VIRTUAL REALITY AND ITS ELEMENTARY APPLICATION IN THE SLIDE ANNIMATION OF LANDSLIDE

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ABSTRACT:
Virtual reality is a appreciable body which has vision, hearing, feeling and smell by using computer, it is a hotspot recently. There are few research that using virtual reality in the field of landslide. I think it has signification to combine the physical-based deformable method and the simulation to a slide landslide, which can really simulate the dynamic process of a landslide slide, observe the active way, analysis dynamic rule, provide foundation to forecast and make it became reality to foretell the disaster.

KEY WORD: Virtual Reality , Animation , Landslide

1. INTRODUTION

VR(Virtual Reality) is a popular term used for computer-generated 3D environments and was first put forward in the paper entitled “Ultimate Window” by American scholar, Ivan Sutherland in 1960s. In the paper, the virtual world was supposed to be established in the computer environment and could be observed, heard and felt like real by user through the windows in computer screen.

With the IT developing for tens years, especially with the help of computer technology, computer graphic and related sensing technology, great progress has been made in the VR field and it has also been successfully applied to some fields. Landslide is a main part in the field of the geological hazard, it is a complex variety process. But the research is focus on the quiet landslide recently. Using VR, we can simulate the dynamic process of a landslide glide truly, observe the active mode and analysis the dynamic rule, those will provide foundation to forecast and make it truth to foretell the landslide disaster.

2. PRESENT CONDITION ABOUT VIRTUAL REALITY

Virtual reality often refers to the computer-generated virtual environment in which user can naturally interact with the computed-generated entities through i/o devices such as HMD, data glove, data coat, 3D mouse and so on. What’s more, we can nearly not tell the distinction between the virtual world and the real world because it feels like very ‘real’.

It should be acknowledged that the VR is the integrated product of many techniques and will be growing up with the IT developing. It consists of three basic features (Burdea G): immersion, interaction and imagination. The meaning of the immersion refers to the phenomena that the user interacting with the computer-generated virtual world believes that he lives in the real world. The concept of the interaction means that user who is interacting with the computer-generated 3D environments can give impact on the virtual world through input device and on the contrary he is

inevitably affected by it through output devices. Additionally the imaginative term shows that designer can express his idea in the more lively, more hyperbolic and more fancied way.

The components of the virtual reality include hardware and software from the point of technique. Hardware is described as above and the software is composed of the dynamic modeling technology, real-time graph generating technology, developing tools for application system and multi-system integrated technology. And dynamic modeling and real-time generated graph can be accomplished by using application-system developing tools for graph-modeling purpose. There recently are some popular developing tools such as VRT of the Superscape Inc, WTK of the Sense 8 Inc and MultiGen of the MultiGen Inc.

VR system is composed of the virtual-environment generator and human-machine interface. The virtual environment generator mostly refers to the application software and database related to virtual environment.

VR has very extensive application prospect. Originally it is applied in military field, VR technology has been extended in many fields such as medicine, entertainment, manufacture, commerce, education, communications and so forth for the passing 20 years. At present it is mostly focused on the military, medicine, manufacture and entertainment.

The VR technology was firstly used to train pilots in military field. In the way, pilots can feel as they do in real world and the cost will decrease greatly and the most import is that no injury could happen to pilots. After the success, coming the military equipments like the battleship, tank, missile to the virtual battle field. So it is true that application of VR in military field can train battle-skills of army, examine the function of weapon and help to improve cooperative capacity of army. It is concluded that the usage of the VR can bring about advantages with military field.

In addition to military field, the VR is also applied to the medicine. Some new terms like virtual operate and remote treatment have emerged. Those physicians who are in remote district can collaborate with each other to diagnose and treat patient. The medical training also makes use of the VR technology that allows students to operate similar to the actual operation in the real world. But the specific application of VR in the medicine has been in the stage of experiment, many theories and methodologies have been provided. And great progress of the field has been made in our country for the near years. Furthermore the third virtual human body database was built in our country in 2002.

Virtual design firstly comes to the manufacture. Some big auto companies began to design automobile models with the help of computer around 1960s. P.E.Bezier of the Renault automobile Inc in France built the well-known Bezier curve and applied it to the auto designing filed. The application of the virtual design technology develops from the appearance design of product to the functional measurement, simulation for the past years.

It is in the entertainment that the VR tightly linked with people in the recent years. Computer game has occupied a great part of the entertainment market and grown up from origin

single-machined game that just allow user to play with keyboard to the network game that can be played on the internet and have multi-interactive manner. The computer game based on VR mainly consists of the Driver, Battle and Intelligent game.

2. PRESENT CONDITION ABOUT LANDLSLIDE

Landslide is a phenomenon that the rock of a slope slides along a weak face, and a bad physical geology problem that occurs at mountainous area frequently. Building railway, highway, irrigation works, mine and other digging things will lead landslide. There are other reasons just as earthquake, landslip, flood and rainstorm and so on. It can halt traffic, jam river, destroy plant, and bury village.

The development process of landslide is complex, there are four ages commonly, creepage, extrusion, slippage and concretion. Although the process is clear, the environment a landslide belonging to is different, it is difficult to describe the development instant and shape of every process exactly, which is nodus to research. From the appearance, a landslide often grows by the order of back-edge crack, cut crack and front expand-crack. The relation between the appearance character and the four processes is not changeless, like the front expand-crack, which could happen in the creep process or the extrusion process.

While researching the landslide stability and forecasting, the important effect factors are terrain and physiognomy, stratum lithology, geological structure, hydrogeology, human infection and so on.

The terrain and physiognomy means the height, grade and shape of a slope. From the shape, A landslide where influx surface water and groundwater is easy to slide. Stratum lithology is the physical base to a landslide. Weak lithology is easy to slide than others. The rock near a list of big rupture structure is cracked, which can form crash-rock landslide. Structure frame face can control the spatial distribution of slide surface and the range of landslide. What's more, geological structure decides the type, distribution, state and movement rule of groundwater, which effect a landslide occurring and developing. Hydrogeology is important to landslide too. Most of them happened after the rain. The groundwater and surface water will depress the slide-face intension, bring buoyancy and play down back-slip force. Human action, like digging, makes grade steep, can lead slide too.

These days, researching landslide is focus on the quiet status, the researching way includes stability estimation, repairing and forecasting slide time. There are many methods about the stability estimation, traditional methods involve limit equilibrium method, SARMA method, FEM and DEM. New methods include difference method and DDA. The traditional method like setting landslide-resistance pile and retaining wall is the main way to repair landslide. Because all of above, it is necessary to research the slide process, that can simulate the dynamic process of a landslip glide truly, observe the active mode and analysis the dynamic rule, those will provide foundation to forecast and make it truth to foretell the landslide disaster.

4 . VR-APPLICATION NODUS AND RESOVENT TO LANDSLIDE

Researching the slide process relate to lots of problem by VR. To my point, we can divide the research into two parts, one is the pretreatment of landslide animation, which involves estimating stability, choosing glide face and initializing the landslide. The other part simulates the glide process. The material task is building 3D mode, romancing mode and composite modeling. So the difficulty is initializing, estimating and composite modeling.

4.1 Estimating stability and Choosing slide face

Estimating stability belong to pretreatment is a judge if a landslide would slide. Choosing slide face deciding the scale of a landslide is difficult. Those technique methods can adopt traditional estimating method based on static state, such as limit equilibrium method, SARMA method and FEM. we can combine those methods because of the landslide uncertainty and the advantage of those methods. FEM can estimate the stability and help choose the slide face. Limit equilibrium method and SARMA method can estimate stability, and improve reliability consequently. These methods are mature now, so it is not necessary to introduce here.

4.2 Physical-based Animation Deformation

There are many techniques to realize animation by VR, it can be summarized as keyframe, deformation, process, joint and physical-based animation.

Physical-based animation develops in 1980s. It considers the quality, turning axes and elastic-plastic friction which a object have in the real world. The object would deform with outside force and boundary condition. So the calculating complexity is harder than the traditional animation technique. It has expansive foreground because it can simulate many nature phenomena realistically, and is a hotspot lately.

There are some tries in simulating landslide. The method, keyframe animation, can reappear the slide process, DDA or DEM are good methods to calculate the slide process. The keyframe animation use GIS to landslide data, then produce surface and slide face digital model. A production displays as Fig.1, the landslide slides according to four key factors, then 600 frames landslide shape are produced. The animation is displayed by 3DMAX(Qiao Jianping,2001).DDA and DEM regard landslide body as many little blocks, the block distance and force is correlative, so landslide is a block system, can form a equilibrium equation. Simulating glide process is iterative calculating the block system, operator can research any moment shape by his notion. The research locate at 2D level now, 3D researching is in the discovery period, Jiang Qinhui(2000) and Liu Jun(2002) have research it in our country recently.

Fig.1 surface shape for a digital landslide (from Qiao Jianping,2001)

These days, physical-based deformable animation is researched in the field of cloth. There are not only deformability but also cleavage and welter in the slide process. The early research cannot consider all of this, we can consider landslide as flexible body just like cloth and set up composite modeling combining kinematics and dynamics. Terzopoulos separates a rigid reference-body from the deformable object, and the position of rigid reference-body can be calculated by kinematics. On the other hand, the distance between the object grid-node and the reference-body node can be obtained according to the elasticity theory (1988). Using this method, we can reappear the slide animation of a landslide. FEM and DDA take advantage of realizing concretely.

FEM is a general method to solve elasticity mechanics, belong to the consecutive model, its full name is the finite element method. FEM set the object off a lot of little cell (if it is two dimension, the cell is triangle or polygon; if three dimension, it is tetrahedron or polyhedron), According to the shape, the elasticity and plastic constant, the force the object received and the boundary condition, the model is initialized and concluded the cells' stress, strain and distance.

Firstly, a equilibrium equation of the object can be gained by the least potential energy:

$$KU= F \qquad (2)$$

In the function, K is stiffness matrix, F is the total of physical force, surface force and nod force. The physical force means force distributing in the object (like gravity); the surface force refer to the force distributing on the object surface; throwing on a nod of the object is nod force. U is a unknown vector which is composed of all nod distances. The object inertia and the resistance depending on the object speed should be considered for dynamic deformation. Then there is a equilibrium equation:

$$KU+MU+CU=F \qquad (3)$$

M is quality matrix, C is damp matrix, K is stiffness matrix to the function. FEM scatters the object into lots of cells (like tetrahedron), every cell has some nodes, then calculating those nodes distance by applying the (2) or (3) formula to every node. Using interpolation function, which is selected beforehand, calculates the cell distance and other variables, for example stress, strain and

internal force etc. To FEM, selecting interpolation function, which is used to plot off the cells, is the key step. The cell plotted is often triangle, quadrangle and tetrahedron etc. Most of the time, the interpolation function is a multinomial, which must have n coefficients because the interpolation function has to content the special value of the n nodes to a cell.

The FEM model describes physics characteristic of a object perfectly, and similar to the reality. It is a series model, which is difference with the mass-spring model. FEM is concluded by the series equation, we can get high definition although the number of the cells is small. In fact, applying the strict FEM model is less because the calculation time is very long. To the M, C and K matrix, every matrix has 3n*3n elements, and n is the number of the cells. So pretreatment method is often used. Otherwise, the calculation cannot attain the real-time demand even if the object has hundreds of nodes. On the other hand, although the deformation calculation just need several seconds after the pretreatment, the time spending in the pretreatment will go up rapidly along with increasing the nodes number. For example, the pretreatment to a model, which has 193 nodes, will spend 9 minutes if it is treated by the pentium processor, and spend 8 hours if the node is 1735. So the FEM method is not applicable to the real-time simulation if the topology structure of a object will change or there is a deformation. The M and K matrix will change and they must be calculated again if the object deform very much, while the pretreatment can't be applied and we can not gain the real-time effect.

There is another method named the discontinuous deformation analysis. The theory was established by Dr Genhua Shi in the 1990s. The aim of the theory is to solve the numerical simulation in the civil engineering. The theory can simulate the large deformation and great distance in the case of the discontinuity, it takes distance as unknown, uses the stiffness, quality and load submatrix, and bases on minimizing the total potential energy to set up the equilibrium equation, then analyze the relationship between force and distance of the block system by calculating the structure matrix. On the case of analyzing the block movement, the apply range of DDA is better than FEM and DEM (distinct element method). DDA has the merit of two other methods, it allows that every block cell has distance, deformation and strain, the block system can slide, and there are slide, turn puff and closed between the interface of block cell; it is more flexible than FEM and DEM in the aspect of dividing block, the block form would be any polygon which is bulgy, concave or concave polygon, the block vertex not must contact with other block vertex in the case of the block grid; the distance and deform able mode are same with the structure -matrix analyzing of FEM; what's more, it has other merit which FEM and DEM have not, like analyzing the movement of block system, contacting and embedding way between blocks etc.

In this paper, DDA and FEM are used based on the kinematics, because the thought combines kinematics and dynamics to simulate the slide process of landslide. Which means that DDA and FEM are used to treat the deformation and the movement process is treated by kinematics.

5. CONCLUSIONS

The paper not only makes a description of present condition of VR and the concept and theory of landslide but also provides the feasible way of simulating glide process by VR. Though it is in the first stage, the simulating landslide by VR could be achieved with joint efforts from

experts.

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