Application of Virtual Reality Technology in Library Visual Information Retrieval

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Abstract: Information retrieval is one of the important service contents of libraries. However, traditional information retrieval methods cannot guarantee the efficient use of book resources and good reader experience. Therefore, this paper mainly discusses how to introduce virtual reality technology into the construction of digital libraries and provide a new service mode for library visual information retrieval. In order to break the traditional way of building information platform in libraries, we propose to construct a library VR information retrieval system, and introduce the architecture, construction process and scene modelling of the system. This system can improve readers' information retrieval experience from the perception and interaction level, and greatly promote the integration and effective utilization of library information resources.

1. Introduction

Virtual Reality (VR) emphasizes the natural immersion of human-computer interaction, and its core audience is "human". At present, all the modern university libraries aim at "reader first". The coincidence of the two concepts makes it possible to apply VR technology to contemporary university libraries, which has become one of the development directions of library innovation services. However, various intricate factors based on VR technology, especially the external equipment, are restricting its application development in university libraries. This paper is based on the needs of university libraries for modernization development to discuss how to make full use of VR technology to explore new service methods and technical support points, and proposes several design schemes so that libraries can better assume the responsibilities of social knowledge and culture service centers.

At the same time as the rapid development of information technology and digital technology, the library's related resources have also changed from the original paper medium to electronic data. Therefore, library information retrieval also needs to be transformed into electronic and visual, and VR technology plays a vital role in this process. In library information retrieval, the visual retrieval mode supported by VR technology can achieve rapid integration of resources, and also ensure a quick search of relevant literature content, thereby ensuring the efficiency of retrieval and providing users with a better retrieval service experience. VR technology can also create a more complete search environment through scene construction, and achieve the accuracy and comprehensiveness of the search content. Three-dimensional model of the library is built with VR technology, to present the detailed structure of the library structure and the book in a three-dimensional environment, so that the user can quickly locate the location of the document and generate an optimal book selection path.
2. Library visual information retrieval
Because traditional information retrieval systems still have some defects in information organization, information storage and information reality structure, browsing cannot fully play its role in traditional information retrieval. Therefore, visual information retrieval came into being. Visual information retrieval is to convert various semantic relationships in information resources, user questions, information retrieval models, retrieval processes and retrieval results into graphics, and display them in a two-dimensional, three-dimensional or multi-dimensional visualization space to help users understand the retrieval results and grasp search direction to improve retrieval efficiency and performance. Visualization technology provides an interface between humans and computers. Using an effective visual interface, you can quickly and efficiently interact with massive data, and through the visualization of information retrieval, discover hidden features, relationships, patterns and trends in massive data. It is the fundamental difference between information retrieval visualization and traditional information retrieval that directly reveals such knowledge that is hidden in information and cannot be directly observed.

With the support of visualization technology, the online public access catalogue (OPAC) of library can not only help users to explore, filter and discover the knowledge system and information features hidden in the bibliographic information in the process of information retrieval, but also improve the efficiency of user information retrieval. Through the visual multidimensional view, not only the user's decision can be guided at the semantic level, but also the internal connection of data, information and knowledge can be revealed from the perspective of knowledge management, and the recall and precision of information retrieval can be improved. The use of visualization technology can visualize the whole process of information retrieval, making the information retrieval process intuitive and transparent, rather than the inability to observe in the traditional information retrieval process. In addition, it can provide users with friendly human-machine dialogue and interactive environment, so that the user's cognitive ability is naturally integrated into the information retrieval and information browsing process. This is highly consistent with the characteristics of VR technology, facilitating the application of VR technology in digital library information retrieval visualization.

At present, many libraries and institutions at home and abroad have developed research and application of library information retrieval visualization, and have achieved many research results. For example, human-computer interaction laboratory in University of Maryland, Xerox PARC and ISI have developed a set of software for visualizing digital library information retrieval. Visual information system centre (VISC) in University of Pittsburgh have developed research on visual data mining, geographic information systems, environmental systems and other visualization projects. Similar software developed by UC Berkeley is a simple and practical information retrieval visualization system based on Web. Stanford University research team developed an ontology-based information retrieval visualization tool - Topic Map. The visual information retrieval system TouchGraph can not only visually search text information such as books and periodicals, but also can be used for visual retrieval of chart information including network information resources, shown in Figure 1.
In the information management of domestic libraries, the visualization of information retrieval results is the most outstanding achievement. The Library of Tsinghua University can not only search through the collection catalogue, but also find out the specific shelf location of the book in the library through the "shelf detail map". The visualized cross-database retrieval system of the National Science Library of China includes text mode and graphical mode, which can realize subject visualization, database visualization, age visualization and author visualization. Users can interact with the system intuitively and participate in the whole information retrieval process in the visual interface.

In addition to the application of visual information retrieval in entity libraries, some digital libraries, mainly based on database services, have also developed the application of information retrieval visualization, e.g. Wanfang Data Knowledge Service Platform has also increased the knowledge context analysis in information retrieval.

3. Application of VR technology in visual information retrieval

3.1 Virtual reality system

Virtual reality technology refers to the use of computer technology as the core of modern high-tech production of realistic visual, auditory, tactile and other integrated virtual environment, and users interact with objects in the virtual world in a natural way by means of necessary devices, thus producing feelings and experiences such as being in the real environment. It is a new type of human-computer interaction that emerges with the development of new technologies including computational graphics, multimedia technology, artificial intelligence, human machine interface technology, sensor technology, highly parallel real-time computing technology, and human behaviour. Virtual reality technology provides users with a virtual environment that can achieve interoperability, as well as a sense of immersion with a high degree of immersion, which makes virtual reality technology widely used in product design and display in various industries.

VR system usually consists of visual, auditory, olfactory, taste, tactile and other perceptual information. In order to integrate into the realistic virtual environment, participants not only need to interact with digital gloves, data clothes, spherical screen, head blue display, stereo headphones and other devices, but also need to interact with the virtual environment generated by computer software environment and development tools. On the other hand, the system constructs a virtual environment generated by the integration of computer software and development tools and hardware. In other words, the computer software and hardware in the system can not be separated and are closely integrated.

Wang Bei, chief scientist in the field of national planning information, pointed out that, a typical VR environment is composed of human and VR system, while the latter includes man-machine
interface, computer system and VR-oriented hardware and software facilities. In addition, we think that detection module and feedback module are also important parts of VR system, shown in Figure 2.

![Figure 2. Composition of VR System](image)

The first consideration in the composition of such a system is that the software and hardware of the system are not separated, and it meanwhile emphasizes that the main body of the system is human. As shown in Figure 2, participants control sensor module to interact with virtual environment perception through detection module; feedback module provides real-time feedback for participants; on the one hand, the sensor module receives instructions from participants to act on the virtual environment, on the other hand, it feeds back the results of the operation to participants; the control module controls the sensor and makes the participants interact with the virtual environment and the real world in real time; the 3D model library can represent the real world in three dimensions and generate the corresponding virtual environment; modelling module obtains the real world three-dimensional data and establishes the corresponding three-dimensional model.

3.2 VR technology in visual information retrieval

The application of VR technology in visual information retrieval of digital library can realize the three-dimensional reproduction of retrieval process and results. In the process of three-dimensional information retrieval, the vivid and intuitive visual environment is not only more convenient to provide abundant information resources, real immersed interactive perception, but also easier to stimulate users' thirst for rules and knowledge. Moreover, the deep-level topic clustering of retrieval results is more suitable for three-dimensional vivid display.

In specific application scenarios, VR technology can be used to model the real environment of the library's borrowing library and sample book reading room according to the actual proportion; through secondary development of library OPAC interface, develop a precise positioning system for web-based collections with seamless links to bibliographic retrieval systems. The system can not only retrieve the specific location of the collected documents, but also visually inform readers of the three-dimensional environment, specific orientation and route of the document. This application enables readers to clearly understand the location of books, solves the problem of inconvenience for readers in traditional borrowing services, and improves the efficiency of borrowing. Through virtual reality technology, the traditional retrieval process and results can be represented and analyzed by multi-dimensional visualization, and readers can participate in the whole retrieval process. It will provide readers with deep-seated knowledge discovery and in-depth guidance, which provides a useful attempt for library service discipline construction and scientific research innovation.

For the application of VR technology in the visualization of information retrieval in digital libraries, when it comes to three-dimensional environment, it is necessary to involve relevant display devices. At present, digital libraries generally do not have any special equipment to help information retrieval except computers and the Internet. Without the relevant display devices, no matter how wonderful the virtual three-dimensional world is, the users of digital libraries can only watch it on the two-dimensional screen by computer. More importantly, the service of digital libraries is to acquire knowledge from document resources rather than three-dimensional beautiful graphics and images. Like the construction of document resources in traditional libraries, the visualization of three-
dimensional information retrieval in digital libraries also needs the material support of three-dimensional information resources.

4. Construction of library VR information retrieval system

4.1 System architecture
The library VR information retrieval system is composed of virtual reality platform, library database and terminal equipment, as shown in Figure 3.

![Figure 3. Architecture of library VR information retrieval system](image)

The core of the library VR information retrieval system is virtual reality platform. The construction of the system is based on virtual reality modelling language (VRML), and utilizes 3DS MAX to realize it. VRML is the mainstream language of WWW-based three-dimensional interactive website production on the Internet at present. Essentially, it is a Web-oriented and object-oriented three-dimensional modelling language. Moreover, it is an interpretative language with platform independence. VRML modelling language creates modelling with Shape node, which is the most basic and important node in VRML. The appearance, material and shape of all models in library virtual scene are basically created and controlled by Shape node. Scenarios created with VRML can be spread through the Internet, displayed on the user's screen, and allow multi-user participation.

4.2 Construction process
The construction of the library VR information retrieval system includes two modules: three-dimensional scene modelling and roaming system building. Firstly, a virtual scene is constructed by building models in real libraries with actual dimensions such as buildings, floors, partitions of various spaces, furniture, etc. Secondly, build the information retrieval system, and then according to the needs of information retrieval mode and various operations on objects in the process of retrieval, complete the design of information retrieval interaction for three-dimensional scene of library.

The whole construction process can be described as: determine the scale, display effect and development platform of virtual library; determine model data, and collect real book building, furniture feature data, floor and space environment data; preprocess the data and optimize the model to create the main building model and the space model of the library, and establish data response and exchange relationship between database and related objects; set up scenarios, generate application definition files, set roaming mode, and finally realize roaming start of virtual libraries. The construction process of library VR information retrieval system is shown in Figure 4.
4.3 Scene modelling

Scene modelling of library VR information retrieval system includes three parts: scene acquisition, data acquisition and three-dimensional modelling. The real scene provides the basis and data for the establishment of the model, usually originated from digital camera shooting or building CAD construction drawings. Data acquisition includes accurate specifications and real textures of buildings and furniture, which can be used to modify and render three-dimensional models. Specification and Scale Data is Obtained from CAD Drawing Documents, while texture data is usually imported directly into the computer, corrected by Photoshop software, and then collected the real texture and texture data of physical objects. Three-dimensional modelling is based on Creator Pro software and simulation software Vega Prime, supplemented by component GIS-MapObjects software. The scene modelling process of library VR information retrieval system is shown in Figure 5.

The library VR information retrieval system achieves the following design goals:

1. It allows readers to freely observe any object in the virtual library from any angle from a first-person perspective.
2. It allows readers to arbitrarily choose to enter any floor, library, and area in the virtual library for retrieval.
3. It supports readers to interact and browse in real time during the information retrieval process.
4. It supports the reader's real-time link to resource data during browsing and operation.

The system is a simulation virtual environment of real space based on entity library. It adopts the immersive virtual reality form to provide readers with various control methods, so that readers can retrieve information in the virtual library in a natural way, and they can feel the feeling of being in the same place.
5. Conclusion

Information visualization is an innovative application in university digital library. In the digital library, the application of virtual reality technology is mainly reflected in the visualization of information resources, information retrieval and human-machine interface. The development of virtual reality technology has created favorable conditions for library information retrieval to carry out innovative services, and further provides a new perspective for library service readers. Visual information retrieval function is realized by VR technology, which enables readers to participate in the whole process of information retrieval and browsing, enriches the means and content of retrieval, aggregates complex information content, and obtains more intuitive, vivid and image retrieval results.

This paper breaks the traditional way of building information platform in libraries, and explores how to utilize VR technology in visual information retrieval. Then we propose to construct a library VR information retrieval system, and introduce the architecture, construction process and scene modelling of the system. This system can improve readers' information retrieval experience from the perception and interaction level, and greatly promote the integration and effective utilization of library information resources.

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