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Simulation of Earthworks Based on EON , 3DS Max and AutoCAD

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Abstract: In view of the earthwork construction with long duration , heavy and complicated construction conditions , and earthworks cannot be verified , using virtual reality technology to simulate the process of its construction. As a hydropower project for an example , the terrain model using AutoCAD and 3DS Max combination of building , equipment model in 3DS max using entity model building. In the transporting section , will be built in 3DS max key frame together with the model of import in the EON and set the parameters of the animation node; In digging scene , using multiple place nodes to control of the excavator digging operation; Interaction part of the scene , using the built-in mouse node (Click Sensor) and keyboard nodes (Keyboard Sensor) implementation scenarios and user interaction. Research shows that through excellent virtual reality software EON to apply virtual reality technology in earthwork construction simulation stage , found possible quality problems and potential safety problems in engineering , through the simulation can be more perfect earthwork construction. Verified , earthwork construction of virtual real earthworks has certain guidance and reference value.

Key words: virtual reality; eon studio; 3DS Max; earthwork

1 Introduction

Industrial and civil construction , first of all is the earthworks , while the earthwork construction with long durations , the characteristics of heavy and complex construction conditions of labour , its ease of construction , are directly affected by topography , geology , hydrology and construction season and the effects of environmental factors around the construction site.

The overseas study on the virtual construction technology is a hot issue ^[1-2] , Reseracher in Strathclyde University of Information Science and the Department of Civil Engineering studies the synergistic interaction of the construction process visualization program; Al-

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bert University of Simaan AbouRizk , who develops integrated construction management system-Simphony , used for civil engineering construction organization and management; University of Dundee Naives project designers want to allow roaming in the structure , a role of the observed performance and the simulation execution of this action , in the process while continuously watching the message; United States National Institute of standards and technology building fire research laboratory (BFRL) Vineet R. Kamat and Julio C. Martinez , discrete-event simulation (Discrete-Event Simulation) methods for excavators , tower cranes and road construction machinery such as cranes were three-dimension dynamic visual simulation; Prasant V. Rekapalli and Julio C. VITASCOPE + + three dimensional animation system to validate the simulation system of earthwork; Robert A. Rodgers^[3] schedule using 4d-CAD J space Simulator.

A few domestic studies on this aspect , there is less mature software system. Zhang Xi-qian and Shi Yi , Shanghai Zhengda square steel structure hoisting construction scheme of virtual simulation system of virtual construction created a domestic precedent , most of the domestic researches are water conservancy system , and specific studies are as follows: Zhong Deng-hua^[4] et al study on the construction of the hydropower system simulation; LI Guo-cheng , Wang Jing-Tao^[5-6] complex structures to study the construction of a virtual realize how complicated construction in a virtual environment simulation , optimization of the construction plan for the construction and training of personnel; Most of these are no studies on a particular research project suitable for virtual reality simulation system on earth excavation and transportation scheduling and software used mostly for their own development , and therefore , this article will use the generic virtual reality software Eon Studio to carry out research work excavation and earthmoving equipment scheduling.

How to improve construction efficiency , so that the construction process more orderly manner , which is the construction of earthworks need to be resolved. The following four aspects from the virtual construction of earthworks transport system in detail , namely to build (terrain and device model) model , animation production (3DS max key frame technology) , import (import and model using the menu EON dedicated plug-Eon Raptor) , earthworks and construction.

2 The construction of model

2.1 Construction of terrain model

Method is to use AutoCAD generated terrain contour generated terrain in 3DS Max , specific steps are as follows:

- 1) The DWG format terrain file open , the extra layer deleted , only the Contours , these contours reclassified by elevation layers , save;
- 2) In 3DS Max IMPORT the saved DWG files;

3) Since the DWG file import is flat , then according to the layer name and select a different elevation contours , Z direction to a predetermined elevation;

4) Select all the contours , choose terrain button in the compound objects , you can get a three-dimensional terrain. Converts three-dimensional topographic to quadrangle , save for the.3ds format.

2.2 Equipment model building

3DS max8 is excellent three-dimensional modeling software. In 3DS Max , the construction method using solid models were established excavators and car models , and save it as x. max (or x. ds) format for used by EON (x. ds format can be directly imported into the EON) imported by way of the menu.

3 Animation productions in 3DS Max

Animation based on the principle of human vision , which quickly sees related series of still images , you will feel this is a continuous animation , definite for each image as frame.

3DS Max animation can be created for any parameters in the scene; you can also modify the animation parameters , material parameters for animation. The formulation of the animation parameters , the renderer for shading and rendering each key frame work , so as to generate high quality animation.

Animation realization process is divided into the following three parts:

- 1) Excavator digging , and make the earth into the truck;
- 2) The drained soil transported to the waste soil site;
- 3) Vehicles fitted earth return point , the first step in re , and so on. Until the completion of the project.

First , in order to facilitate the study of the earth to simplify the construction process , the earthwork construction animation is divided into three parts: the installation of soil processes , transportation , as well as the return process. Used in the transport process in

3DS Max method to establish the key frame animation, and then import the information into the EON in the returns process established by methods consistent with the transport. For loading process will not be able to use this method, you need to set in EON, specific method will be described in detail in the following content, is not described here.

4 Model import

Virtual reality environment not only gives a three dimensional graphic display, interaction can be achieved, and the reality of the environment more realistic. Eon Studio software for use in this article, it is a fully GUI-based design tools; you can easily import a variety of 3D models. After importing the model, you can use EON intuitive graphical design interface and easily add behavior for the model. As a good virtual reality software, integrates a number of controls within the software and sites for your use, as well as to adapt to different areas of application development, it also has the scalability, users can establish their own control, and support for this programming, allows software to be extended^[7]. Eon Studio supports importing x. ds file is divided into two ways to import, import the x. ds file from the menu and use of Eon Raptor plug-in to import x. DS files. The import method is as follows:

4.1 Format 3D Studio file menu import

In this article, because of the terrain data is large, when inside 3DS Max export data for x. DS, 3DS Max tips to the huge, export failed. If the terrain segmentation, are derived respectively, in the EON implementation, the terrain piecing different parts together, and the process of the error and the workload is very big, therefore, this paper use another method, namely the use of plug-ins for Eon Raptor to import the 3D file format.

4.2 The use of plug-ins (EON Raptor) into the 3D file format^[8]

EON Raptor is a 3DS Max and Autodesk VIZ plug the

VR program, you can browse the large and complex real-time 3D content, not on the basis of any programming language can create their own VR program, and published to the web in a very short period of time, whether it is online publishing or burn a CD all at no cost.

Using Eon Raptor steps here:

1) The first production model and animation (complete model and establish key frame), textures, etc. may also be included in 3DS max;

2) In the use of EON Raptor to browse at any time during the process of producing results;

In 3DS Max choice "EON Raptor Web Studio Raptor Window", can see in the Window that displays import EON in the picture, and then select "Save As", file storage into x. eon format. When modifying the 3DS max content, select "Refresh" to Refresh the display in the window, so that when the appropriate to save again.

3) Using the operation easy wizard to convert 3D files into interactive content.

5 Earthworks construction based on EON

The project to develop a hydropower project as examples, the main part of the project required materials mainly come from the concrete aggregate. The total construction of permanent buildings and temporary concrete reservoir approximately 478 km^3 , calculated, to all levels of finished aggregate $1090 \times 10^3 \text{ kg}$, which coarse aggregate $720 \times 10^3 \text{ kg}$, fine aggregate 370 km^3 .

Elevation of 884 m RCC arch dam, the top width 8.0 m, height of the dam is 98.5 m. The total amount of earthwork excavation of 670 km^3 , 378.4 km^3 of roller compacted concrete dam, concrete and reinforced concrete pouring $93\,000 \text{ m}^3$, consolidation grouting of 23 km, curtain grouting 19.5 km, mainly in mechanical construction. Excavator type of equipment is Carter 320B excavators, truck is Dongfeng car. Men-

tioned earlier , the animation setting mode of soil process are different from transports. This section will in detail the construction process of the three dimensional animation ,specific content is as follows:

5.1 Transport scene

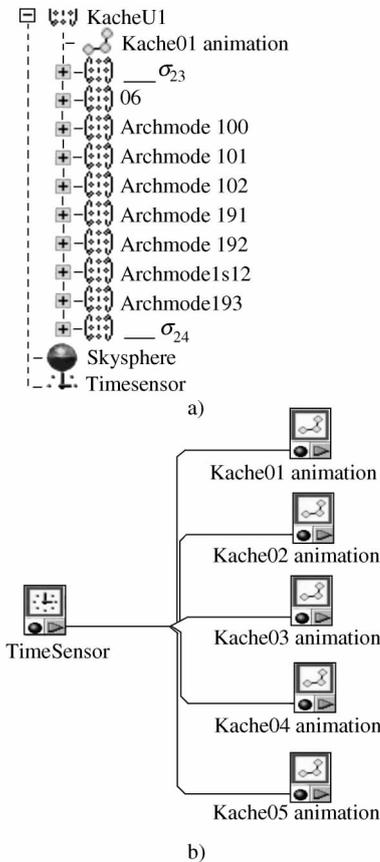


Figure 1 A truck simulation tree and TimeSensor Logical structure

After importing the EON model can be found in the simulation tree node , by setting the animation nodes of each car model parameters make the animation to run in the EON. Parameter is set to “Active” to “Yes” (by default the value of this parameter is “No”) , the executive will display in the EON dynamic transport scene. If you need to control the transport animate scenes at what time , you can add the clock node “Time Sensor” , controlling animation with “Time Sensor node”; or by adding “Click Sensor” and “Keyboard Sensor” nodes to implement , such as mouse clicks and keyboard controls during transport , realizes in the EON the scene transported in an interactive animation of the scene (As shown in

Figure 1 and Figure 2) . Meanwhile , to add to the scene will look , so not too obtrusive, “Sky Sphere” EON Environments can be used for a class of components ,display shown in Figure 3.

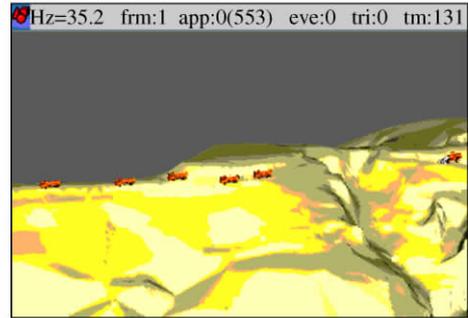


Figure 2 Transport Scenes

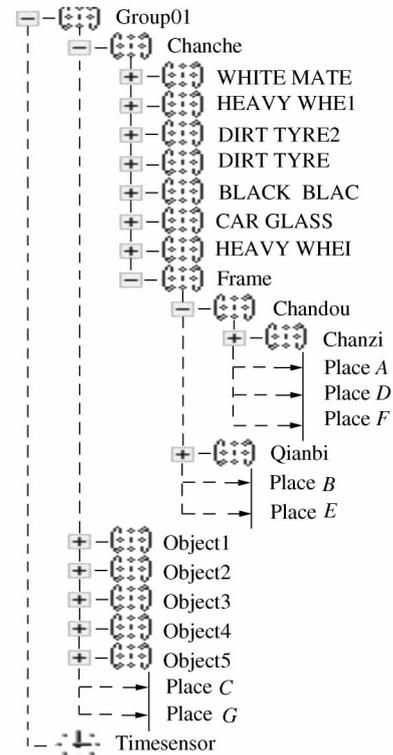


Figure 3 Excavator simulation tree

5.2 Scene of soil

The animated scene is relatively complex and cannot use the max key frame import EON way to operate , need to move to move to the parameter to adjust the direction of movement of the parts to create and set Place node below the node movement and time angle (or distance) , and timing of movement (i. e. , the

movement speed). At the same time, the need to place the nodes can be placed below a node setting operation, therefore, the digging operation of the excavator, is in fact the result of a plurality of members of the plurality of actions executed sequentially obtained. Therefore, the use of multiple place nodes and by the continuity of the operation, so one place to another place node may trigger node. Specific tree structure shown in Figure 4 and logical relationships between the places of the node is shown in Figure 5.

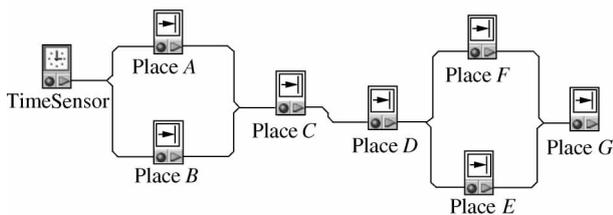


Figure 4 Place node and TimeSensor logic diagram



a)



b)

Figure 5 Excavator keyframes

To control the construction in the animation system to add a clock node schedule, by setting the parameters of the clock node enables the construction simulation

according to the predetermined time. If in the process found in the construction process is too slow or too fast, the parameters and place nodes can modify the clock node. If you want to on the image of the pause, you can use the “Click Sensor” node and the “Keyboard Sensor” node operation.

5.3 Extended animation

The previous section completed by adjusting the clock and control node to adjust the transport process of animation to add the mouse and keyboard. This is the most simple interaction process; interaction is the biggest difference between virtual reality and 3D systems in general. In the virtual reality system, through the interaction between man and virtual environments, can give people a feeling of being there, and thus give guidance to build a real system.

EON development environment supports both Java script and VB Script scripting language features of secondary development, improves flexibility and practicality; EonX controls can be embedded into the browsing the EON control used in high-level programming languages published documents, it defines the TControl2 class provides the methods of a class, can pass through the object class definition to use these methods to achieve with the EON in the Script interaction. In addition, Eon Studio also has its independent development package of EON SDK; it can combine with VC++ to develop new function node or module [9].

6 Conclusions

Many problems in the process of construction, in the virtual environment for earthwork engineering simulation based on virtual reality technology, to find possible problems in engineering, the virtual reality system interactive nodes by EON own realizes interactive, a guide role for project implementation. With the deepening of the research, in the future will further the advantages of using EON to realize manual control of the construction process, to adjust the construction

schedule , construction layout optimization objective. Thus the more intuitive perspective to help solve problems in construction of earthworks. Optimization strategy of earthwork construction will be detailed in the subsequent papers , this thesis will not were introduced in detail.

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Brief Biographies

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