Exploring the Application of Virtual Reality Technology in Surveying and Mapping Archives

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***Abstract*— Firstly, this paper introduces the concept and main characteristics of the virtual reality technology (VR), and enumerates its applications in various fields. Secondly, requirements of using VR in surveying and mapping archives are presented by analyzing the shortcomings of traditional workflow of Chinese surveying and mapping archives. Thirdly, we develop the key methods and technologies to build a virtual warehouse management system, which can help the staff complete their daily work on a three-dimensional scene. And finally, we make a conclusion of this information system after applying it to the National Surveying and Mapping Archive of China for one year.**

Keywords-Virtual Reality(VR); Surveying and Mapping Archive; Web3D

I. INTRODUCTION

Virtual reality (VR), sometimes referred to as immersive multimedia, is a computer-simulated environment that can simulate physical presence in the real world. VR can recreate sensory experiences, which includes virtual taste, sight, smell, sound, and touch [1]. There are many excellent features of VR, for instance, 3D modeling, visualization, interaction, immersion, imagination, and so on. It recreates a virtual world which realizes 3D visual and sense by computers so that the user has the natural interaction experience in the virtual world and produces the interaction with the virtual world. At present, this technology has been used in the aerospace, military, architectural design, archaeology, fine art, games, travel, medical, training, education, and many other fields [2-5]. For example, the U.S. army has built a training system for the soldiers which allows them to train in a virtual environment such as wide variety of terrains, situations, and scenarios where they can improve upon their skills without the consequence of failing the operation [6]. Even the National Library of China, Tianjin Library also have tried to apply the VR to the library [7]. Virtual reality's visualized, interactive, and immersive series of other features make it possible for users to increase the convenience of the daily work, and to effectively improve their work efficiency and productivity, which is meeting the needs of surveying and mapping archives warehouse management work: networking and facilitating. Therefore, the main contents of this paper is how to apply the virtual reality technology to the routine work of surveying and mapping archives warehouse management, and expand the breadth and depth of the application of VR.

II. REQUIREMENTS OF USING VR IN SURVEYING AND MAPPING FILE ARCHIVE

With the rapid development of Chinese economy and infrastructure, a large number of high-value surveying and mapping data archives have been gathered and accumulated. However, generally speaking, the management level of mapping archives seriously lag behind the development of geographic information science. Many archives had not gotten standardized sorting, group packaging and labeling, resulted in a large number of management issues: non-standard management of archive files, unclear storage location and quantity of the archives [8-9]. While some sort of archives have completed sorting, group packaging, and labeling, or have implement prototype information systems which have some functions like search, edit, and statistics. The National Surveying and Mapping Archive of China, for instance, has developed a digital archive system in/around 2005, which has realized the collection and organizing of archives files. And the digital archives information system of Henan Surveying and Mapping Archive also finished some information work like storing, querying and distributing the basic geographic information data [10]. But these cases above are the file-level management, warehouse-level management work which plays an important role of archives management work, still uses traditional inefficient manual methods.

Currently, the shortcomings of surveying and mapping archives warehouse management work mainly focus on the following two aspects: ① the existing system does not record the location, include the warehouse number, the cabinet number, and the cell number after the archives files are added into the warehouse, so, once these files are needed, the staffs cannot find them quickly; ② the daily warehouse management including archives shelves, file query, file location, file migration, the warehouse planning, the warehouse statistics, etc., the current work of warehouse management is mainly completed by manual operation, which is tedious, inefficient, and lacking of an integrative information platform which could manage these works together.

Creating a virtual archives information system makes it easier for managers to quickly familiarize the environment of the archives, know how many archives it has, and where they are located in. And a virtual archives information system can help users simulate the operation of each business in the virtual environment, reduce the mistakes, improve work efficiency, and

effectively overcome the mapping problems which exist in archives warehouse management for a long time.

III. METHODS OF APPLYING VR IN SURVEYING AND MAPPING FILE ARCHIVE

A. Surveying and establishing database

A surveying and mapping archive consists of warehouses, cabinets, cells, archives and other entities. It is necessary to survey and identify how many warehouses, cabinets, cells, what archives there are, where the archives are located in, and which kind of container is packaged with the archive before exploring the application of VR in surveying and mapping archive. In the early stage, each warehouse is initially visited, then all of the warehouses, cabinets, and archive types are counted and given the uniform code. At the same time, a set of standards on the survey results are formulated. In order to facilitate the later designing of software functions, we establish the index number of archives which record the warehouse, cabinet and cell that every archive belongs to. The index number is encoded by three parts, expressed by eight digits, and followed by the 3-digit warehouse number, 3-digit cabinet number and 2-digit cell number, the coding structure is shown in Fig. 1. On this basis, the archives in each warehouse and cabinet are uniformly surveyed and imported into the database. The form of survey result and example data is shown in Tab. Ⅰ.

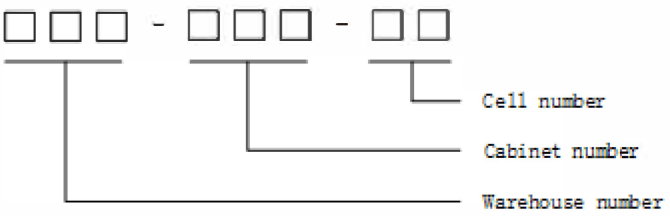

Figure 1. Coding structure of archive location

TABLE I. INFORMATION OF THE ARCHIVES

ID	Archive number	Cabinet ID	Box type	Archive name	Archive location
1	TD411G-D54E46001.A	GJ03	ZJ13	1:10 (54)(E-46)	304-201-1
2	TD411G-D54E46001.B	GJ03	ZJ13	1:10 (54)(E-46)	304-201-1
3	TD411G-D54E46001.C	GJ03	ZJ13	1:10 (54)(E-46)	304-201-2
4	TD411G-D54B47001.A	GJ03	ZJ13	1:10(54)(B-47)	304-201-2
5	TD411G-D54B47001.B	GJ03	ZJ13	1:10(54)(B-47)	304-201-3
6	TD411G-D54C48001.A	GJ03	ZJ13	1:10(54)(C-48)	304-201-3
7	TD411G-D54C48001.B	GJ03	ZJ13	1:10(54)(C-48)	304-201-4
8	TD411G-D54D49001.A	GJ03	ZJ13	1:10(54)(D-49)	304-201-4
9	TD411G-D54D49001.B	GJ03	ZJ13	1:10(54)(D-49)	304-201-5
10	TD411G-D54D50001.A	GJ03	ZJ13	1:10(54)(D-50)	304-201-5
11	TD411G-D54D50001.B	GJ03	ZJ13	1:10(54)(D-50)	304-201-6
12	TD411G-D54B51001.A	GJ03	ZJ13	1:10(54)(B-51)	304-201-6

B. Choice of Web3D engine

The Web3D engine technology is the core technology of building a VR system, it usually contains several modules: the scene management, resource management, character animation, UI, server scheduling, and so on. Every module works together to realize the dynamic scheduling of large scenes, and the Web3D engine technology has some characters such as low-end hardware compatibility, high compression ratio, multi-threaded download, supporting high concurrency, high performance physics engine, supporting for scripting, and so on, so it provides strong support and guarantee for the virtual warehouse management system based on Web3D. There are many kinds of mainstream commercial Web3D engine technology existing in the world; there are VRP [11], Sun3D [12], Conserve 3D [13], and 3DVIA Studio Pro [14], Unity3D [15]. Different 3D engines have different scales and virtual platform types which are suitable for developing due to its different properties. The author attempts to analyze and compare the famous Web3D engine in different aspects, for example, the difficulty of developing the system, quality rendering, interactive ability, compression ratio, whether it needs the web browser plug-in, and whether it supports the Oracle database, and the details are shown in Tab. Ⅱ.

TABLE II. COMPARISON OF THE WEB3D ENGINES

Name	Company	Programming languages	Difficulty of development	Interactivity	Compression ratio	Rendering effects	Browser plug-ins	Oracle
VRP	VISTAND ARD	Lua	Low	Good	High	Very Good	Required	Support
Sun3D	SUN3D Technology	Lua、Javascript	Low	General	High	General	Required	Support external connection
Converse 3D	Beijing Zhongtian Hao Jing	c3d-JS	Low	General	General	Good	Required	Support external connection
3DVIA Studio Pro	Dassault Systèmes	Virtools Scripting Language	High	Good	General	Good	Required	Not support
Unity3D	Unity Technologies	C#, JavaScript, Boo	High	Good	High	Good	Required	Support, poor compatibility of Chinese encoding

Table Ⅱ illustrates that the VRP engine has the following features: high compression ratio, excellent image quality effect,

better supporting Oracle database, and using the Chinese Lua script, low programming difficulty, therefore, VRP is a suitable Web3D engine for the virtual warehouse system.

C. Construction of 3D warehouse scenes

The process of 3D warehouse scene construction could be roughly divided into the following 4 steps, as shown in Fig. 2.

1) Data collection: collecting data including archives CAD reference map, real size specifications of the building, surface texture of facilities.

2) Constructing 3D model: the establishment of the entire archives using 3DMax model and related animation, finally, the whole scene baking output as VRP format files.

3) The VRP scene synthesis: baked model in VRP software platform integration. At the same time, interactive function design.

4) The formation and release of VRP system: the interface editor for VRP system, and the final release.

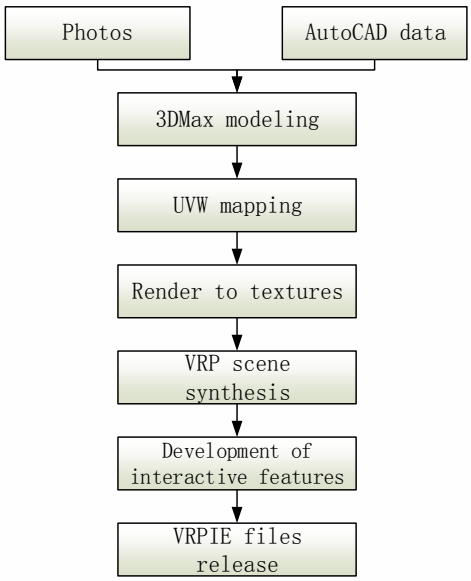

Figure 2. Flow diagram of the construction of 3D scene

D. Development and integration of the system

On the basis of the 3D warehouse scene, we establish an integrated warehouse management system by using Microsoft Visual Studio 2010 as integrated development environment (IDE) , selecting the C# language, an object-oriented language, choosing a B/S architecture model, using Oracle 10g relational database to store and manage data, which integrates every warehouse in 3D scene together. This software is associated with the Oracle database in real time and has nine basic functions: 3D warehouse, archives search, archives location, archives add, archives transfer, archives statistic, warehouse log, warehouse plan, and system manage. The main user interface of this software are shown from Fig. 3 to Fig. 6.

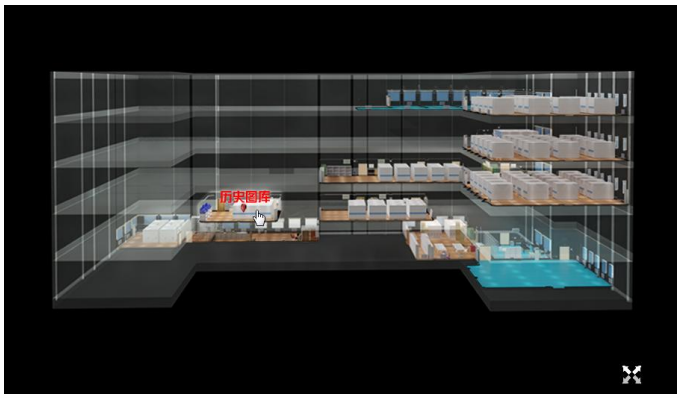

Figure 3. 3d rendering of the building

Figure 4. 3d rendering of the warehouse

Figure 5. Search archives and location it in the 3d warehouse

Figure 6. archives transfer

IV. CONCLUSIONS

The system has been successfully applied to the National Surveying and Mapping Archive of China. After a year of use, its practical effect has been unanimously endorsed and praised. It offers a wide range of facilities for the National Surveying and Mapping Archive of China's daily management work, mainly in the following two ways:

On the one hand, it makes the warehouse staff or visitors to quickly get familiar with the warehouse environment, and so that to save a lot of time. Before the establishment of the system, staff, or visitors, when visiting the warehouse has to walk around it, while after implementing the system, the staff only need to type the access URL of it in the browser's address bar, and then enter an immersive three-dimensional virtual warehouse scene at anytime, anywhere, without any access restrictions as long as they have a valid account. In the virtual warehouse environment, staff can easily swing open every cabinet and look over the archives inside, like a realistic operation. And moreover, it can help quickly switch to a different warehouse without walking to another floor.

On the other hand, it simplifies the workflow and improves business efficiency and reduces staffs' work pressure. For example, when a new batch arrives moved into the museum, the staffs can use the system's transferring and planning features based 3D packing algorithm to accurately simulate and calculate some suggested storage solutions, and no longer need to worry about finding a suitable storage location by walking around the warehouses one by one.

The virtual warehouse management system makes full use of the characters and advantages of VR, and integrates the entire workflow of surveying and mapping archives, it fully meets the various needs of the department.

ACKNOWLEDGMENT

The authors would like to express appreciations to colleagues in our laboratory for their valuable comments and other helps.

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