Abstract. Yuan Ming Yuan is regarded as a masterpiece of ancient Chinese architecture and garden. Its unfortunate ruin by the British and French Army more than 100 years ago became a shameful record in the history of China. Since then, although many Chinese have appealed for its reconstruction, a rebuilding project is believed to be impractical both from the economic and the historical aspect. So we develop a study on the task by using computer graphic technology as a visualization method. This paper will describe the process of modeling and rendering developed by 3rd year undergraduates and our continued attempt to create a VRML world on WWW.

1. Background

Yuan-Ming Yuan Imperial Garden is known as the greatest and most beautiful garden in the Ch'ing Dynasty (1644-1991). Situated in the northwest suburb of Beijing, it was first built in 1709 (Kang-Xi 48). And the construction was continued by emperors Yong-Zheng and Ch'ian-Long. Covered a total area of 5,200 mu (1 mu = 0.0667 hectares), it consists of three parts: Yuan Ming Yuan, Chang Chun Yuan and Yi Chun Yuan, which then also were called “Yuan-Ming Three Gardens”.

Yuan-Ming Yuan Imperial Garden inherited and developed Chinese traditional fine workmanship in garden-arrangement and landscape architecture. Following the example of many famous classical gardens in south China, it combines hundreds of scenic spots and finally gained a reputation of the “Garden of Gardens”. With huge collections of the richest art treasures and ancient books, it was also known as a cultural treasure house.

Unfortunately in October 1860, this most beautiful garden in the history of China suffered ferocious devastation. The British and French Army plundered and razed it to the ground. Now the once magnificent scenery only can be seen from the remains of the architecture foundations and rockeries. Yuan-Ming Yuan became a symbol of Chinese humiliation in China’s modern history.

Today though most of Chinese people are eager to see its beauty, reconstruction on the remains is always believed to be impractical both from the economic and historical aspect. So we develop a study on the task by using computer graphic technology as a visualization method to reproduce this splendid garden.
Yuan Ming Yuan was the greatest garden among “Yuan-Ming Three Gardens”. With a total area of 2 square kilometers, it consists of many different smaller gardens. They are known as "Yuan Ming Yuan's Forty Beautiful Scenic Spots" which constitute the main part of the whole garden. Our project is focused on simulating these spots. The whole garden would be a future work.

2. Modeling and Rendering

Modeling is the first part of our projects. The 3rd year undergraduates joined in this task as a two weeks practicing studio required by the course -CAAD method. This studio is opened for students to learn how to use graphic software such as AutoCAD and 3DSMAX. In this project, all of the 78 students were arranged into 26 groups. Each consisted of 3 to 6 persons and selected one or two spots to study.

2.1 FIRST STAGE: COLLECTING INFORMATION

Information to guide us in modeling mainly comes from four resources:

● Pictures and Poem of Yuan Ming Yuan's Forty Beautiful Scenic Spots (see reference 1, p309-391). During Ch‘ian-Long period, two royal painters Shen Yuan and Tan Dai drew traditional Chinese ink paintings for each spot, appended with the emperor’s praised poems, which gave us the most hints to study.

● 清式营造则例-Kung-ch‘eng tso-fa tse-li (Construction Regulations) of the Ch‘ing dynasty.(see reference 3)It is one of two “grammar books” on Chinese architecture which contains a well-regulated set of rules governing the designing and execution of architecture in the Ch‘ing dynasty.

● Existing traditional Chinese buildings. Especially the Summer Palace located in the west of Yuan Ming Yuan. They are similar in many aspects.

● New Yuan Ming Yuan. It was built in Zhuhai city in 1996 for commercial purposes, following the example of Yuan Ming Yuan but was constructed with new concrete technology. It was designed based on long-time research to seek a accurate reappearance by School of Architecture, Tsinghua University.

2.2 SECOND STAGE: ANALYZING AND MODELING

Making a further analysis of the materials collected from the above mentioned is important. Though the Pictures and of Yuan Ming Yuan's Forty Beautiful Scenic Spots give a good view of each spot, they are somewhat not true to life because the painters drew them from an artist’s view. So we have to synthesize the
relevant data and decide on the precise 3D data of each building, bridge, hill and so on.

The most difficult thing in modeling may be the curved roofs which are considered the most beautiful part in Chinese buildings and are not easy to shape. In fact the roof’s curve is decided by an accurate calculation given in the grammar book, so it becomes easy to simulate by using powerful modeling software such as AutoCAD. What the students need to do is to study the rules and change them into digital data.

Another important thing is to determine the complexity level of modeling. If we create all details such as the decorated doors, windows and beams with 3D objectives, our computer will die. So we generally simulate details with simple models by applying texture maps. Those texture maps were images scanned from materials mentioned in 2.1.

2.3 THIRD STAGE: RENDERING

At the end of the studio, each group provided computer generated rendering for each spot. Most of them are a bird’s-eye view. Some groups also did some research on the spatial layout, and showed us some interesting view. Photoshop is used at this stage to add some special effects. Different styles of the students’ final graphic were encouraged based on their understanding of the spot’s character besides the physical space.

3. Publishing on WWW

The advent of the World Wide Web (WWW) gives a new idea of distributing information including text, graphics and sound. It give us an good opportunity to share our “Virtual Yuan Ming Yuan” with people around the world. This is just our ultimate goal to carry out this project.

3.1 HOMEPAGE OF YUAN MING YUAN

We’ve created a homepage to illustrate all aspects of this project via url: http://dns.architecture.tsinghua.edu.cn/caad/ymy/ymy.htm. Here some relevant messages as paintings, poem are also shown. This page has just been set up and we will add more information about Yuan Ming Yuan into it. We hope it can become a virtual community for people who have special interest in Yuan Ming Yuan.

3.2 VRML WORLD

Web browsers that make use of HTML create an essentially two-dimensional
interface to Internet information. VRML expands this interface by allowing the creation of a three-dimensional world on the WWW, offering a much more vivid way of presenting information.

We think VRML will be a good tool for our project. So we attempt to create VRML models for Yuan Ming Yuan. While VRML is a new thing, we find it has many limitations: First, we can hardly get a modeling software like AutoCAD to create complex and precise models like Yuan Ming Yuan. Second, though some software like 3DSMAX can output a VRML file, we find it too large to explore on the Internet. The reason may be due to the fact that it uses points and faces to describe every shape. So we remodel them using VRML primitive such as Box, Cylinder. As a result, we can minimize the file size about 10 times. You can see the .wrl files of a building illustrated in Figure 3, which are no more than 20 Kb while one coming out from 3DSMAX is larger than 200 Kb. The third thing is that the three-dimensional world VRML document created is often different with different browsers. Though VRML has so many shortages, we are confident in its future. We’ll continue to study it.

The following is the list of a VRML file (.wrl) for creating the curved roof. Here the extrusion node is used. The coordinate data comes from a AutoCAD file (.dwg). Figure1-3 show VRML models which were captured from a browser.

```
#VRML V2.0 utf8
#roof
Transform {
  translation 0.1 0 0
  rotation 1 0 0 -1.57
  children [Shape {
    appearance Appearance {
      material Material {
        texture ImageTexture { url "img/roof.jpg" }
        textureTransform TextureTransform { scale 6.0 6.0 }
      }
      geometry Extrusion { convex FALSE 
        creaseAngle 0.52
        crossSection [3.7491 0.6234, 3.3500 0.8097, 
                      2.3864 1.2980, 1.7269 1.6934, 
                      1.4218 1.8993, 1.1333 2.1217, 
                      0.8530 2.4430, 0.6799 2.6407, 
                      0.5727 2.7477, 0.4820 2.8383, 
                      0.3831 2.9125, 0.2759 2.9701, 
                      0.1522 2.9948, 0.0000 3.0097, 
                     -0.1522 2.9948, -0.2759 2.9701, 
                     -0.3831 2.9125, -0.4820 2.8383, 
                     -0.5727 2.7477, -0.6799 2.6407, 
                     -0.8530 2.4430, -1.1333 2.1217, 
        ]
      }
    }
  }
}
```

4. Conclusion and Future Work

Chinese architecture is as old as Chinese civilization. From such sources as literature, graphics and exemplars, we can see there are so many splendid works during the past thousands of years. But due to wars, fire and other reasons, most of them no longer exist. Yuan Ming Yuan is one of them. From this project, we
are so glad to see that it is practical to reconstruct them on computer. It will be a new method to study the history of architecture.

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