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Application of 3D Roaming Technology in Micro - course Design

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Abstract. A spatial interaction-based method for design and realization of a 3D virtual reality library navigation platform is proposed for design issues of a library navigation platform. Firstly, the library website frame based on the spatial integration concept is studied. The 3D virtual reality frame of the university library includes the real space and the virtual space both of which may achieve a quick view of key information of the library. Secondly, the library navigation platform is designed with 3D virtual reality technique. It also introduces a processing mode oriented at the human-machine interaction model and realization of KeyBoardInput. Thirdly, the effectiveness of the proposed design strategy in library information navigation is provided by the test plan and the results.

Key words. Spatial interaction, AR, Library navigation, Human-machine interaction.

1. Introduction

With the application of mobile electronic terminals such as IPAD in all aspects of life, each and every innovation in the information field will lead to a change of the behavior pattern in terms of people's life and work. In particular, these changes are obviously reflected in libraries playing a central role in culture information of universities and colleges. Today, the Internet-based library 2.0 has effectively integrated and searched any and all information including text, pictures, sound, video, etc. as required by readers. However, there is a big gap between the information service mode of the traditional 2D space and the environment under which readers wish for acquisition of information. The virtual reality technique is an existing mainstream mode. The term virtual reality technique also known as VR technique or human-machine environment was proposed by Jaron Lanier, the founder of VPL Research Inc., in the 1980s. This is a kind of computer technique developed based on intercross and fusion of multi-disciplines including computer graphics, computer simulation, sensing technique, display technique, etc.

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In the last several years, more and more Web technologies are applied to information service of libraries, such as RSS, Blog, WIKI, SNS, etc. The service concept of university libraries is gradually changing from storage of information to application and service of information knowledge. The application of VR technique in the fields of life to an extent of slight similarity reflects the improvement of VR technique in viewing of scenes including urban planning, exhibition display, digital hotel, museum, art gallery, etc. More applications and improvements are seen in information interaction and retrieval.

This paper mainly focuses on the design realization of the design and realization processes of a 3D virtual reality library navigation platform based on spatial interaction. It proposes a design concept of an interactive university library website architecture based on the spatial integration concept. Also, it describes the design and realization of the navigation platform with 3D virtual reality technique.

2. Library website frame based on spatial integration concept.

According to 3 basic requirements of D.Dinucci for website design, this paper provides a case of the general framework design of a spatial integration-based interactive university library website for college and university libraries (Fig.1). The general framework consists of two levels: real space and virtual space. Further, the information that users want the most or is frequently used is located as close as practical to the top of the website structure. Design of this level will enable readers to have understanding of major functions of the library in terms of the spatial angle and have a quick look at any key information provided by the library.

3. Realization of roaming viewing of the virtual library display platform.

3.1. Design of display platform.

Library navigation view represents one of the core functions of a virtual library display platform. Participants may develop knowledge and understanding of the books and environment in a library by navigation view. One may get close to the future library environment with this roaming view system even if the library is under construction. Virtual library roaming enables users to blend in the virtual 3D world. Participants will have a feeling for surroundings as if they were there. The system generates interactive feedback of all your behaviors and actions. A good model image processing technique develops visual, hearing and touch feelings for mattes and books in the library. The library roaming view provides readers a quick and convenient way of information acquisition.

Implementation of the virtual library display platform design is to provide an economic and practical way for book display and reader communication. During the virtual library roaming, users are reflected in the virtual scene as entities in the virtual environment. The process of user's view operation in the virtual library navigation system is shown in Fig.2.

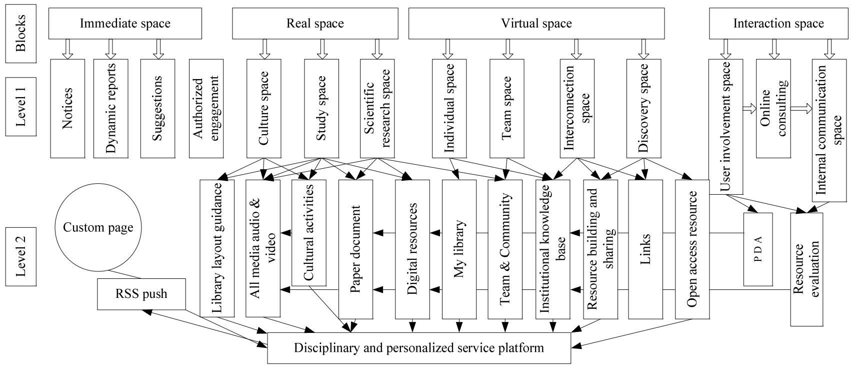

Fig. 1. Schematic diagram of a spatial integration concept-based interactive university library website architecture

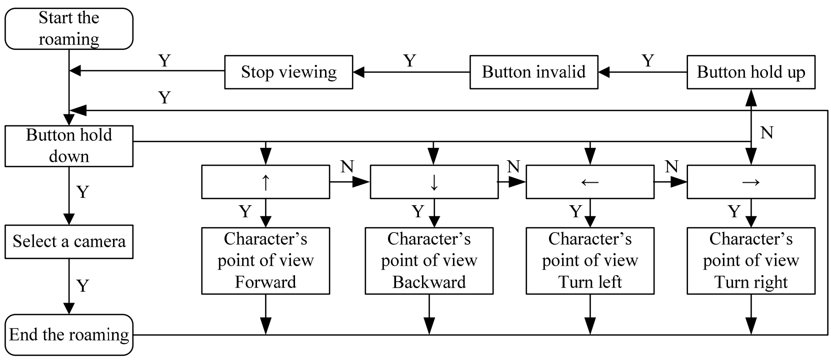

Fig. 2. Design of virtual library display platform

A key step of virtual library display is that it is possible to walk through the virtual library navigation. The platform system provides a relatively real virtual library reading environment where viewing is permitted for users. A borrower will obtain the information from visual, hearing and touch feelings. Realization of virtual roaming view is to reflect the virtual library view action to be realized by entering the interactive graphics with the keyboard. The interactive architecture of software is designed followed by realization of the behavior. Programs are capable to relate keyboard events to specific functions. Interaction will be achieved through keyboard input of users by adding a class to keyboard interface.

3.2. Processing at human-machine model direction.

The human-machine interaction graphic user interface GUIEventHandler class is realized with the event handle Handle() method. The class of handling pick-up event inherits from osgGA::GUIEventhandler interface event handling. The handling of human-machine interaction graphic user interface design event is to enable osgViewer::Viewer to respond to the events of mouse and keyboard. Handle method is to check the action type and value of GUIEventAdapter and execute the given operation. GUIEventAdapter is used to send a request to GUI system. If an event is correctly handled, the Boolean value returned from handle method will be true. If not correctly handled, the value will be false.

GUIEventAdapter uses GUIActionAdapter to request GUI system for execution of actions including request of redrawing scene book object requestRedraw(). The following is the class code of Handler event handling:

```
class LpHandle:public osgGA::GUIEventHandler
{ public:void
handle (osgGA::GUIEventAdapter ea,osgGA::GUIActionAdapter ent
{
switch(ea.getEventType())
(case osgGA::GUIEventAdapter::KEYDOWN:
if (ea. getKey()==osgGA::GUIEventAdapter::KEY_ W){
}
break;
case osgGA::GUIEventAdapter::PUSH:
break:
}
```

The case below states the method of interaction between GUIEventHandler and GUI design system of human-machine graphic user interface. An operator with a class regarded as viewer is inherited from osgGA::TrackballManipulator. Mouse events are received in the form of GUIEventAdapter case. The parsing of visual events of a camera changed by externally dragging the mouse is completed by TrackballManipulator class.

```
bool TestManipulator:: handle(const osgGA:: GUIEventAdapter & ea, osgGA::
GUIActionAdapter & us)
{osgViewer::Viewer* Viewer =dynamic_cast<osgViewer::Viewer*> (&us);
if(!viewer)
return false;
return false;
}
```

Upon parsing of an event, TrackBallManipulator sends a request to GUI system to start the Timer and enable itself to be repeatedly called so as to obtain new direction and coordinate data of a book object model.

3.3. Realization of keyboardinput keyboard input.

Keyboard Input function provides the method of accepting and handling keyboard input. Users may need different actions generated by the "Press Down" and "Release" events of a single button to register the button. Upon registration of the button in the interface class and setting of }++ response function, the table entries may be created. The listbox is a control window with a series of options available for selection of users. The table is for storage of key values (“d”, “F6”, etc.), key state (press down, release) and C++ response function.

The key event action can be processed by addFunction. Such a function comes in two forms. In form 1, the key value and the response value are regarded as the input value. Such a function is for the case under which users only process a KEY_DOWN event.

```
class keyboardEventHandler:public osgGA::GUIEventHandler
{
public:
typedef void (*keyFunctionMold)();
enum keyStatusType
{KEY_UP, KEY_DOWN}
struct functionKeyStatusType
{functionKeyStatusType() {fkbState=KEY_ UP; kbFunction=NULL}
keyFunctionMold kbFunction;
keyStatusType kbState;}
}
```

The descriptions above create the basic environment of roaming view of the virtual library display platform that is specifically realized in VRP. Upon introduction of the model to VRP editor, the CreateObject panel should be opened to select the camera module where the system sets walkthrough camera, flying camera, camera rotating around objects, role control camera, following camera, fixed-point observation camera and animation camera. Upon selection of the walkthrough camera in the panel, the first window set by the walkthrough camera parameter will pop up. In this window, the name of such walkthrough camera may be set for subsequent settings of camera selection interaction. The name is set to be “roaming camera”. The camera will be set by clicking OK.

3.4. Optimization of model.

Contradictions between reality and complexity exist in the model creation flow. It is mentioned in the modeling principle that standard geometrics such as cylinder and cuboid should be used as much as practical in object modeling as these standard geometrics are relatively standard, whether in terms of the joints or the planes. Random planes similar to strips will not occur. Large buildings have rectangular surfaces with relatively standard shapes. Simple cuboids may be used as physical structures for construction like block building. Corner may be achieved by overlapping big and small cuboids at locations with corners. However, for long and thin objects such as handrail, security window, barrier, etc., facets with patches are used as much as reasonably practical for realization purpose. This takes the fact into account that long and thin objects may lead to an increase of the number of model and faces under which reality will be affected by unreal phenomena such as sawtooth and blink in real-time scene rendering. For this reason, it must be avoided. Tree modeling is considered from the data size. Modeling is achieved by a comination of the crossing method and the billboard method, which maintains reality and reduces data capacity. All these are strengths of using the combined modeling method. Modeling may be carried out as required to balance the contradiction between complexity and reality.

An object in the virtual system has many redundant faces. Such so-called redundant faces are the excessive faces that cannot be seen in the virtual system, such as faces with which geometrics connect and touch, the back of object leaning against walls, bottom face of buildings, etc. Existence of these faces has no effect on the system display and interaction. For purpose of reduced data redundancy, they must be deleted. Removal of redundant faces reduces data size and complexity of the system and enhances the utilization efficiency of mapping and resources to increase the operation speed of the virtual system.

3.5. Optimization of mapping.

In the process of material editing, mapping should be attached to the surface of a corresponding object so as to reflect the surface image and feature of the object. The data size of such mapping is far less than that of detail modeling. Use of mapping may achieve the objective of an accurate expression of the surface texture feature of an object so that use of a number of data generated in detail modeling can be avoided and complexity of the system will be effectively reduced. Mapping of the project is pictures collected from school network. It is treated with graphical software and optimized according to specific requirements of the object in the virtual system. The length-width ratio of mapping is generally no more than 2 according to mapping setting principles. A value approximate to that of a square is preferred.

In VR-Platform, the mapping of all system scenarios can be compressed and optimized. First of all, total consumption data of mapping in the entire system should be checked; it is done by the mapping manager. A comparison is made between the available total capacity of video memory and the total consumption of video memory in terms of the difference and the proportion, followed by mapping compact operation. The purpose of general compact operation is to enable the value of available video memory to be a half more than the total video memory. Mapping number is reduced in mapping compaction that is done by reducing the mapping size and adjusting various mapping forms. The mapping manager in VR-Platform adjusts the capacity occupied by mapping by changing the size and form of mapping. The relevant parameter is vertical/horizontal size parameter setting and mapping capacity setting.

3.6. Optimization of case.

The case action operation in the virtual system of the project does not create a new object model. Instead, it uses the point variable to orient to an existing data model in the database, which is fundamentally different from reproduction. In 3DS MAX, a case operation is enabled by the array implement tool and the case move tool. It guarantees low complexity and high accuracy of the object model in the virtual system and controls of the number of model objects, which achieves operation of the virtual system at high speed. For example, trash can, tree, green belt, etc. repeatedly occurring in the virtual library roaming system are reproduced and generated by the case technique and placed in a designated area with the move and bloom tools.

3.7. Optimization of three-dimensional effect.

The effect of the stereoscopic scenario of the 3D virtual library roaming system in the project has a big direct effect on the system reality and fidelity and further affects the operation feeling and sense of identity of users. This is one f the major causes for the fact why attention is paid to the stereoscopic impression throughout development of the system. For enhanced stereoscopic impression, modeling and placement of objects are carried out in strict accordance with the scenario of a real library in system development. Stereoscopic impression is also fully allowed for in camera setting in VR-Platform. If the operating speed of camera setting is compatible with humans' common habit, it will improve the comfort sensation of users and avoid any feeling of faintness. Comparison setting of the operating angle will highlight the three-dimensional effect of a virtual library. For setting of the animation camera path, strong visual impacts will be generated to reinforce the effect as it sweeps past tall trees along the way.

3.8. Optimization of collision detection.

Unnecessary calculations in the collision detection are also optimized to further enhance the operation efficiency of virtual system. Collision detection may not be set as partial planes and lines of some models will not be subject to collision when users are roaming in the virtual library. For some complex three-dimensional polyhedral models, more calculations will be needed by collision detection as they have many planes and sides. A simple model with similar shape may be created to be added to the collision detection algorithm of the model according to the object profile. It can effectively reduce the planes and sides receiving collision detection and enhance the efficiency of the detection algorithm.

4. Experimental analysis.

4.1. Creation of an Operation Interface.

The control panel of the interface consists of two parts: graphic button control panel and text information button control panel. The former is for home, stop, animation camera selection, roaming view camera selection and music on/off control, while the lesser is for the library environment, book reading environment, reading seat road condition, library function model display callout and close/setting of human-machine interaction, as shown in Fig.3.

Graphic buttons share the same mode of creation but have different trigger events. Creation of the animation camera selection button is taken as a case in this paper to describe how the graphic button is designed and created. Upon opening the primary interface panel and opening the drop-down list of Create a New Panel, display button, navigation chart, image, color block, switch, picture in picture (PIP) and compass creation options will show. Here, the button option is used to create the interaction button.

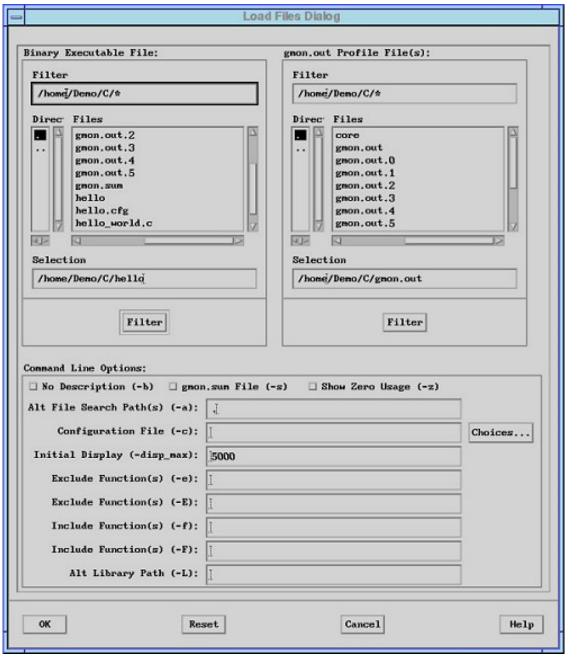

Fig. 3. Primary interface creation panel

4.2. Test Realization and Plan.

In the function test of the unit operator, particulars of the system structure and design are unknown to the operator who will use the navigation system to view each library scenario and operate every reading module and walk in an irregular operation practice manner. Deficiencies are found in the test. Debugging and modification are given to such deficiencies. The test plan and results of the virtual library display platform system are included in Table 1.

According to the results in Table 1, tests under different scenarios may be realized based on the designed test plan. Solutions will also be provided. The interactive virtual library display platform is fixed. The virtual library models displayed may be replaceable. Three-dimensional models can be replaced for different virtual libraries to meet the requirements of several users and develop a simple model replacement specification. It will be convenient for readers to replace the pattern and related information of a virtual library. It effectively saves costs and duration of development and greatly reduces the cost. Such research results will save much cost for readers once applied to market practice. Also, it will provide readers with a more pleasant and visual book selection way so as to promote the innovation of library reading modes.

Table 1. Testing process and result table of virtual library display platform

Test function	Test method	Test result	Solution
Component function of interface	Visual inspection	Conform to the visual identity principle	None
Component function of interface	Manual operation, test the function of each component	Errorless human-machine feedback	None
Convenience of interface design and user operation	Visual inspection and operation	Button recognition rate: 100%, conform to routine operation practice	None
Human-machine interaction error rate	Repeatedly call the module or close the module in different ways	Quicker responses are obtained by clicking at the initial rate. However, increasing number of clicks may lead to exceptionally low system	System cache, no processing is needed
Scenario test 1	Manual	Absence of stereoscopic impression in book information setting	Words are reflected by modeling, which removes the drawback of an absence of stereoscopic impression in planar mapping
Scenario test 2	Manual	Black edge occurs in the mapping at part of model corners	Return to 3DS MAX to adjust UV mapping, reduce the developed area to be within the effective mapping area
Scenario test 3	Manual	Direction error occurs in book material	Return to 3DS MAX for adjustment, redefine the book from mapping UI
Scenario test 4	Manual	Words of partial books with small spacing will be unclear	Re-bake the material of this portion to 1084dpi
Scenario test 5	Manual	The condition that the path of external exe scenario calls cannot be found exits	Apply VRP release function and package external files

5. Conclusion.

This paper proposes a spatial interaction-based method for design and realization of a 3D virtual reality library navigation platform. Firstly, the library website frame based on the spatial integration concept is studied to achieve a quick view of key information of the library. Secondly, the library navigation platform is designed with 3D virtual reality technique. Thirdly, the effectiveness of the proposed design strategy in library information navigation is provided by the test plan and the results. This platform requires further improvement in terms of the service environment. Major technique barrier lies in existing network environment. Three-dimensional roaming has high display requirements, while it may be difficult for existing network environment to meet the image display requirements of three-dimensional virtual roaming.

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