An introduction to the 3-dimensional virtual library sites-navigation system at Capital Normal University Library

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Abstract Capital Normal University Library (CNU Library) initiated the first practical application of a 3D virtual library sites-navigation system (an electronic kiosk version) among Chinese academic and research libraries in 2010. It was primarily based on the technologies of 3DsMax and Virtools. This paper concentrates on the discussion of the methods in creating the 3D model and in realizing the interaction among the data usage of the system. As a result, several important service functions of the system have been developed successfully so far for convenient public access. They include the functions of virtual-book searching, path navigation online, real-time message exchanges, and multi-media sharing, etc.

Keywords Library sites-navigation system, Book-navigation system, 3D Studio Max (3DsMax), Virtools, Virtual library

1 Introduction

The appearance of Second Life 3D virtual online world (secondlife.com)\(^1\) has led people to a new lifestyle of living in the virtual world. The 3D virtual technologies and their wide-spread applications have caught more and more public attentions these days. In the professional field of library and information science, 3D virtual reality technologies are being adopted to build the next generation digital library for improving library’s digital services, especially for facilitating and enriching library users’ information access experience. In order to optimize Web-based online digital services and to heighten users’ satisfaction, some large academic and research libraries have established virtual services on Second Life. For example, the Digital Bleek and Lloyd collection\(^2\) on Second Life is built by the University of Cape Town in South Africa. In China however, most researches remain focused on the development of a feasible 3D virtual system applicable to digital library operations.

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For instance, the 3D virtual navigation system\cite{3} created with Quest3D software has been developed by the National Library of China; the 3D Scene Library Services System\cite{4} based on RIA technology has been developed by the Beijing Forestry University and so on.

It was under the circumstances of the above-mentioned changing trend of the intensified technology-assisted library operation, CNU Library began its exploration and research on virtual library in 2006 and finished the prototype design of the 3D book-navigation system in 2008. After that, CNU Library continued to expand its research on improving the service in the virtual library, and finally launched its virtual library sites-navigation system construction project in 2010, which is based on the 3DsMax and Virtools. This undertaking was a first in its kind of experimentation at the time among all types of libraries in China. In 2011, the system has been put into service. The system construction project was established for the following two underlying reasons.

Firstly, it aimed to reconstruct a more advanced virtual library. Secondly, it strived to solve a common problem that many Chinese university libraries were facing at the time when accelerating the mode of their operational expansion, particularly for meeting the public calling for a more efficient and effective access to information resources and related services. Such public demands, which are largely generated by the dawning of a transformed information society of our times, became ever more pressing on the library operation aimed to serve learning, teaching and research. In addition, it is further compounded by an ever growing of library physical space and increasingly diversified library collections both in multifarious print formats and digital formats. Such increasingly complicated information storage and retrieval situation immeasurably obstructs the information users from finding their needed information effectively and efficiently. Thus, the development of the 3D virtual library sites-navigation system ameliorates this situation considerably.

The module of library building and facilities in the 3D virtual library sites-navigation system of CNU Library simulates library service arrangements in real life. It pinpoints the path to locate the desired library item such as on which floor and on which shelf that the desired items can be found. Thus, the system saves time and efforts for a reader to find the desired book or library items. Meanwhile, the system provides an immersive 3D environment, so users can interact with the sites-navigation system in many ways, such as strolling and browsing around the whole virtual library site, sharing the multimedia service with other library patrons and engaging real-time communication with service providers, etc. This can greatly enhance the user’s level of satisfaction for a broadened knowledge-base in using CNU Library’s digital library.
2 System design and implementation

2.1 Objectives and the system design

According to the physical building and the collection layout of the CNU Library, the objective of this system was designed to provide the following services: 1) Locating and navigating the book collections which are housed from the third floor on up to the seventh floor; 2) realistically sighting all library facilities on the first and second floors by means of using multimedia equipment; 3) strolling in the virtual library; 4) browsing and reading full-text journals in a virtual environment; 5) engaging in real-time communications with service providers online.

As shown in Fig. 1, the system is composed of three segment layers: 1) A data layer, 2) an application layer and 3) a Web-based user service layer in carrying out the objectives of the system design. When a command is sent online by a library user for a piece of desired information, it is processed in the application layer for pulling out the relevant data, which are induced from the data layer; the processed results are then returned to users. For example, a library user sends a command for locating a book, and then the command can activate a relevant engine from the automatic management system Aleph500 to navigate bookshelves based on open database connectivity (ODBC) and to get the desired item from the data catalog. Thus, the information about the precise location of the desired book is gained and the navigation path is calculated in the application layer. Finally, the results are returned to the library user and the navigation path to the book is shown in a 3D image online. So the two characteristics in a 3D virtual environment, the representational fidelity and user interactions, mentioned by Barney Dalgarno and Mark J. W. Lee\[5\], have been fully considered during the process of CNU Library’s system design.

![Diagram of CNU Library’s 3D virtual sites-navigation system](http://www.chinalibraries.net)
2.2 Implementation

As shown in Fig. 2, the implementation process of the whole system is divided into five steps: 1) Collecting essential information about the library building and the layout of its floor plan; 2) taking photographs of the key functional areas of the entire library building including its facilities on each and every floor of the library building; 3) creating models, 4) texture mapping, and 5) realizing functions.

During the process of the system construction, we need to solve two problems: Keeping the truthfulness of imagery representations of each site scene on the one hand, and avoiding a possible reduced data loading speed caused by an overload of the multi-module configuration for the site viewing on the other hand. To solve this problem, some measures were taken. For example, all imagery models went through a simplification procedure. With appropriate maps attached to them for pinpointing their locations, users’ visual experience can be ensured and improved. In order to avoid too many components that are contained in these modules, which may slow down the Internet downloading speed, we simplified the information displaying functions. Thus, the network uploading was improved by distributed network uploading.

2.2.1 System modules

CNU Library’s 3D virtual library sites-navigation system consists of two modules, namely, the library building layout module and the personnel image module. Both
modules are created with 3DsMax after having taken photographs of onsite library collections, facilities and service program operations.

(i) Library building module  This module depicts graphically the structure and the functional layout of the library building, including its space usage on each and every floor. The facilities and equipment that are made available in the library are also individually programmed into this module for virtual displaying purpose. Then all functional elements in the library are presented in real life dimensions and scales.

In order to solve the problem of slow loading caused by a relatively large number of modules in the system, we adopted a method of separate data uploading for each floor. In addition, modules of each facility and equipment created were also needed to be processed for simplification. Generally speaking, there are two ways to simplify a model formulation. One is to lessen the extent of embossment and depression to reduce the redundant “faces”. This will cut down the amount of data required for building a module. The other is to achieve a three-dimensional effect by using a photographed picture as the textural base for building a module in order to show its complexity structure.

(ii) Personnel image module  In terms of role playing, the personnel module of this system includes two gender characters: The male and the female library users. In terms of action, CNU Library’s system has two types of animations created for the library users, i.e., a waiting posture effect and a walking posture effect.

The personnel module requires the creation of a person’s bones, skins and animations (Fig. 3). The procedure of making a character’s physical appearance resembles to that of an object modeling. However, there is a distinct difference in that we need to create bones for personnel characters and cover their bones with
After binding with skin, it is important to know the bone structure during the process of creating character animation with Character Studio module. The system adopts BIPER bones in 3DsMax. Each link of bone has a pivot at its bottom and the bone can make turns around the pivot. This is to say, the parent-bones rotate in responding to the movements of subsidiary-bones. In addition, the muscles are created with another relevant module, which demonstrates a certain degree of muscle flexibility in its association with the bone movement.

2.2.2 Functionalities of the system

(i) Sites-navigation and browsing  The functions under this caption include but not limited to the following areas: The first one is to retrieve and store information from an OPAC. The catalog information from an OPAC including ISBN, title, call number and shelf location mark is uploaded and stored into the MySQL database of the system. When library users search the information about a book, the system can connect the MySQL database through ODBC automatically and acquire the data through the module of Execute SQL Statement Building Block in Virtools and then store the results in an array.

Then, the navigation path to the targeted books is confirmed. According to the shortest path algorithm, the system gets the shortest distance to the targeted bookshelf. As shown in Fig. 4, the white horizontal marks, which are achieved by the 3D Frame in Virtools, are reference points to guide users to the targeted bookshelf. Moreover, the system does not allow personnel figures to pass through the solid objects (such as desks, chairs, pillars and other facilities, etc.). In order to get the effective path drawn from the current position to the targeted point, the following measures need be taken: 1) Labeling these objects as obstacles; 2) marking the impenetrable areas as grid objects; 3) using the Building Block of Layer Slider (a functional module in Virtools) to control the impenetrable motion in Virtools; and finally 4) showing the correct navigation path in the virtual library.

After getting the information about the floor where the book is located, the “Switch-on Parameter Building Block” is used to realize the floor’s model uploading. The Building Blocks of “Get SubString”*, “Get Row”*, “Test”* and “Op”* are used for uploading the bookshelf data upon which the book is situated. Then the

* Get SubString Building Block can return part of a string.
* Get Row Building Block can get the cells of a chosen row.
* Test Building Block can activate the appropriate output, according to the test between A and B.
* Op Building Block can process any valid paramOp. This module allows you to perform a paramOp at any moment. For example, suppose you need to get an object's position and want to store this position in a local parameter.
message is sent to the main program by the Broadcast Message Building Block to generate an appropriate navigating path online.

![Path navigation diagram](image)

Fig. 4 Path navigation diagram (on the 4th floor of CNU Library).

(ii) **Real-time message exchanges** There are two modules of real-time message-exchange that can be used for users to communicate with one another on the same floor or within the whole library building. The enabling function of real-time message exchanges can be divided into the following two steps:

- Firstly, multi-users are connected by using Building Blocks of Join Session and Create Session to realize intercommunication among multi-users in the virtual library. The specific process is that the number of such session users is confirmed beforehand. Then the session is connected via Join Session Building Block. Meanwhile, the session object is confirmed according to the Connection ID. Then the Connection ID’s behavior of stepping in or out of the session is managed by the Building Blocks of “Get Incoming User” and “Get Outgoing User”.
- Secondly, after multi-users are connected, the message is sent out by the “Network Send Message Building Block” and received by the “Network Wait Message Building Block”. The exchange of messages online is achieved in the virtual library.

(iii) **Digital journal linking** Chinese journals and foreign journals are kept separately on the third and the seventh floor at the CNU Library. Linking digital journals refers to the mode that paper journals are linked with their digital counterparts version in the system. When the users double-click the cover of the print journal, the hyperlink would bring them immediately to the corresponding digital source. For example, when a user browses a journal shelf on the third floor in the virtual library and double-clicks the cover of *Journal of the National Library of China*, the
full text of the journal in CNKI database would be linked and opened for the user’s reading task online.

To achieve the function of digital journal linking, we need to make a preparation from two aspects. On the one hand, the file named `a.txt` is needed to be created under the installation directory, in which every digital journal’s URL (on the left column of Fig. 5) is stored. On the other hand, an array is created in Virtools, in which the ID code of a digital journal is displayed (e.g., the first row on the right column of Fig. 5). The URL can be connected by triggering the ID code of the journal in Virtools.

![Table](https://example.com/table.png)

**Fig. 5** Digital journal linking.

(iv) Multimedia sharing  Multimedia sharing is the function of displaying and sharing resources, such as audios, videos, and image resources, etc., which are available in the virtual library. These digital resources need to be uploaded to the server by the system manager. In fact, in this system, it is supposed to imitate real life environment in playing the video resources on the TV or the LED screen.

3 Data analyses

The 3D virtual sites-navigation system of the CNU Library has been placed on an online trial basis. In order to test the effectiveness and practicability of the system, a questionnaire survey involving the system’s functionalities and users’ satisfaction was constructed. A total of 111 copies of the questionnaire were sent out and subsequently we received all feedbacks in valid returns.

The questionnaire consists of four sections: 1) User’s profile, which can be used to analyze the needs of different user types; 2) users’ access experience, which gives indication about users’ feeling of the interface, their reaction to the visual contact while using the system; 3) users’ level of satisfaction about the various system functions, which explains whether a particular function can meet his information searching needs well enough and whether it can help him to utilize the library better; and 4) suggestions, which contain some open-ended questions to solicit suggestions from readers for the further improvement of the system’s functions and design.
The result of the survey is detailed as follows. 51% of the respondents visited the library more than 20 times per month, and 32% respondents visited 10 to 20 times (Fig. 6). The data show that at least 75% of the readers borrowed books more than once per month (Fig. 7), which implies that the main reason for readers to visit the library is borrowing books.

Furthermore, 58% of the respondents had the experience of failing to find the right bookshelf. According to our returned surveyed data (Fig. 8), it demonstrates that most readers are in need to have a path-finder system to help them to locate a desired book.

From perspective of the user experience, 68% respondents reported that the virtual environment was consistent with the reality, which let them feel as if they were actually in the CNU Library (Fig. 9). In addition, 97% respondents thought that it was easy to operate the virtual sites-navigation system (Fig. 10).

After having used this system, 59% respondents believed that the system was very helpful in getting themselves familiarized with the library layout. 41% respondents believed that it was of some help in locating their desired book or library items (Fig. 11). 61% respondents agreed that it was very helpful in such
pursuit, while 39% respondents thought it helped not much (Fig. 12). In addition, 70% respondents held the view that they could remember the sketched path-finding route map provided by the system prior to their coming to the library for a quick finding to their desired books. In other words, it is much easier now for library users to find their desired library book or any library item either online or offline.

As far as the system function is concerned, 78% respondents indicated that they liked the online message exchange function (Fig. 13). And 70% voiced that the digital journal linking is convenient and innovative (Fig. 14). Finally, 96% respondents considered that they would like to utilize the 3D library sites-navigation system in the future. And 85% respondents provided many valuable suggestions to improve the system.

According to the survey data gathered, most respondents believed that the system has a high practical value. It can greatly help users to know the library layout and locating the desired book being placed on a particular bookshelf quickly. It also enriches the users’ social networking experience by its embedded function of online message exchanges. In a word, the system expands and improves the service delivery of the library immeasurably.

4 Conclusions

As one of the pioneers in the arena of research and development of a 3D virtual library in China, CNU Library’s 3D virtual sites-navigation system has demonstrated its weight in gold in such an undertaking. The objectives as well as the design, the construction and the operation of this system are introduced in some detail in this paper. It explained the method of creating 3D models with 3DsMax and how the system’s interactive function was achieved by applying the software of Virtools. Moreover, the statistics and relevant data about the system’s usage situation from
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these authors’ questionnaire survey will be a rich source of new inspirations for further studying of this topic.

The system has been in sound operation at CNU Library for more than one year. Despite its limited features in service delivery design and operation, it holds great promise for its expanding role in giving unprecedented innovative support to the Library’s strategic missions. Such being the case, we shall concentrate our future research on this issue in the following two directions: 1) To enhance and improve the functionalities of the system, such as enriching personnel character image design with more face pictures and more animation and strengthening the multimedia feature in the system; 2) to refine the design and to expand the scope of service features so as to meet the users’ information needs. For example, we can introduce scripts and plots to the virtual system so as to stimulate users’ interests and make users more motivated in using this system; we can also build a 3D online theater by connecting with other multimedia systems to expand the multimedia service feature, and add the feature of distant education classes to the system.

To sum up, the virtual reality technology is playing an ever more important role in the development of a modern digital library. As an important pioneer and forerunner researcher on the adoption of applicable virtual technologies to the library service scene, CNU Library’s project of developing a 3D virtual library sites-navigation system undoubtedly will serve as a pivotal catalyst to trigger a wide-spread movement for all libraries in China to assess its professional implications and to adopt such applicable virtual reality technologies into their strategically enhanced scheme of service operation in the days ahead.

References


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