

Development of 3D Library Application System

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Abstract: With the development of computer technology, more and more traditional application systems begin to integrate 3D technology. With the advantages of 3D technology, the user experience is constantly improved. Three dimensional library application system is also becoming the mainstream trend. This paper combines the traditional library application system with three-dimensional technology, and explores the library of Henan University of technology from the perspective of students. This paper analyzes the key technologies used in the system, and introduces the overall structure, design and implementation method of 3D library application system. The system is based on two core functions and extended to study the application system of 3D library. Finally, the system realizes the functions of book Search, seat reservation, seat occupancy detection, reservation statistics and borrowing query. The system makes the service mode and service scope of the library more diversified, and expands the functions of the traditional library.

Keywords: 3D library; 3D; website; SuperMap; cesium; Node.js

1. Introduction

The traditional library application system, such as the search function, is usually in the form of two-dimensional or 2.5D, which is not intuitive enough [1,2]. With the development of network technology, multimedia technology and Web3D Virtual technology, the virtual library system with three-dimensional display is becoming more and more popular. Three dimensional library system has many characteristics that traditional library system does not have [3]. Firstly, 3D library system can display the real library vividly and beautify the model with 3D modeling technology. Then all the functions that need to be developed can be built in this virtual three-dimensional scene [4,5]. We can use three-dimensional technology to present the boring text data in the form of three-dimensional graphics. In the application of three-dimensional library [6], we can not only let people have the feeling of being in the scene, but also can intuitively carry out various operations.

The essence of the construction of digital library is to provide convenient services for readers by various digital means. The digital library designed and produced by using Web3D technology provides a new service for

readers. At present, the main function of digital virtual library is also concentrated in the environment of virtual library for users to browse in virtual 3D [7-9]. As a part of digital virtual campus, the work that digital virtual library of university can undertake is mostly limited to this. The virtual library system of Hunan University is three-dimensional [10]. However, the system focuses on letting users know the library, focusing on three-dimensional scene roaming, and lacks other business functions. Although the three-dimensional library system launched by Zhejiang Library has the function of book Search, the interaction is not good enough and does not fully show the advantages of three-dimensional [11].

Many libraries have set up their own virtual libraries. The library extends from two-dimensional space to three-dimensional space, but its main function only stays in the virtual roaming environment of the library. This paper focuses on exploring the possibility brought by the combination of traditional library application system and 3D technology, providing 3D library visualization information, realizing the functions of traditional system more perfectly through 3D scene, and also making some functions such as seat occupancy detection and Book 3D navigation which are difficult to realize by traditional system, so as to bring better experience for users.

2. Key Technologies

The core technology of 3D library application system in this paper is SuperMap iClient3D 10i for WebGL. The system back-end technology stack is Node.js+express+ejs+MongoDB. Node.js As a back-end development environment. Express provides simple server creation and routing management and the use of various middleware. Ejs is the rendering engine of the page. MongoDB as an excellent NoSQL database provides guarantee for data storage and query of the system. The front-end uses bootstrap to design UI interaction. All the controls and windows are not designed in the style of hypergraph example, but are generated by using the original bootstrap style and customized. The 3D scene model used in the system is made by using 3ds max2014.

SuperMap iClient 3D for WebGL is a cross browser client product without any plug-ins in the service GIS architecture system. It is based on excellent Cesium open source framework, and is developed for HTML5 oriented 3D application system. It is used to build 3D real space

applications with rich content, fast response and powerful performance. It has many characteristics, including flexible interaction design and rich data presentation, good compatibility with other frameworks; good compatibility between terminal equipment and browser. This framework is usually used with SuperMap Iserver products, which can make full use of the various services published in Iserver and give full play to the advantages of the system.

3. System Design and Implementation

3.1. Design Objectives

In this paper, the main function modules of 3D library application system are as follows:

- Scene browsing: after the 3D scene is loaded, you can translate, rotate and zoom the scene through mouse operation.
- book Search: search the library collection data through the keywords provided by users, and find the matching information. Moreover, users can choose to send the result information found in the system to their own mailbox.
- Seat reservation: the system realize the reservation of library seats, as well as the functions of sign in, sign out, temporary leave and return after reservation.
- Seat occupancy monitoring: the system obtain images of library seats through monitoring equipment (such as cameras) and reuse them TensorFlow.js identify the image, and analyze the recognition results and library seat reservation data to find out the situation of seat occupancy.
- Reservation analysis: the crawler program is used to obtain all the seat reservation data within the specified time period, and the analysis results are displayed in the 3D scene according to the specified reservation mode.
- Borrowing statistics: by analyzing the data of books borrowed by users within the specified time range, the number of books borrowed by each unit in the campus is counted.
- User management: provide user registration, login function and log off function after login.

3.2. Database Design

According to the system design, mongodb can be used as the database of the system. The database table can be divided into bookshelf (as shown in Table 1), bookshelfmap (as shown in Table 2) and users (as shown in Table 3).

- Bookshelf: stores information about bookshelves in the library.

Table 1. Bookshelf data table details.

Type	Meaning
Int32	Bookshelf model ID
Int32	Bookshelf floor
String	Bookshelf orientation (East West)
Int32	Number of rows of bookshelves
String	Side a and B of bookshelf (front and back)
Object	Camera positioning parameters of bookshelf

- Bookshelfmap: the SmID and SmUserID of bookshelf can be checked mutually.

Table 2. Details of datasheet of bookshelfmap.

Field name	Type	Meaning
SmID	String	Bookshelf model SmID
SmUserID	String	Bookshelf model SmUserID

- Users: authorized user ID and authorized user ID.

Table 3. Users data table details.

Field name	Type	Meaning
Username	String	User name
Password	String	Password
TargetSeatID	String	User reservation target seat ID
SeatName	String	Name of target seat reserved by user
UserId	String	User ID
Tag	String	Remarks

3.3. 3D Visual Library Design

The construction of three-dimensional visualization library environment includes five levels of three-dimensional views.

- View of the whole museum: Display the complete three-dimensional structure of library appearance.
- Floor view: Three dimensional view of the layout structure and room location of each floor of the library.
- Stack view: The three-dimensional layout structure of each stack room and the position of each book shelf in the stack room.
- View of the bookshelf: The location of the books on each shelf.
- View of the library collection: Abstract information or book card content of a book.

3.4. Function Realization

3.4.1. Scene browsing

After entering the system, the system will automatically load the 3D scene. After loading, because the 3D scene is usually relatively large, only part of the scene will be displayed on the screen. In order to see the scene in other places, interactive operations need to be carried out through the mouse, such as pressing the left key, right button, middle button, etc., to move, zoom and rotate the scene. The internal scene of the library is shown in Fig 1.

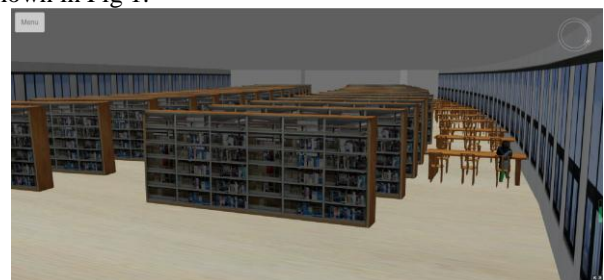


Figure 1. Library scene display.

3.4.2. Book search

After users click the search button, the system will submit the keywords to the back-end crawler module. The crawler module starts to work, crawls the keyword search information on the school library official website, formats the information processing and returns to the front end. Users select the books to borrow from the search results, and then perform the similar process again to crawl the detailed information of books provided by the library's official website, including location information and collection information. At this time, the user can click the positioning button to carry out three-dimensional positioning and two-dimensional positioning of the book. When carrying out the three-dimensional positioning, the user needs to request the corresponding camera positioning parameters of the bookshelf from the database. In addition, users can also enter the email address to send the query results to the mailbox. The system will submit the text information, two-dimensional images and three-dimensional images to the back-end server, and then the information will be sent to the user's mailbox after being processed by the back-end server. Fig 2 shows the three-dimensional and two-dimensional information of the books searched.

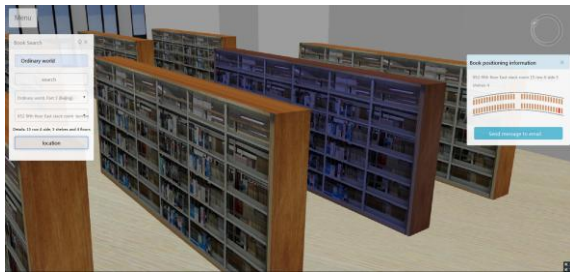


Figure 2. Book search.

3.4.3. Seat reservation

When the user enters the seat reservation function, the system will detect whether the user has logged in the account. If not, it is forbidden to use this function. After login, when the user opens the reservation function panel, the system will automatically retrieve and query the seat reservation status of the user, and update the status of all seats reserved. After that, users without reservation can click on the spare seat (there will be a character model on the reserved seat) to make an appointment, and the reservation meeting the library reservation rules can be allowed. After the reservation is successful, a character model will be loaded into the spare seat, which means that the seat has been reserved. Users who have already made an appointment can sign in, sign out, leave temporarily, leave back and so on. These operations are submitted by the system to the library server for processing, and the processing results are presented to the user. Seat reservation information is shown in Fig 3.



Figure 3. Seat reservation.

3.4.4. Seat occupancy monitoring

After the user turns on the seat occupancy monitoring function, the camera and other monitoring devices start to work and send the captured images back to the front end. After the front-end receives the images, tensorflow is used to identify the images. According to the recognition results, which seats are occupied can be obtained. Then, the library server is requested to obtain all seat reservation data, and the occupancy status can be obtained by comparing with the image recognition results. Seat occupancy monitoring is shown in Fig 4.

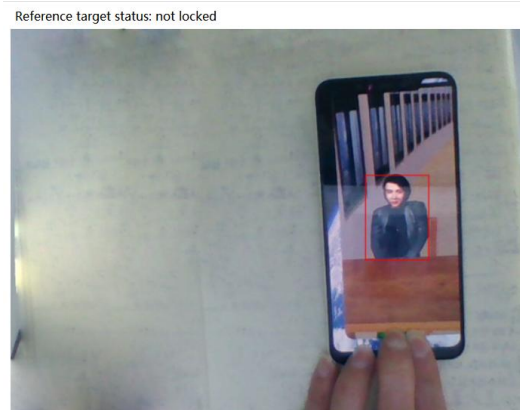


Figure 4. Seat occupancy monitoring.

3.4.5. Appointment statistics

The user selects the time period and analysis method to analyze the data in the function panel (analyze the seat with the most reservation times or the seat with the least reservation times), and then click the statistics button. The system submits the time data and other parameters to the library server. The library server receives the request and returns the data. The system analyzes the data after receiving the data, and after the analysis is completed, the data will be analyzed in the three-dimensional scene, three-dimensional visualization is carried out. The appointment statistics are shown in Fig 5.

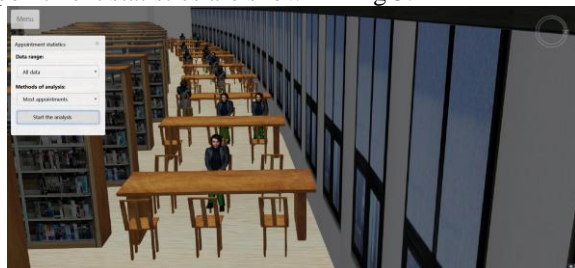


Figure 5. Appointment statistics.

3.4.6. Borrowing statistics

The user selects the data time in the function panel, clicks the data statistics button, and the system submits the time data and other parameters to the library server. The library server returns the data after receiving the request. The system analyzes the data after receiving the data. After the analysis is completed, the geographic data required for 3D visualization are generated according to the analysis results. After the completion of the analysis, the 3D visualization will be carried out in the 3D scene Visual display. The borrowing statistics are shown in Fig 6.

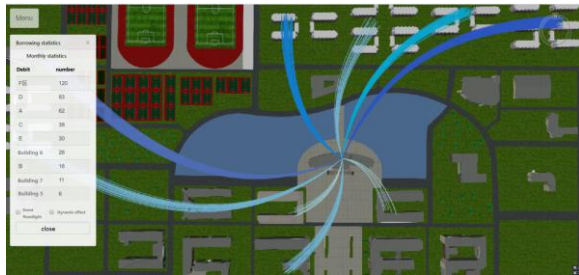


Figure 6. Borrowing statistics.

3.4.7. User management

The user can click the registration account button on the login page to register. Input the account number, password, confirmation password and verification code in turn, and then click the registration button to submit the registration request. The back-end server verifies that the request submitted by the user is legal and approves the registration request. After completing the registration, the user uses the registered account to login. After inputting the account number, password, verification code and other information in the login interface, the user can click the login button to log in. After the background server passes the verification, the login operation can be completed. The logged in user can click the logout button to log off the login information, and the cookie information set during login will be destroyed.

4. Conclusion

The system adopts the principle of high cohesion and separation of functions (B/S), which makes the system easy to upgrade and upgrade by adopting the principle of "no coupling, no maintenance". In addition, the user management system provides users with a resource management platform which is easy to operate and realize dynamic system update and maintenance. The system has powerful functions, friendly and intuitive management interface and convenient operation. The system realizes the three-dimensional visualization query of library collection information in the form of

interaction, and displays the collection information and function area in the library in the form of three-dimensional virtual. It truly shows the architectural features, reading environment and collection resources of the library, makes the service mode, service content and service scope of the library realize three-dimensional visualization and networking, expands the functions of the traditional library, and provides readers with three-dimensional real and visible library literature information.

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