AN APPROACH TO GENERATE 3D ANIMATION BY INTEGRATING BUILDING MODEL INTO SITE PICTURES

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Abstract. The paper deals with a simple and cheap solution to represent 3Danimation of a future building at its actual site scenery. It is hopeful to be used in small or middle projects in order to get satisfy effect and save design cost.

1. Introduction

Traditional model of house (*i.e.* physical model), which is made up by cardboard, plastics, organic glass, etc., and follows a relative size to scale, may let us to see how a future house will be. However, its effect is discounted a great deal because of desalination in material impression and shortage in necessary lighting and shade. Furthermore, when we look at such a model, we have a failure of feeling in a proper situation. A model is made with a uniform reduction while our eyes are not yet reduced at the same time. We still view it in a normal scale of sight. It appears that, as Yu-Tung Liu (1999) said, "the size experience looking at a model when above it or near it seems as the same to look at a house on the earth from an airplane ----it's interesting but not real".

As a modern tool computer gives us an opportunity naturally to walk-through a future building. It enables us to generate 3D model of house in real size (*i.e.* computer model), to experience it in normal illumination or space view rout, to examine the ornament effect of surface materials, and so on.

We know that a ***pure*** 3D model of house (no actual site circumstances) generated by computer can easily be made into 3Danimation. Also, we know that a ***static*** perspective of computer model can be inserted into a site picture conveniently. These two types of representation have commonly been used to show the architect's design to the proprietor or users. The complete 3D animation including artificial and/or natural site scenery is rarely seen at least in the continent of China.

Why do we seldom create 3D animation by putting the model together with the site circumstances? There are a few problems yet. First, it is very expensive for most projects to take a site film using some flying vehicle or to construct the whole site environment including every tree and its each leaf completely by computer. In fact, only those individual projects having huge investments and indicating large social or economical benefits are able to do this. Second, by plane we can only take the film from far away, and can’t be in the sky and then just above the land, or even so into the future building. It is difficult to find an ideal (and sometimes even complex) view route, which can represent perfectly the features of the designed building. Third, there would be more frames to make a composition if we can get both the site film and 3D animation of the building model. We need 30 frames per second at least, and it means almost a thousand pairs of frames to composite for an advertisement of 30 seconds.

Is there a simple and cheap solution for most projects? The paper describes an approach to generate 3D animation, which can completely integrate a building model by CAD into the actual site scenery. Here, the constant frames of the site view will be created through several key pictures taken in advance. This method of 3D animation has already been proved by example and we are ready to put it into an actual project.

2. Planning View Route

A good works of design should wholly and naturally co-ordinate itself to the real circumstances that it will be placed in. For this reason, the best way to evaluate the quality of a design is to examine it together with its site condition. It is important equally for either architects or other persons such as proprietors and users.

In order to simulate the effect of the design perfectly, we first need to plan a space view route, which can view the future building from the sky, the land, and even so into it freely. Of course, this route should be decided based on man's habit of seeing so as to display the building and its surrounding scenery as real as possible.

As described above, we are not able to take a film along a free space route due to the limitation of technology and economy. We can only take some pictures from the near houses, streets and open grounds. In other words, we must make some compromise. There would be a series of view lines from those places where we can take picture to the targets. The planned space view rout should be decided only by points just on the lines. Thus, we choose some key points on the view lines to construct a smooth route. These key points are right the points of intersection between the route and each view line. Such a view rout is not only capable to become a walk-through rout by some technical means but also satisfy the necessity of evaluation about the project design.

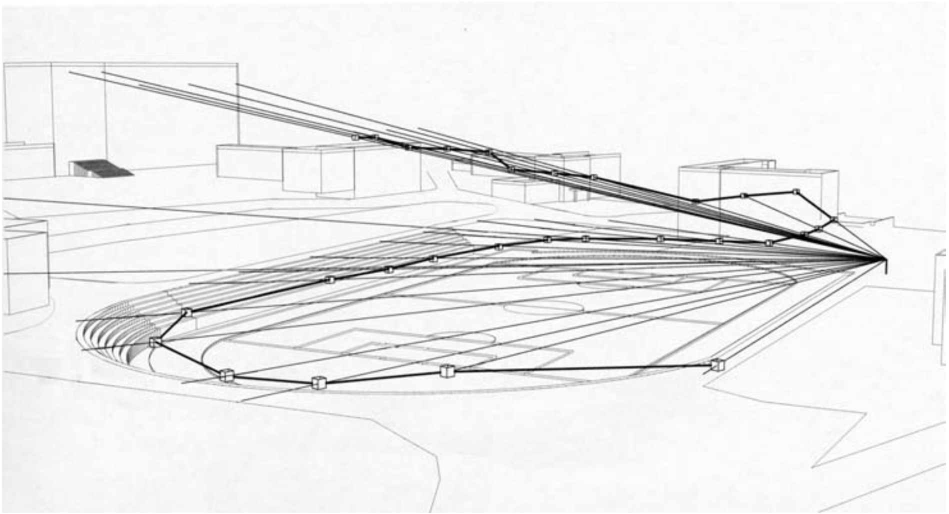

Figure 1. An Example of Planning View Rout.

In order to prove this approach, we select a site in the campus, where is constructing a house. As showed in Figure 1, there is our target of site in the middle of right side and a series of view lines directing to it from buildings or roads far and near. A black spatial line *i.e.* view rout winds from right bottom through left side then to right side and finally up to a higher place. If we would be able to go along this rout, we would have a better look of the future house from different perspective directions.

3. Taking Pictures and Clipping Them

After the space view route and some key points on it have been decided the next step is trying to get pictures from these points. Generally there are two ways to get a picture with large scale of a target building or a site: 1. Not to change the place locating our camera, while applying changeable focus lens to enlarge its focus distance. 2. To move ahead to an ideal place while not changing the camera focus distance.

However, we can not take pictures freely from anywhere in the space. The pictures about the site are always taken focusing on the target from some places such as roofs or open lands. Equally we are not able to have freely changeable focus lens. Thus we can only manage to infer an image at some ideal point on the same view axis from a given picture.

According to the basic principle of optical lens, an object outside 2 times focus distance will generate an image between 1~2 focus distance in camera as given in figure 2. Generally, the farther an object is, the smaller its image, and the nearer the image is to the focus, *i.e.* almost one focus distance.

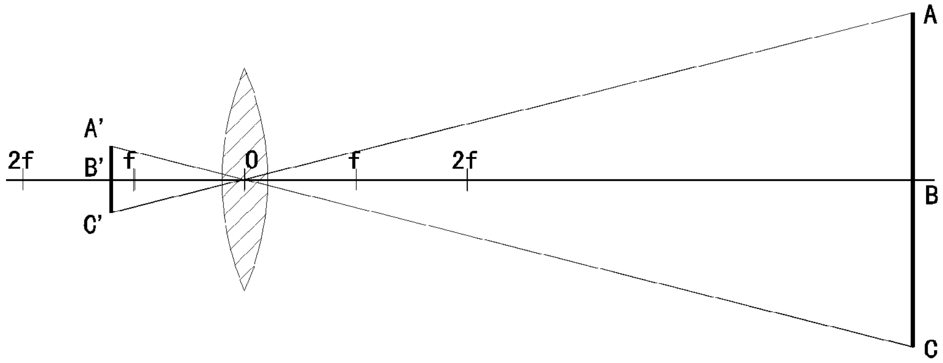

Figure 2. Schematic Diagram about Optical Image.

The whole law of optical image should follow as the formula (1).

$$1/d+1/D=1/f \qquad (1)$$

Here, D=BO, called object distance,
d=B'O, called image distance, and
f is focus distance of the optical image system. The ratio of object to image in size is equal to:

$$K=AC/A'C'=AB/A'B'=BC/B'C'=BO/B'O=D/d \qquad (2)$$

Through formula (1) and (2), we can infer out a theoretical formula (3):

$$L=((K+1)/(K0+1))2\cdot(K0/K)\cdot L0 \qquad (3)$$

Here, L_0 — the distance between object and its image, generally regarded as distance between target and camera.
$K_0=H/h_0$ — ratio of object to image in size for original picture, H is height of object, h_0 is height of relative image in the picture.
K=H/h — new ratio of object to image in size for wanted picture, h is height of new image in the wanted picture.

Formula (3) is inferred under a supposition that the picture is taken in a standard situation, *i.e.,* the view axis or optical axis is horizontal. If a picture is taken from place higher or lower than the target, a problem of inclination angle should be considered.

Thus depending on the formula above we can infer a new location parameter L. On the contrary, we can select a point on the relative view line in advance and get its L. Then we infer relative K and clip the picture according this new K. In short, having formula (3), we can properly clip the pictures taken from those places as pictures from the key points, which can be used as key frames of the site animation. Figure 3 is an example of original picture in which a rectangle frame shows the position of new picture being clipped.

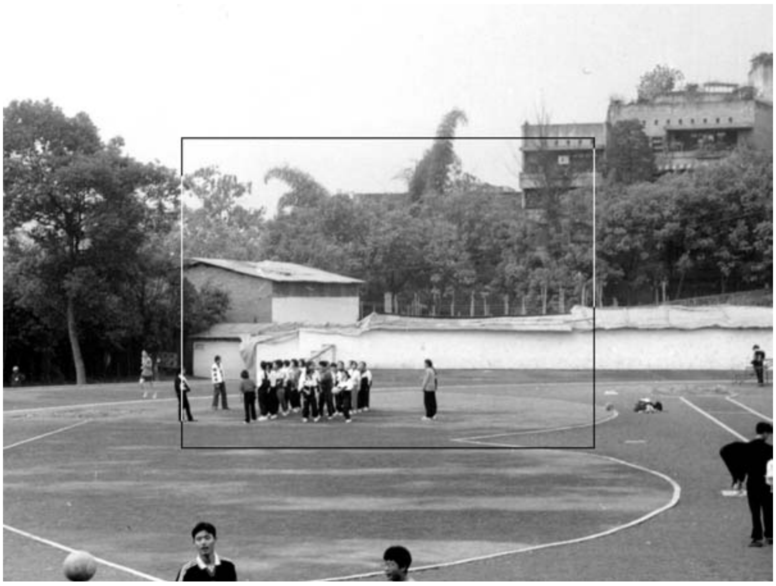

Figure 3. A Picture Being Prepared to Clip.

However, it should be pointed out that the future key frames can only contain those static objects such as buildings, trees, stopping cars and etc., which will move in the opposite direction to the moving view points. The moving objects such as persons and cars, having each own different rout of movement, should be completely deleted from the reduced pictures in advance.

4. Image Synthesis

The further step is to generate animation from respective key frames, both the site and the building model individually. Then, we synthesis combine the two animations into one automatically through a program we developed. The final episode shows the effect of the future building in the actual site perfectly. Figure 4 gives one of these key frames.

Figure 4. A Picture of Key Frame.

5. Summary

We have developed a simple and cheap solution for most projects to generate 3D animation through integrating a building model by CAD into the actual site. Here, the constant frames of the site view will be created through several key pictures taken in advance, and the processing to them is based on the principle of optical image.

The example represented shows that the effect of this method seemed satisfying. It's suitable to be used to most small and middle projects for saving design cost, especially in developing countries or districts, where the technical condition of computer is commonly not so good.

Perhaps the research about digitized city or virtual reality would be finally an ideal solution. However, the current construction of digitized city or virtual reality by wholly 3D modeling has a shortage of becoming effective very slow. The approach we introduced may be another selection.

Acknowledgments

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