

The Construction of Virtual Archaeological Museum

Kensuke UEHARA¹⁾, Kazuaki TANAKA¹⁾, Norihiro ABE¹⁾, Jiang Yu ZHENG²⁾

1) Science and System Engineering Kyushu Institute of Technology

Kawazu 680-4, Iizuka, Fukuoka, Japan, 820-8502

kens@sein.mse.kyutech.ac.jp

2) Indiana University Purdue University Indianapolis

425 University Blvd., Indianapolis, IN 46202-5143, U.S.A.

jzheng@cs.iupui.edu

Abstract

In recent years, VR has become more general technology by fast development of information technology, such as the Internet, and improvement in a performance of personal computers and workstation. In connection with it, VR has come to be applied in various fields. Virtual archaeology is mentioned as one of them. In this paper, we notice the exhibition technology in virtual archaeology, and aim at the free appreciation of remains on the Internet. Here, we show the result of the simple modeling which consider how to display the model on a PC which take up the museum of In Sichuan Ceramic statues Warriors and Horses in China, Hessian. And for the problem of this research, we propose the solution methods, streaming and VR fusion system and the change of the model by visual-angle calculation.

1. Introduction

In recent years, virtual reality (VR) is becoming general technology by fast development of information technology, such as computer networks including the Internet, the improvement in the processing speed of CPU, increase of memory capacity, and improvement in a performance of personal computers and work station, loading of 3DCG Acceleration board. In connection with the improvement, VR has been introduced into various fields, such as medical treatment, city planning, education, entertainment, and so on. Especially, the 3D modelling of the historical inheritance for the preservation and exhibition in virtual archaeology is briskly performed from the following advantages

1. People can see a past state (Original figure)
2. People can see from various directions (Interaction)
3. Without degradation by natural factors (Digital archive)
4. More people can see via Internet (Informational share)

However, generally, this kind of research needs a large amount of capital, uses expensive equipment and many expensive talented persons. The result is commonly available in a company or a government office. Then, if 3D environment can be built as cheaply as possible and many people can share it, the possibility of VR will spread further. In this research, we notice the 4th advantage mentioned above, and built a virtual archaeological museum. As a subject exhibited in the virtual, we have taken up the pit No. 2 of the museum of Qin Shihuang Ceramic statues Warriors and Horses in China, Hsian. This implies that they are not simply restored the present shape, but it restores them still in the state at the time of construction based on references. It aims at realizing 3D environment that makes a user look at this freely and turn around them. The

construction of a museum as 3-demention environment on Internet means extending the role of a museum, that is “many people learn exhibits by appreciating them”. Educational effect is also expectable. Moreover, although there are some home pages that have the same concept as this research, there is nothing that offers large-scale 3D environment. On this point, it is clear that this research is original. When we carry out the modelling of the large-scale virtual space using computer graphics, there are two points as requirements that should be satisfied. They are "realization of rendering speed permitting a comfortable appreciation" and "the accommodation of many object with reality." However, in 3D computer graphics, there is a kind of trade-off between reality and a rendering speed. It is the essence of this research to look for the blending point suitable for the virtual environment on a network, and to satisfy these two requirements.

Here, the construction of 3Dimension virtual space, which requires the display on PC, and introduction of the exhibition methods instead of a real-time rendering are important for the problem solution. This paper explains the technique of the modelling with consideration to the level that can operate on PC. Then, the solution over the problem produced by it is proposed, and the result is described. Furthermore, we propose the exhibition system on one to one, which unite VR and streaming.

2. Modelling

We use iOpen Inventorî made by SGI, 3D object-oriented graphics library, in order to get the high efficiency in modelling. Open Inventor has functions to make tree structural operations easy. So, the changing of a 3-dementional model is easy.

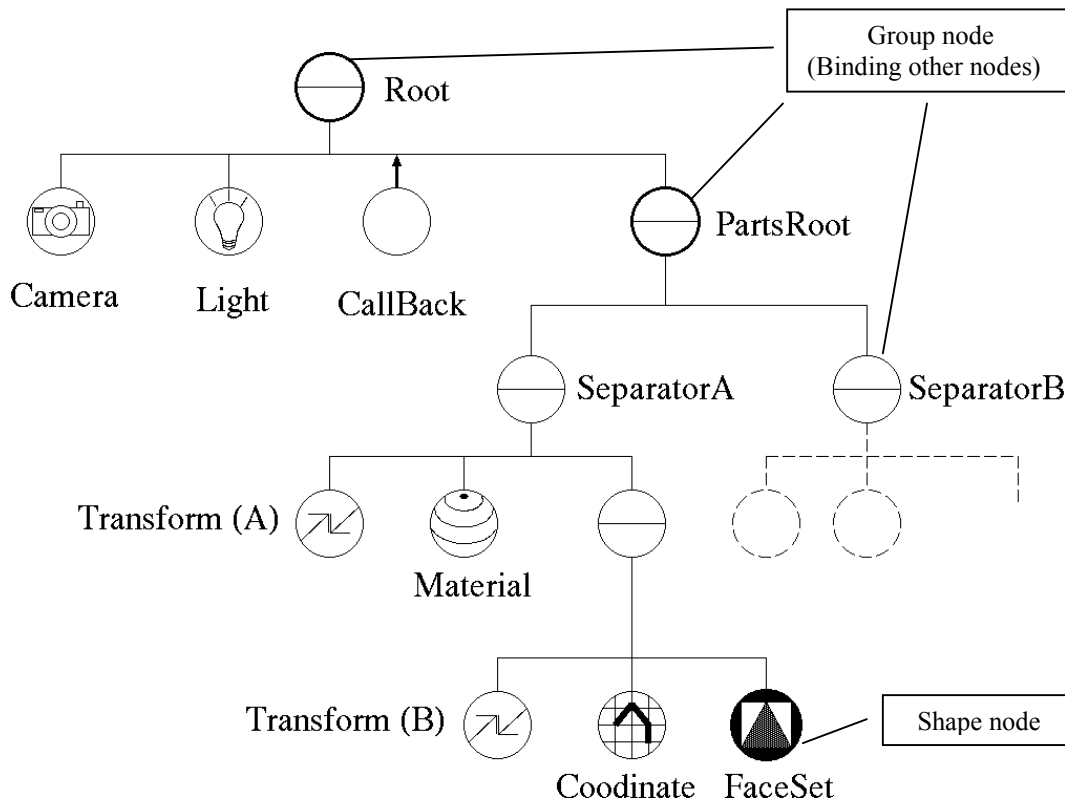


Fig 1. Tree structure

2.1. Subject Matter

We take up the inside of the pit No. 2 of the museum of Qin Shihuang Ceramic statues Warriors and Horses in China, Hsian. The inside has an L-shape structure and the area is 6000 square meters. Various ceramic statues are put in order regularly, such as warriors who had armor on, and battle horses, battle carriages. In order to prevent degradation of ceramic statues, the present pit No. 2, leaves a part, is returned. And cannot see the whole aspect.

2.2. Simple modelling

We explain the process of modelling using Fig 2.

1. The excavation pit No.2 and ceramic statues are modelled by simplifying their shapes. Because of we could not know suited data quantity for display on PC.
2. We make the arrangements of the model of ceramic statues. At this time, We reproduced faithfully the position and turn of models, the width of pit No.2. It is based on the drawing that the scale attached.
3. They are integrated the arrangements, pit No.2 is divided for every domain in which the regularity of arrangement is alike, for making arrangement groups.
4. All models, the pit No.2 and arrangement groups, are integrated, for making a simple virtual space.
5. The reality of warrior ceramic statues is raised.

In each phase, the operation is verified by using a PC and a workstation to the check of operativity sake.

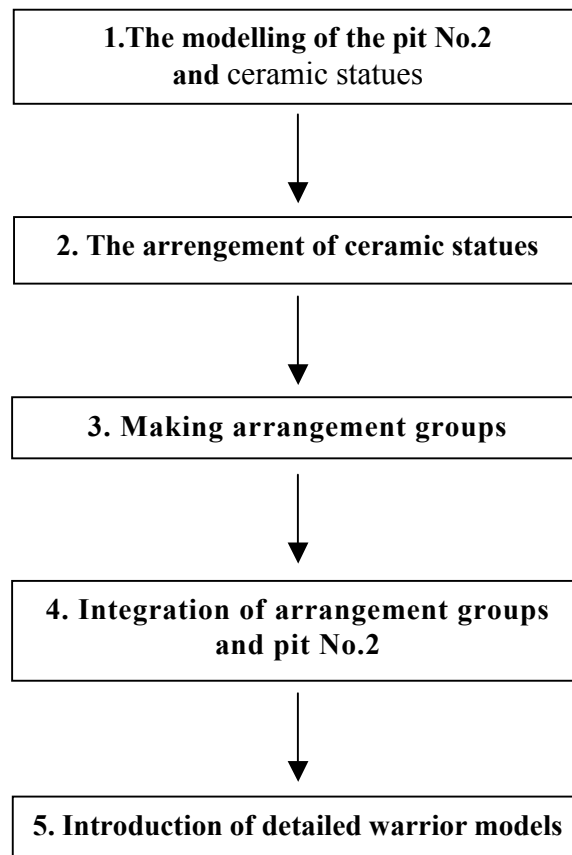


Fig 2. The flow of modelling

Because the data quantity of the whole must be reduced so that it can be treated with PC, the pit No.2 is approximated as a simple hexahedron. Moreover, the data quantity is successfully reduced by approximating ceramic statues with geometric models and changing their colors into monochrome. We attach importance not each shape of models but only position information. As a result, the data quantity was set to about 296KB. The result is shown in Fig 3.

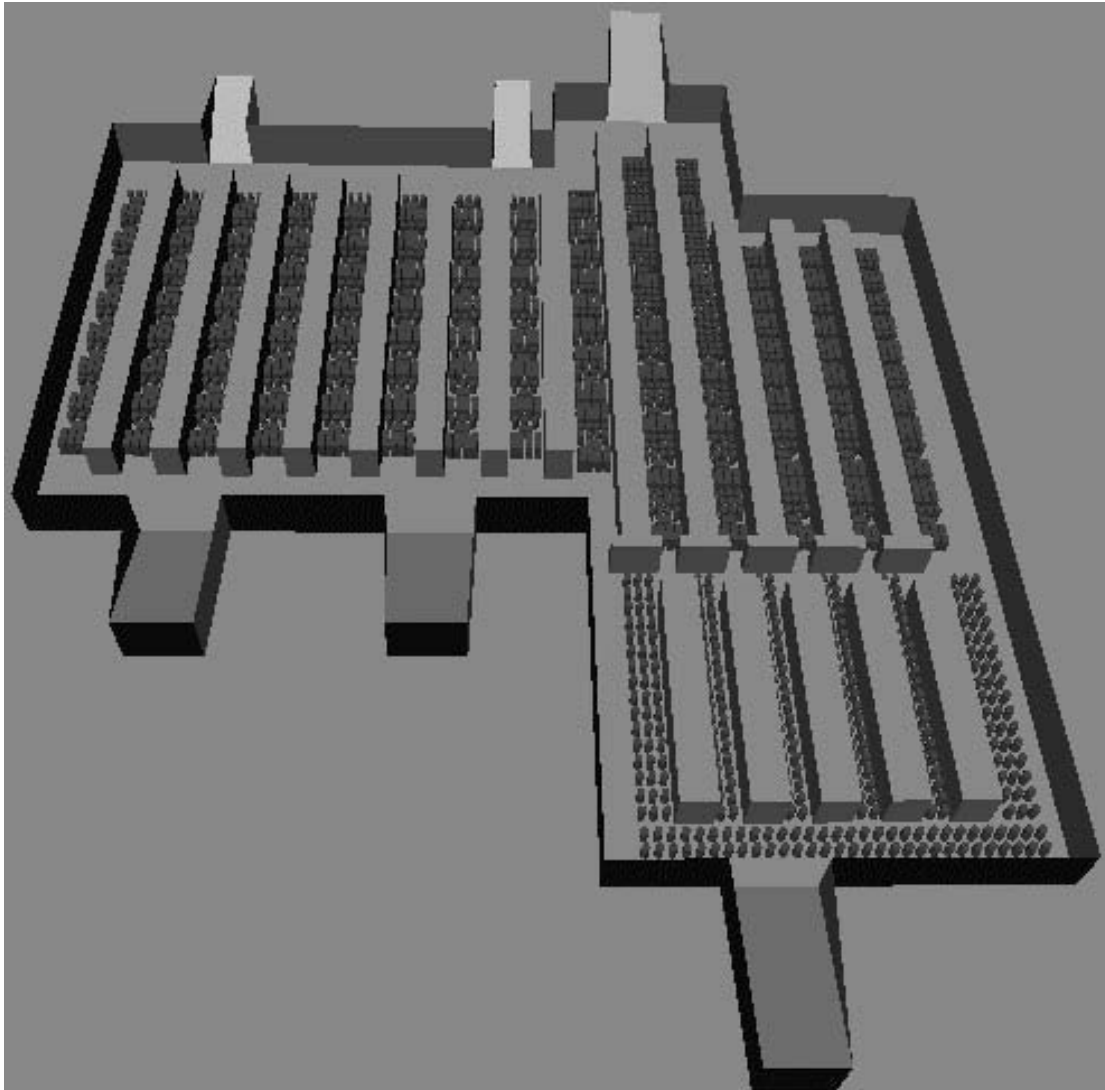


Fig 3. A simple space

2.3. Introduction of detailed warrior models

A detailed warrior model means the one that is faithful to a genuine article. They are made from the coordinates data measured with 3D laser measurement. Thereby, Our museum can attain more realistic virtual space rather than it makes models by imagination to see photographs.

But, because we could not estimate the data quantity suitable for display, only the upper body is used for representation. Moreover, the color information is changed into single color. As a result, the data quantity became 0.7KB.

After the introduction of this model into excavation pit No. 2, the data quantity of the whole pit No. 2 was set to about 21MB. The result is shown in Fig 4.

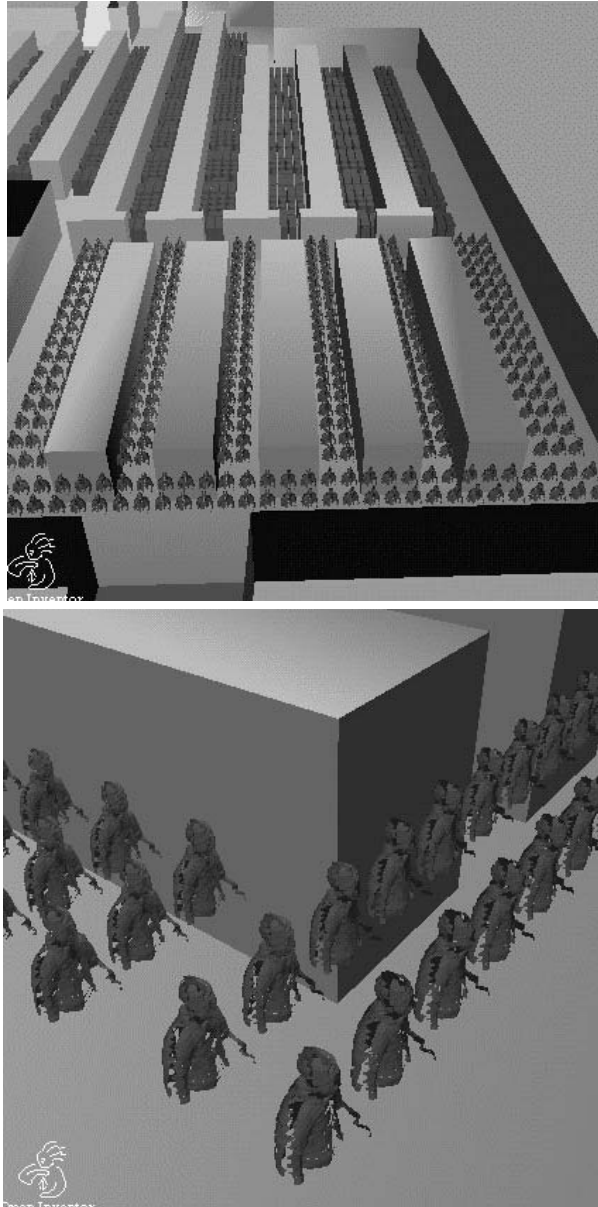


Fig 4. The result of introduction of detailed warrior models

It is impossible to display even the upper half of the bodies with a workstation without the data reduction. Because the data quantity is 100 times, compared with a simple space, drawing calculation takes great time. Then, We devised and applied the method of further data reduction.

3. Change of model by visual-angle calculation

Usually, when a 3D model is drawn on a display, Hidden-surface-elimination processing algorithm and shading processing by the Z buffer are performed. These drawing calculation cause response delay. In order to reduce such an amount of calculation, it is the most effective to reduce the number of surfaces that constitute a model. Then, the following operations were added when drawing a model.

First, See one model from a top, divide into four domains, and it is considered that each is another model. (Please refer Fig 1.)

Second, Acquire the position coordinates of a camera, and calculate a vector connecting the camera position and the center of the model.

Third, Calculate the angle that the normal vector of the model and the vector calculated above make. The value is used for a condition judging of “Switch” node of VRML, change the domain displayed.

That is, the invisible surfaces from a viewpoint (a camera) are beforehand excluded from the model, only the visible domain is displayed.

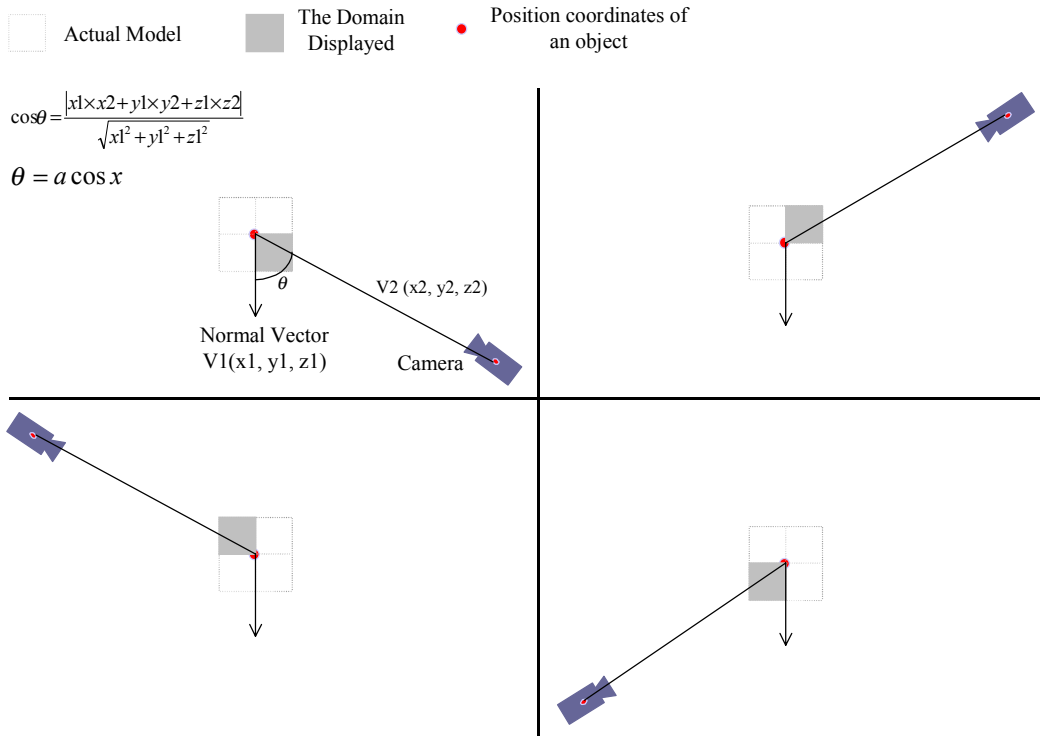


Fig 5. Change of a model by visual-angle calculation

This method is applied to the east area into the pit No.2 where warrior's ceramic statues arrange densely. The result is shown in Fig 6. Only the model is displayed to make a result legible.

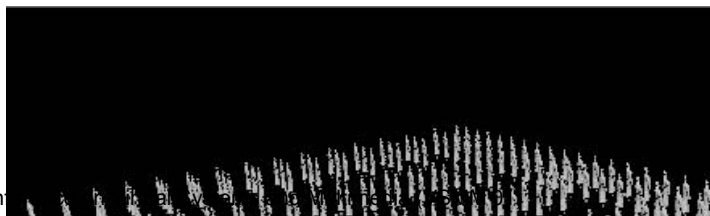


Fig 6. The result of Change of a model by visual-angle calculation

The drawing speed is improved a little by this method, but we could not acquire the dramatic effect that leads to the solution of the problem. What is worse, the reality is spoiled compared with displaying the all. However, it is effective in displaying a simple model. Now, we propose the exhibition methods other than a real-time rendering, using the virtual space built so far.

4. Streaming and VR fusion system

4.1 Outline

This system aims that users have experience that the virtual environment with higher reality if use a low performance machine such as PC. We explain the data flow of this system by Fig 7.

1. When a user accesses a homepage, the data of a simple space held by the Web server are transmitted, and a client PC draws the simple space.
2. When a user walkthrough the simple space, a viewpoint moves. The system obtains the viewpoint information (mainly position coordinates of camera), it is sent for the Web server.
3. The Web server sends the viewpoint information for another server (we call the CG server). At the same time, the Web server accumulates the information.
4. The CG server generates a series of images of a detailed space according to the acquired viewpoint information.
5. The images are sent for a user via the web server. At this time, the Web server takes the synchronization of the images and a simple space.

The Fig 8 shows the interface of this system. A left window shows the simple space in real-time, which is what has been built until now. While a right window show the images of a detailed space generated on CG server with an original quality. For this system, the virtual space as Fig 9 is under construction. A user will use this system on the homepage.

This system allows people to walkthrough and turn around the high-quality virtual space because it does not receive bad inference of hardware performance exploited.

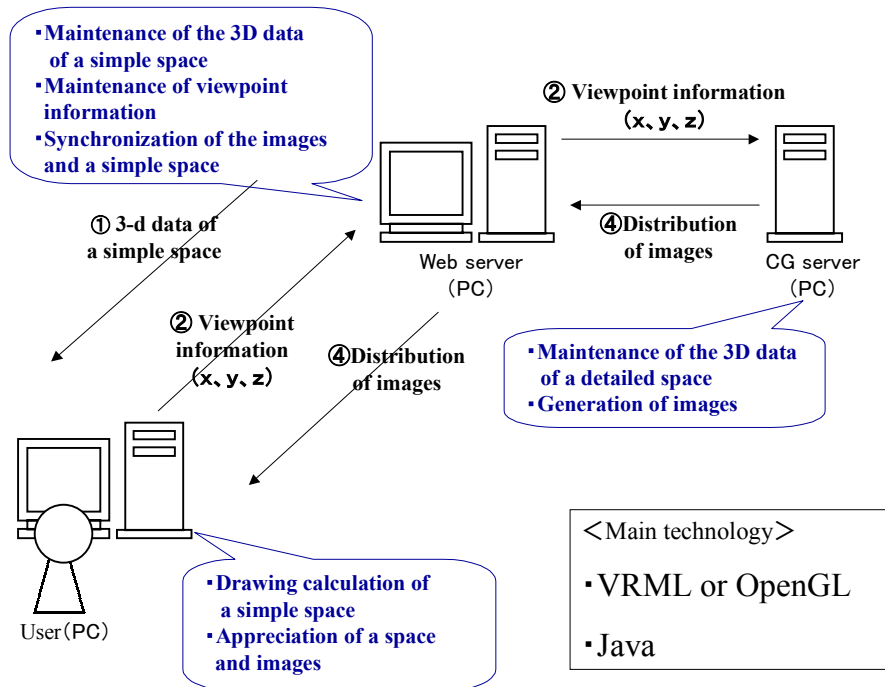


Fig 7. The data flow of streaming and VR fusion system

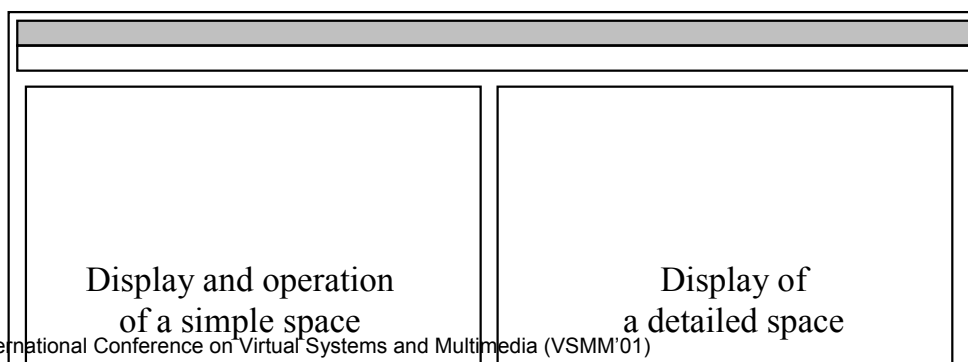


Fig 8. Interface on the web browser



Fig 9. A detailed space

5. Conclusion

First, We have taken up the pit No.2 of the museum of Qin Shihuang as a subject matter, and have performed 3-dimensional modelling.

Second, as a solution for the warrior's ceramic statues modelling problem, on the basis of the viewpoint information, we have performed the method that change of model by visual-angle calculation. Consequently, the drawing speed of virtual space is improved a little.

Third, as the exhibition methods, other than a real-time rendering, we proposed the exhibition system where Streaming and VR were united.

The problem of this system is the time difference between the transmission of a simple space and that of a detailed one. It is because of the data quantity to be transmitted. We consider using motion-JPEG for distribution of images, but it is hardware dependant. However, this is the case where it processes on real-time. In the experiment phase, when this time difference is large, we consider generating and distributing not a series of images but movie on the basis of the viewpoint information accumulated the web server.

References

- [1] Jiang Yu Zheng. *Virtual Recovery and Exhibition of Heritage*, IEEE Multi Media, pp31-33, (2000)
- [2] Yasuhiro WATANABE, Kazuaki TANAKA, Norihiro ABE, Hirokazu TAKI, Yoshimasa KINOSHITA, Akira YOKOTA. *Proposal of new method for generating surface model from slice images*, vsmm2000, pp190-199
- [3] F.Yamaguchi. *Jissen computer graphics*, Nikkan kougyou shinbunsha (1987)
- [4] Josie Wernecke. *The Inventor Mentor*, Addison-Wedkey Publishing Company (1994)