# Talking about 3D Image Transformation in Graphics

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**Abstract:** This paper introduces the processing method of transforming 3D image into 2D graphics, and describes the transformation process involving graphic transformation, model transformation, projection transformation and viewport transformation. The content of this paper provides some reference for readers to be familiar with the problem of 3D image transformation.

**Keywords:** 3D image, model transformation, projection transformation.

## 1. Introduction

In computer graphics, when drawing an image, because the display screen is flat, when creating a 3D object, the 3D object is converted into a 2D image for processing, and finally a series of graphics are generated by the computer.

## 2. 3D image drawing process

The basic steps for rendering a 3D image on a computer are as follows:

(1) According to the 3D image to be drawn, first draw a 3D sketch on paper, then build a 3D model according to the graphics unit, and describe the code according to the data information of the 3D model of the sketch, including the coordinates of the vertices, lines, surfaces, images and bitmaps, they are all basic graphic data units.

(2) To place the set 3D model in the 3D space, you must first create a control to store the 3D model, and finally set the viewpoint to observe the created model.

(3) Calculate all the point coordinates and surface colors of the model based on the drawn 3D image, the color of each surface depends on the actual situation, because sometimes the lighting conditions, texture methods, and whether there is smoke in the environment must be considered.

(4) The mathematical description of the 3D model and its color information are converted to the pixels on the computer display screen, which is called rasterization..

## 3.  3D image transformation

In the process of converting a 3D image into a 2D image, there are generally four steps [1]: graphics transformation, model transformation, projection transformation, and viewport transformation. The specific transformation process is shown in Fig. 1:
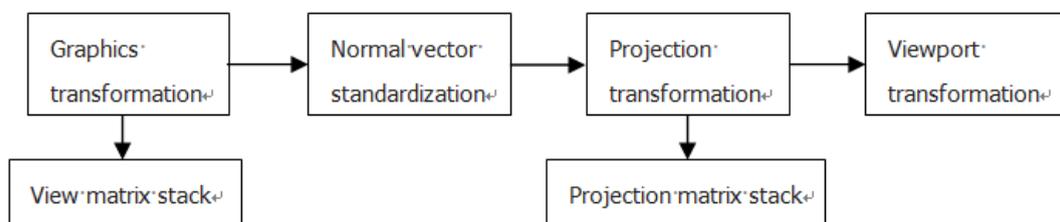


Fig. 1 3D image transformation process

### 3.1 Introduction of Coordinate System

When using a coordinate system, the coordinate system can be divided into the following types of coordinate systems:

In most cases, the right-hand coordinate system is used, and the unit length of the coordinate axis of the coordinate system is defined by the designer himself. Of course, according to the user's requirements, sometimes the coordinate system used is also different. The polar coordinate system or logarithmic coordinate system in mathematics can also be used. The world coordinate system is the first coordinate system for graphics.

Display equipment includes computer display, plotter and digital instrument, these are real display graphics hardware devices, there is also a coordinate system in hardware equipment, which is called equipment coordinate system [2], and adopts 2D rectangular coordinate system. For example, the unit of the screen's positive axis is not the same as that of the screen's positive axis. For example, the unit of the screen's vertical axis is the same as that of the screen's right axis. For devices such as plotters and digitizers, as people are used to, the origin of the coordinates is placed in the lower left corner of the device table according to the mathematical coordinate system, the right side of the X axis is positive, and the upper side of the Y axis is positive, and the unit of length is the device. Therefore, the value range of the length unit of the coordinate system is the length and width of the display device.

The third type of coordinate system is called the normalized device coordinate system. In order to closely and cleverly connect the right-hand coordinate system and the device coordinate device, and better facilitate graphics processing, a coordinate system independent of the device is adopted, which is a virtual coordinate system, this kind of coordinate system has nothing to do with the device. Through it, the world coordinate and the device coordinate can be connected. This is a dimensionless unit

coordinate system. The user's graphic data is converted into the value in the normalized device coordinate system. It can separate the application program from the graphics device and increase the portability of the application program.

## 3.2 Graphic Transformation

With the introduction of the standardized equipment coordinate system, it is possible to calculate how to convert between the model diagram of the right-hand coordinate system and the equipment coordinate system. This conversion uses graphic transformation. Graphic transformation is the basic content of computer graphics, which can convert right-hand coordinates into device coordinates. In fact, a key problem in computer graphics is to create a 3D object in a 2D plane. Therefore, when constructing a 3D graphic, it is necessary to design and think in a 3D coordinate system. Using the conversion relationship between the coordinate systems, the coordinate points of the model in the 3D coordinate system are calculated, and the 3D coordinate points are converted into the pixel positions of the display to achieve the ideal visual effect.

## 3.3 Model Transformation

In graphics, how do we define a model? Generally, we have two methods. The first method is to define a set of vertices to form a model through the vertices; the second method is to establish the model through other software, That is, use 3D modeling software to build a model, and then import the model. The model is the object of our research. After the model is established, the developer implements the transformation of the model by setting the corresponding code. During the model change, the developer needs to continuously observe the change of the model's viewpoint and angle, and continue Adjust to achieve perfect and realistic model transformation effects.

The model changes are usually achieved through operations such as translation, rotation, and scaling of the model. Next, we will briefly introduce them:

(1) The first is to realize the model transformation by translation: the translation transformation is to realize the linear movement of the model by changing one or two coordinate values, and the model does not rotate during the movement. Of course, in the transformation, we must also consider the apparent transformation and projection transformation.

(2) The second way is to achieve model transformation through rotation. Rotation, as the name implies, is to rotate a certain angle around a certain axis. The same is true in model rotation. The rotation of the model can also be rotated through a fixed point.

(3) The third way is to achieve model transformation through scaling. In the 3D coordinate system, the scaling model transformation is realized by transforming the coordinates of the three coordinate axes. When the coordinates of the coordinate axes

are changed, the changes of the three coordinate axes are independent of each other, and the similarities and differences of the scaling parameters are set To achieve uniform or non-uniform scaling of the model.

## 3.4 Projection Transformation

Projection transformation [3] determines how the object is projected onto the screen. Here are two projection methods: perspective projection and orthographic projection. Perspective projection, which is similar to the scenes we see in daily life. Perspective projection makes distant objects appear smaller. If you want to create a very realistic image, you must use perspective projection. Orthographic projection, which directly maps objects onto the screen without affecting their relative size. Orthographic projection is generally used in CAD applications and architecture. In these applications, the final image needs to reflect the actual size of the object.

## 3.5 Viewport transformation

The viewport transformation and projection transformation jointly determine how the scene is mapped to the computer screen. The projection transformation formulates the generation mechanism of the mapping, and the viewport transformation determines the shape of the effective screen area mapped by the scene. Since the viewport specifies the area occupied by the scene on the screen, the viewport transformation can be regarded as defining the size and position of the final processed photo.

## 4. Summary

In computer graphics, we need to transform the geometric model in 3D space. In this paper, through the processing of graphics transformation, model transformation, projection transformation and view transformation, we can realize the transformation from 3D image to 2D image, so as to achieve the purpose of displaying the 3D image on the screen.

## References

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