Design of Core Modules on Three-dimensional Roadway Engine

Zhou Hong-bin¹, Liu De-jian², Wang Yu-kun³
¹ Wuyi Macro link Gas Limited Company, Jinhua, China
Email: 691334921@qq.com
² Institute of Computer Science & Technology, Henan Polytechnic University, Jiaozuo, China
Email: liudejianw@163.com, wyk@hpu.edu.cn

Abstract—In order to raise the development efficiency and quality of three-dimensional tunnel roaming system, the paper utilizes object-oriented technology and underlying graphics interface to design three-dimensional graphics engine which can be applied in the three-dimensional laneway roaming system and other virtual reality systems. The paper proposes common framework model combination of object-oriented design patterns, focusing on the design of core module of the engine. The simulation results show that the three-dimensional roadway based on engine pattern has higher degree of simulation and faster speed of roaming.

Index Terms—three-dimensional roadway; engine; core modules; design patterns.

I. INTRODUCTION

With the rapid development of virtual reality technology, high-realism, realistic three-dimensional nature of roadway roaming systems have become an urgent requirement for the industry and academia. Prior to research three-dimensional roadway roaming systems, mostly based on OpenGL, DirectX and other low-level graphical interface modeling and rendering mode of implementation. This three-dimensional graphics library, in the three-dimensional graphics rendering has outstanding performance advantages. But they were only calculated on the underlying graphics API interface library, object-oriented operational relatively poor. If you use these API interface directly to system development, not only require a long development cycle and the efficiency is relatively low, but also the reliability is low and the simulation is poor, the rate of roaming is also significantly low, does not meet the three-dimensional roadway practical requirements for the use of roaming systems and modern software development trends [1]. Therefore, using 3D engine technology can greatly improve development efficiency, is a new means of development and design.

Although the three-dimensional 3D engine technology developed fast at home and abroad, there are a lot of 3D products, but the cost is high, and the target is poor, it is difficult to find suitable systems in the development of three-dimensional roadway roaming products. Therefore, building a Three-dimensional graphics engine basic on graphics functions, application-oriented, modular is the key to develop the virtual reality Navigation System [2]. This research was designed to achieve the establishment of a subjective and interactive, high-realism and the ability to develop business in the common three-dimensional roadway structure of the engine, to discuss the structural model of core modules of the engine.

II. THE FRAMEWORK OF ROADWAY ENGINE

Three dimensional roadway roaming system is a large software engineering, which is made of by many modules. From developers’ perspective, the roadway engine provides API needed for the roadway developers, which also offers some core libraries auxiliary means for developing. The roadway engine is divided into two parts: engine core and peripheral interface of the engine. The specific simulators interact with the engine by the peripheral interface, whereas the information conveyed is delivered over up to the core to deal with by engine. The peripheral interface is subdivided into the following parts: the input system module is in charge of detecting the input to input device in the beginning of each frame, the results of which are given to the logical decision part of the engine to deal with; the audio system module takes charge of loading, playing the sound and sound effect; the message processing module is responsible for sending the events received to the main control module in the way of messages; GUI interface module is with responsibility for the interface display.

![Conventional diagram of the framework model of laneway engine](image)

The engine core module is subdivided into the following parts: rendering system takes charge of the parts of coordinate transformation, hidden-surface...
removal, illumination and pigmentation, texture mapping and particle system; the physical system is in charge of detecting and responding to simulated collision of physical laws; the resource management system are given to manage the texture resources, the model resources and so on; the mathematics common module provides the points, the vector, the matrix and other three-dimensional mathematical operation. To enhance reusability, expandability and maintainability of the design, design pattern must be used synthetically to design each module. Use Factory pattern to load all kinds of resources; Use Composite pattern to manage the scene and organize resources; make use of Singleton pattern to guarantee the uniqueness of virtual tour characters; make use of Flyweight pattern to realize the resource sharing [3]; make use of observer pattern to realize the event processing and message routing. The general framework of roadway engine as illustrated in Fig.1.

III. CORE MODULES

By constructing the laneway engine, using object-oriented approach to rendering laneway, you can handle from the geometry level detached work out and instead deal with specific scenes and objects in the scene. In which object includes: movable objects (laneway car, roaming characters), composed of static objects in the scene itself (laneway scene itself), lights, cameras and others. Just putting the object into the scene, the engine will complete mess of the geometry rendering treatment to out of dependence on the API. Scene management module, rendering module, file system module and the main control module complete most of the functionality, are the core modules of the engine [4].

A. The design of the roadway engine’s scene management module

Scene graph in the graphics engine, the position is without doubt, it not only provides space for users to find and search for objects provide high-speed optimization, but the need for rendering library, it provides the search, sort and remove function. Sometimes also used for collision detection. In some specific design inside, scene graph can even be used for all subsystems, such as voice and physical systems may rely on a scene graph to achieve the corresponding functions. OGRE reference in the laneway engine solution, discard the traditional design method, using a scene graph and scene design from content, the scene graph structure and its use of data nodes as equal inheritance system.

1) Scene graph structure

In the laneway engine we use the scene node to organize the laneway scene content; the scene node is the actual transforming elemental area in the scene. The scene node has own connection level (to have a father node and certain subnodes), the node operation supports three kind of different coordinate system spaces: World coordinate space, father node space and own space. Therefore, in the move, rotate, zoom, they can choose to use the coordinate space. Scene node can exist independent of the scene graph, where the scene shows the contents of independence and the benefits of scene graph: the content will not be affected by a specific scene graph; it can be re-attached to the other scene graph. Scene graph of the Scene management module is in Fig.2.

In the laneway the concrete scene content needs to hang in the scene node to be able to display. The scene content has interior equipment, including: guide rail, car, and transformer substation and so on. Abstracting scene models to specific classes for the Mesh, Mesh class inherits entity (Entity Class); the entity inherits the active object (MovableObject), and created through the scene manager. After the scene content founded, binded to the scene node which already existed. When the scene contents attached to the scene node, you can use the scene node to manage the entity, and by changing the content of the scene node to change the scene. Scene management module in the integrated hierarchical graph is in Fig.3.
Through constructing the SceneManager classes in the laneway engine, SceneManager class is the core class in the Scene management module, which is responsible for the creation and placement of the moving objects, lights and cameras in the scene, and maintains their travel in the scene graph and transform; Loading the laneway map of the whole model; on the scene to support queries, and will remove invisible objects and push visible objects into the rendering queue; According to current and exaggeration object perspective drawing, Organizing and sorting (by increasing distance) unidirectional lights from the perspective of the current renderable; Setup and rendering of any shadows in the scene, passing this organized content to the render system for rendering. According to the processing mode in OGRE, SceneManager class and interactive rendering system can complete the updating and rendering scenes. As the laneway level of detail of different scenes in different locations, different levels of focus rendering, SceneManager class abstract the interface, the specific details of the level of scene management to achieve by the sub-class, SceneManager realizes applies the Template pattern. SceneManager class of the Scene management module is in Fig.4.

B. The design of the roadway engine’s rendering module

1) the overall structure of the Rendering system

Rendering module is one of the most important functions to complete the model of the engine; it can finish model, animation, lighting, special effects and other comprehensive and display effect. In the laneway engin, renderTarget class is responsible for receiving the results of rendering operations, which can be a window on the screen can also be packaged FPS statistical information and also responsible for creating and maintaining Viewport. Viewport is a rectangular area; it is to get the contents of the mapping from the camera to render the above objectives. In the same render target can contain one or more viewports. Camera connects rendering and scene management system, inherits from MoveableObject and Renderable inSceneManager. RenderSystem is responsible to exaggerate system's supervisory work, is defined as the abstract class, and the realization is completed by subclass through the graph API, realized with the Template pattern in Fig.5.

2) Rendering flow

Rendering system and scene management module with the main control module complete the updating and rendering scenes. After the MainControl initialization completes, it calls StartRendering function to enter the message circulation, and then through the message system realized by the observer pattern and the responsibility chain pattern, calling UpdateAllTarget method in the RenderSystem to update all the RenderTarget. RenderTarget through the Update method to update all of the Viewport. Viewport and then calls the associated rendering method of Camera, then program is into the SceneManager's RenderScene method, through the calculation of the rendered scene to RenderSystem do real rendering.

C. The design of the roadway engine’s main control module

The main control module is in the core position in the system, driven by the message system ongoing implementation of the event logic processing and rendering, completes 3D scene rendering and moving objects. The main control module is the entire laneay engine's outward appearance class (realizes with Façade pattern), may call each sub-system's interface in the engine through it; engine can be opened and closed by MainControl class, when the construction started the engine, the destructor method shuts down the engine. Processing message loop and dispatching events, the master control class realize with the SingleTon pattern, to ensure there is only one object and provide global access points [5]. Sequence diagram of the main control module is in Fig.6.

IV. CONCLUSION

The engine has played an important role in software development system; this paper builds an overall framework of the three-dimensional roadway system based on engine pattern to detach the reuse of code and modules in the systems so as to provide common solutions for the development of three-dimensional roadway system. Systems integration uses various design patterns to ensure system scalability. The paper focuses on the most important modules-the rendering modules...
and the scene management modules and main control module.

ACKNOWLEDGMENT

The authors would like to thank School of Computer Science and Technology in Henan Polytechnic University for their sponsoring to the subject and all the numbers helpful for my paper.

REFERENCES


