3D graphics generation computer, it has the characteristics of low cost and intensive to build distributed virtual environment with VRML.

(5) VRML is scalable. First of all, in theory, VRML should be able to handle the realm of hundreds of millions of objects distributed on Internet. Secondly, VRML realm can be scaled relative to network performance, and can be used in different types of network connections.

III. APPLICATION OF VIRTUAL REALITY TECHNOLOGY IN BRIDGE ENGINEERING

3.1 The research and development of VB-VRP operating system

VB-VRP system combines database with virtual reality model in real time by establishing central integration module, and realizes real-time and interactive control of virtual model by database [9]. It presents the real-time display function of section size, material properties, length, weight, displacement and completion progress of each component during erection, and truly realizes "data is attached to images, and images contain data".

The VB-VRP operating system mainly includes three modules: virtual reality model, database and central integration module. The modeling of virtual reality is through the old application software written by myself. "CIS2CAD" converts CIS2 into AUTOCAD file. the software can directly read, design, analyze and make STP file of the model, and can immediately generate 3d CAD solid model of the whole project. the corresponding Access database generates virtual simulation VRML file. the flow chart of model establishment is shown in figure 1.

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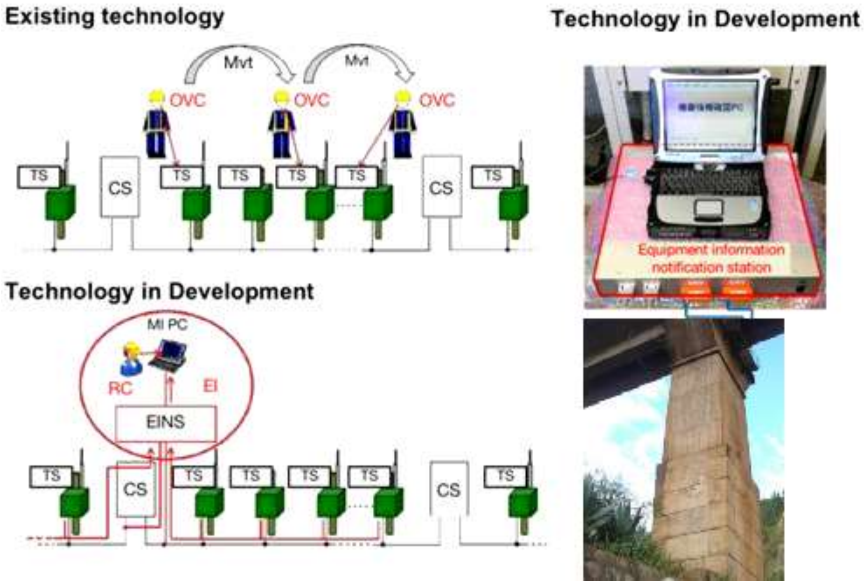

Fig 1: Flow chart of establishing virtual reality model

The database module integrates various massive information in the form of directory tree, and controls the virtual model and corresponding data through node triggering, thus realizing the organic combination of data and images [10].

The central integration module establishes a friendly operation interface through programming, realizes interactive exercises between virtual reality model and database, and realizes real-time correspondence between data and images.

The function of the system is realized by VRP display system, Tree . view, Listview, Picturebox, Textbox and Button, as shown in fig. 2.

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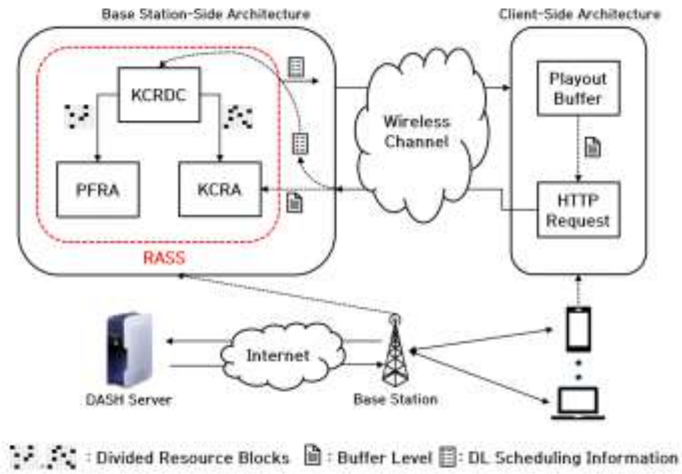

Fig 2: Vb-VRP operating system interface

On the one hand, the system can show the cross-section size, shape, area, length, weight and real-time construction completion percentage of each member in each construction stage in detail, as well as provide detailed animation demonstration, which provides great convenience for the construction unit to carry out the construction and verification of beam cross-section. The second is to realize the database management of bridge calculation results, which can query the calculation results of construction control points in the erection process. At the same time, it realizes the real-time control of virtual reality model through Treeview node, which facilitates the user to call the result data, changes the single data list and chart display, and realizes the automation of construction control.

3.2 The application example of VB-VRP

Baling River Bridge is the first steel truss stiffening girder suspension bridge with a span of more than 1,000 meters in China, as shown in Figure 3. The project has large scale, complex construction conditions and high technical difficulty. The main cable span of the bridge is 28m across the bridge, the sling span is 10.8m along the bridge and the main span is 1 088 m. It is the "No.1 in China and No.7 in the world" long-span steel truss stiffening girder suspension bridge.

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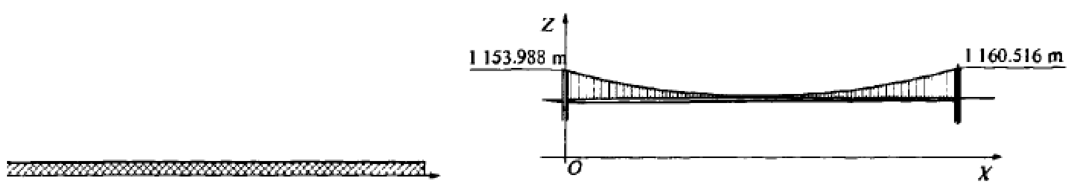
Fig 3: Renderings of Baling River Bridge

3.2.1 Introduction of VB-VRP system

According to the needs of construction when building the model, the coordinate system is selected with the east-west direction as the axis X direction, the west direction as the axis positive direction, the north-south direction as the axis L, the axis direction and the south direction as the axis positive direction, as shown in Figure 4(a). The vertical direction is the z-axis direction, in which the zero point of the stone lies on the axis of the east cable tower of Baling River Bridge, and the coordinates in the z-direction adopt the cabinet coordinates given in the design drawings, as shown in Figure 4(b).



(a) (b)

Fig 4: Schematic diagram of coordinate axis

The display and check of section parameters of cable and truss beam is also an important work in construction. Therefore, the section form and parameters of each construction section beam are also summarized in the program, in which the cable section is circular, and the truss beam section is box and I-shaped, as shown in Figure 5.

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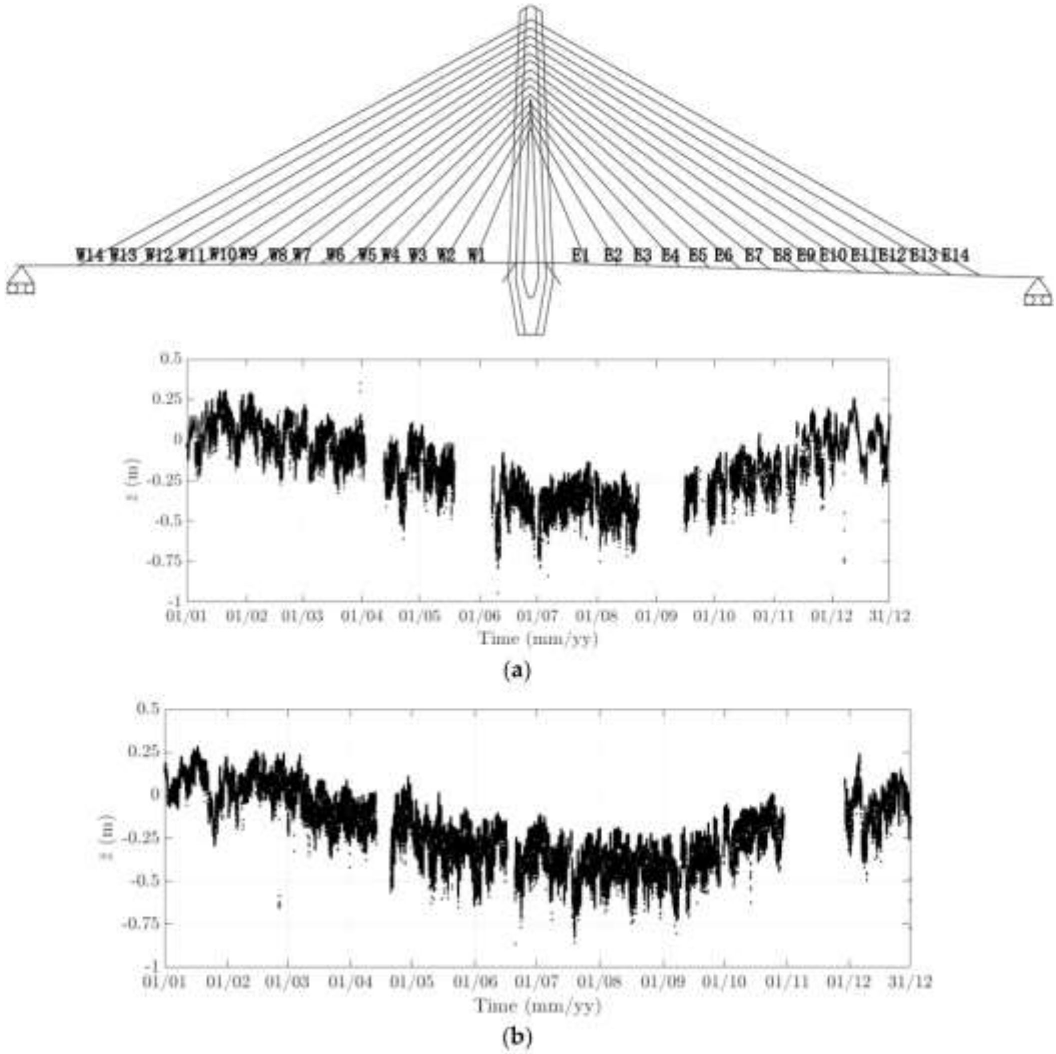

Fig 5: Section form

3.2.2 The functions realized by VB-VRP system

Virtual reality and 3D visual simulation technology are applied in the project, which provides dynamic visual virtual reality model and animation for the whole installation process of Baling River Bridge, the largest steel truss bridge in China. Taking the whole project as a large system, considering the mutual influence and restriction among individual projects in the project, and considering the key issues such as the overall construction progress, construction intensity and process degree, we can get a more real construction situation and fully perform simulation preview in the virtual model, so as to provide scientific basis and measures for the organization of T application.

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Through the designed VB-VRP platform, the real-time and interactive control of image and operation is realized, and the real-time query function of section size, material property, length, weight, displacement and completion progress of each component in the erection process and the demonstration of construction animation are realized. Meanwhile, the bridge construction process can be carefully viewed and accurately inquired from various angles at any time, and the work contents of modern construction management can be "visualized", "concretized" and "simplified", with screen shots as shown in Figure 6-8.

Fig 6: Complete the engineering quantity display

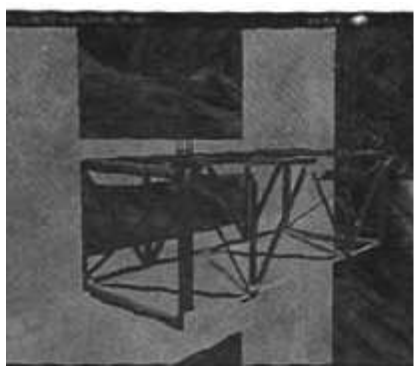

Fig 7: Calculated displacement display

Fig 8: Member attribute display

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At the same time, the establishment of the platform also provides technical guarantee for determining a reasonable and feasible construction scheme, and has practical significance for improving production efficiency:

(1) Selection and optimization of bridge construction scheme. In the past, the selection and optimization of bridge engineering construction methods and construction organization are mainly based on construction experience, which has certain limitations. At the same time, bridge engineering construction is not repeatable. Using the virtual reality technology of the platform will be able to intuitively and scientifically show the effect of different construction methods, can qualitatively complete the comparison of construction schemes, help the selection and optimization of construction schemes, and realize the real optimal construction.

(2) With the innovation of construction technology and the introduction of new technology, on the one hand, the construction simulation technology can enable the majority of construction technicians to test the new construction technology and innovative ideas at low cost, which is helpful to give full play to creativity. At the same time, it can truly show the effect of new technology, shorten the introduction period and promotion period of new technology in bridge industry, and reduce the test risk of new technology and new process. Virtual reality and visual simulation calculation and display methods have become the preferred means of modern steel bridge design and construction. With the continuous expansion of the scale of the project, people will put forward higher requirements for modern bridge engineering design theory, production technology, construction organization design.

V. CONCLUSION

This paper introduces virtual reality technology and database technology into the construction of steel structure bridge, deeply studies the whole construction process of large complex steel structure bridge, optimizes different construction organization design, and has strong operability and human-computer interaction function. It is of great economic value and scientific progress significance to provide scientific theoretical methods and advanced technical means for the construction organization design of large steel structure bridges in China, and to guide the engineering construction and scheme optimization. The work content of modern construction management should be "visualized", "specified" and "simplified", realizing the real sense of "data attached to the image, the image contains data", which is the exploratory application of virtual reality and visual simulation technology in the construction of steel bridge, and provides technical reserves and Application reference for the construction of similar projects.

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