The Construction Foundation and Function Design of the Virtual Tourism Teaching System of the Forbidden City

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Abstract. The virtual tourism teaching system of the Forbidden City is a tourism teaching system developed and produced by the author using GB3DEngine and other software. It can be applied to both tourism and teaching and even scientific research. This paper discussed the technical problems in the system construction and function setting, and the core problem of the construction is data acquisition and fine modeling. The core issues of function setting are fast browsing, information retrieval and interaction. In this paper call for the focus on openness and serving for human production among the large-scale true three-dimensional virtual reality systems.

Introduction

For the tourism and teaching needs, the virtual tourism teaching system of the Forbidden City was constructed. This is a set of advanced, efficient and scalable travel experience and teaching system based on the combination of true 3D virtual reality technology and panoramic multimedia technology. According to the on-site data collection and recorded data file, the whole picture of the Forbidden City is displayed to realize the real-life interactive simulation of tourists in tourism. It can also be used for teaching, to improve the quality of teaching and to train students' professional skills, and to stimulate interest in learning.

The research team of this paper used 3DsMax, Super3DEditor and GB3DEngine to design and construct the "Tiantan Virtual Teaching System", "Confucius Virtual Education System", "Guozi Supervisor Virtual Teaching System", "The Forbidden City Virtual Teaching System", "The Ming Tombs Virtual Teaching System", "The Summer Palace Virtual teaching system, "Honghe scenic area virtual reality", "Pingyao County virtual reality" and other systems have been functionally designed, At the same time related scientific research work has been progressed.[1-5]

System Application Environment

The system can be used in stand-alone applications, or can be used with large-screen multimedia projection systems and touch screen systems. The system clearly displays the magnificent architecture, beautiful scenery and real environment of the Forbidden City to the tourists, so that more tourists can contact the Forbidden City at close and multi-angle. If used as a teaching software, it can strengthen the teacher's teaching demonstration effect, which is conducive to students' correct understanding and mastery of the Forbidden City knowledge. Students can practice repeated simulations through the system alone, and then go to the Forbidden City to practice internships, which greatly improves teaching efficiency. Thanks to the virtual reality teaching system, students are completely learning in a novel virtual environment, which also stimulates students' interest in learning new technologies.

This system should be equipped with large-screen multimedia projection system to show the best application effect. The system includes: spherical ring curtain, control instrument, system integration system, multi-angle projector, main speaker, subwoofer, feedback speaker, console, Audience seats, lighting systems, etc. (see Figure 1). Stand-alone and touch screens require CPU frequency, memory, and graphics memory to be the higher the better, the recommended CPU frequency is 4.2GHz, memory is 8G, Graphics memory is 5G, and monitor is 27 inches or more.
The Foundation of the Virtual Forbidden City

Foundation Technical Route

The basic data of the virtual Forbidden City includes (1) the basic topographic map of the scenic spot (2) aerial photographs or satellite photos of the scenic spot (3) the live photo of the Forbidden City (4) related architectural design drawings or other design materials (5) historical and humanistic materials of the Forbidden City. According to the actual situation of the Forbidden City, data collection methods are determined, and some data need to be digitized.

The technical route for constructing the virtual Forbidden City is mainly: data acquisition → data processing → model making → texture making → effect processing → data synthesis. (See Figure 2)

System Content

All external scenes in the Forbidden City are constructed, and internal scenes are suspended due to objective conditions. The main system construction areas include: city wall, four city gates, moat, three front halls, Wenhua Hall area, Wuyingdian area, Housangong, Neixi Road, Neidong Road, Waixi Road and Waidong Road. According to remote sensing images, the location, shape, area, land use, and overall layout of the Forbidden City are obtained. The attributes of buildings, bridges, walls, roads and other building units are obtained as well. Target elevation and terrain information is also needed. Make full use of remote sensing technology to obtain the most detailed information, and note that remote sensing images are greatly affected by time. Make full use of the scene framing, but pay attention to the fact that the scene framing is more affected by time, weather and
factors. The overall and partial high-definition images of the Forbidden City obtained through remote sensing satellites (see Figure 3).

Figure 3. The overall and partial high-definition images of the Forbidden City obtained through remote sensing.

Software Foundation for 3D Data Construction

The core technology for building a virtual system is the creation of a three-dimensional model. This is the most cumbersome and meticulous work. A large number of three-dimensional models are required for the buildings, terrain and environment in the virtual scene of the Forbidden City. The following is a part of the application software.

3dsmax is the most common tool for building 3D models. GB3DEditor provides a 3dsmax plugin to fully export the models built in 3dsmax. GB3DEditor supports most of 3dsmax's material properties, including baking textures for multiple sub-materials, and supports particle systems in 3dsmax. GB3DEditor completes the 3D model data processing and processing functions, and completes the dynamic update of the 3D data scene of the Forbidden City.

ArcInfo is a mainstream GIS tool, mainly used for data acquisition and data processing. GB3DEditor can convert 2D or 3D data in shape format to GB3DEditor, and support text annotation, and support fast export of points, lines, faces and polygons. The combination of DEM (Digital Elevation Model) and aerial image (Guardian Map) can build a wide range of multi-level 3D terrain (similar to Google Earth). GB3DEditor can automatically splicing and cutting DEM and aerial images to four. The fork tree approach creates 3D terrain data with spatial index relationships. There is no limit to the amount of data supported, and this method can be used to construct 3D data of the terrain of the Forbidden City. The data organization of the tree relationship is expressed by different types of nodes. The data node types in GB3DEditor include group nodes, position transformation nodes, detail hierarchy nodes (LOD), file-based PagedLOD nodes, selection nodes, lighting nodes, animation nodes, geometry, feature nodes, etc. Different types of nodes need to complete their own data organization and rendering operations to maintain an efficient data management structure.

Figure 4. 3dsmaxDataexport interface. Figure 5. GB3DEditorData Synthesis interface.
A variety of data compression methods were designed based on different data types when building the system. For example, the triangle strip optimization representation method is to continuously record the vertices on the geometry with a vertex as the starting point, and form a triangular surface according to a certain rule to improve the storage and rendering efficiency. In image compression, the currently implemented compression ratio is 1:8, and a higher ratio compression algorithm is being developed. GB3DEditor provides a "what you see is what you get" way to edit 3D model software. The data window of GB3DEditor displays the tree organization relation of model data; Property window displays the property (material, etc.) information of the selected node; Render window to 3d rendering engine display 3d scene; Edit and modify of data organization tree nodes and their attributes are directly reflected in the rendering window; The data node and the rendering window interact in real time. Camera properties affect rendering, supporting a variety of different camera type properties and flexibly edit automatic roaming paths and save, even flexibly define camera collections (viewpoints) and save them.

System Function Design

Virtual Roaming

The virtual reality travel teaching system of the Forbidden City is based on the ActiveX component of the 3D rendering engine (GB3DEngine). It is driven by the knowledge of 3D attractions. Users can input the knowledge of the listening to the database. Teachers can also input knowledge in the system. It can fully meet the teacher's needs for three-dimensional attractions in the roaming database, and the teacher can be authenticated by the system on any computer, and the system can access the 3D attraction data arbitrarily. At the same time, they can query and retrieve all the data content of the travel database, and edit the preparation content. The virtual roaming interface (see Figure 6) is controlled by the mouse, keyboard, and gamepad and can be switched at any time.

The information about the Forbidden City is very much, and it is also specific to each attraction. The course knowledge to be taught can be stored in a spatial location relationship. When roaming here, you can query the relevant knowledge here. The knowledge can be text, pictures, archives, and documents all stored in a database in a multimedia manner for quick browsing and query. Quick browsing and query interface (see Figure 7).

![Figure 6. The virtual roaming interface.](image)

![Figure 7. Quick browsing and query interface.](image)

Virtual Roaming Control

The user can flexibly control the movement and rotation of the scene (camera), and simulate the movement of people moving forward, backward, turning, looking up, bowing, etc. in a three-dimensional scene. It is supported by a variety of peripherals (mouse, keyboard, game handle) operation, and other extended peripheral programming. The user can jump or fly to where they want to go, creating an immersive experience. It support a variety of stereoscopic modes (red, green, left eye, right eye, left and right split, up and down split) viewing, and active or passive stereo display. It also support for a variety of devices stereo display (usually using polarization). The rendering engine has basic functions such as 3D model data reading, rendering, and camera manipulation. It also includes extended functions such as spatial query, spatial analysis, geometric correction, and
edge blending to provide custom-specific applications in the form of ActiveX controls. The GB3DEngine rendering engine supports a variety of GIS data sources and can be well integrated. The GB3DEngine ActiveX control has a complete SDK development instructions. Based on this project, the project software can be used for orderly integration of the data of the Forbidden City. Teachers can edit, maintain, and use the various materials of the Forbidden City in a three-dimensional subsystem.

**Automatic Explanation, Scene Recording and Information Inquiry**

Record the historical and cultural knowledge of the Forbidden City, or even explain the video, then insert it into the system in the format of audio file or video file, and use it in the automatic roaming path and information query interface to play the recorded video and audio files. It allows visitors and students to listen and explain while browsing, and can switch between manual mode and automatic mode at any time. The tourism immersion is enhanced and the teaching effect is greatly improved. Automatically explain interface (see Figure 8).

![Figure 8. Automatically explain interface.](image)

The system also supports the user to start the recording and recording system during interactive roaming, record the scene picture, explain the sound, the environment background and other information in the virtual scene, and burn it into a disc for backup. The three-dimensional subsystem query function of the scenic spot information is powerful. For a certain landscape, all the information of this landscape can be displayed separately and conveniently used.

**Conclusion**

The system is a true three-dimensional virtual reality system with realistic scene, and the information can be accessed, which is convenient for tourists to visit as well as for students to learn. The technical requirements are extremely high, requiring the builder to be careful in modeling. The model is realistic and reasonable in proportion, and the data collection is real and the texture map is exquisite and meticulous.

The virtual reality tourism teaching system of the Forbidden City has powerful functions, sensitive response, reasonable design, convenient and quick interactive performance. Tourists or students can master the operation of the system in a very short time. They can focus their attention on the content of the virtual scene, and fully appreciate the fun of virtual tourism. However, limited by the site, equipment and personnel quality, video is still recorded along a certain path in the popular application process, and then dubbing and music playing are performed. This is a very helpless but realistic use method.

Large-scale true 3d virtual reality should be open, it can exchange and transform data with many other formats, and different systems should be able to connect with each other, so that they can truly serve for human production and life.

**References**


