Development of Folding Carton Design System Based on OpenGL Technology

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Abstract: This paper proposes a development method bases on the OpenGL (Open Graphics Library) technology for folding carton system. This system function include 2-D(two-dimensional) designing, frame designing and cartoon designing. The system also designs some different partitions cooperating with 12 different wallpaper boxes in carton designing process. Meanwhile, the system also achieves a series of effects, such as carton texture mapping, 3-D(three-dimensional) transform tools, animation operate tools, color setup, light setup and other functions, which would re-emerge a carton design more clearly.

Keywords: Folding Carton; Computer Aid Design; OpenGL;

1. Introduction

As a kind of sales packaging, folding carton has much excellence, such as shape structure, good printing performance and has been widely applied. Most of domestic enterprises have adopted the computer to complete the design and manufacture of the cartons, but basically remains in 2-D(two-dimensional) design stage. Now not only in the cartons structure design, to be achieved from a two-dimensional structure to change the 3-D effect is need much great demands. The development of computer technology provides a good foundation for 3-D simulation software development. This article describes the application of OpenGL (Open Graphics Library) technology, developed 3-D packaging carton design system and provides an effective method for interactive 3-D realization of the box design.

2. Development environment

This system selects the VC++6.0 programming environment in the WindowsNT platform. At the same time, the powerful capabilities of OpenGL graphics make it become the first choice to develop this three-dimensional box-type design system. In VC++6.0, MFC has provided the interface of window procedure and the basic input & output, and uses the object-oriented technology, are designed based on MFC (Microsoft Foundation Classes) encapsulation, inheritance and reuse of OpenGL as the class

3. Structural analysis of the carton

In the carton design, structural design is the most important part. The design process does not directly address three-dimensional, but make a two-dimensional plan in the first; then start exterior decoration design, printing, die cutting and other processes, folding the three-dimensional product.

Although the box structure complex, cartons can be classified according to structural features of carton. Carton for different types of structural separation, with the most simple and most optimal way to decompose carton into a variety of box element ,in the system parameters of the process of drawing the carton’s two-dimensional plan through stitching the various parts together, so the box element database technology involved. the system is divided into: carton’s panel database, carton’s bottom database, carton’s lid database and rule database.

3.1. carton’s panel database

The carton’s panel database keeps the main part of the parameters of the various boxes

![Figure 3-1 carton’s panel database](image1)

![Figure 3-2 carton’s bottom database](image2)
3.2 carton’s bottom database

The carton’s lid database main collects parameters of the various forms of the bottom.

3.3 carton’s lid database

In the carton’s bottom database main storages a variety of box lid.

3.4 rule database

In what regular storehouse main preservation are constraints and rules in the process of becoming box, such as folding linear way: If the dotted line is the 90-degree fold, solid line is the edge line, folding carton box lid should be equal to the length of width, etc.

4. Carton 3-D model exploitation implement-OpenGL

OpenGL provides a visual programming environment and a series of function, which simplify the development process of three-dimensional graphics program. However, we need to connect opengl32.lib, glu32.lib in the options under project menu construction and add fundamental function warehouse head document gl/ gl behind compiling the header file stdafx.h. Such compiling file has ability to provided the support to the OpenGL database and carton’s element database, which ensure that the system functions comes true.

4.1. Graphic drawing and transform operations

OpenGL uses the basic graphic elements - points, lines, and so on to complete the two-dimensional or three-dimensional graphics, which is completed mainly by DrawScene () function, generating three-dimensional part of the code patch as follows:

```
void CPackagingView::Init( )
{
    PIXELFORMATDESCRIPTOR pfd;
    CView::OnDestroy( );
}
```

OpenGL provides the basic transform operations - translation, rotation, scaling, view transform and so on for the convenience of the user at any point of observation the carton, mainly the application of matrix transformations. Take translates the transformation as the example: The translation transformation is realized through glTranslate () function, and is carried out in the model matrix. The function of glTranslate () function is to relocate the physical coordinates (X Y Z) referred to (X' Y' Z'), and form the new physical coordinate system. The matrix representation method is:

\[
\begin{bmatrix}
1 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 \\
0 & 0 & 1 & 0 \\
Tx & Ty & Tz & 1
\end{bmatrix}
\]

In style, the point (X Y Z) will be moved to point (X' Y' Z') by the translation transformation matrix. Observer can see glTranslate () function is a translation of coordinates, but effect that observer see is that the object has been translated.

4.2. Color mode and illumination

OpenGL have provided two kinds color pattern: RGBA mode and color index mode. Through the device context DC (Device Context) calls the corresponding function, its function is primarily achieved by wglCreateContext (), OnDestroy (), ChoosePixelFormat () function, its part code as follows:

```
void CPackagingView::Init( )
{
    PIXELFORMATDESCRIPTOR pfd;
    CView::OnDestroy( );
}
```

Fig.4-1 Translational transformation
Light and color are the important link complementing each other. In the system of OpenGL provides four kinds of light, they are ambient light, diffuse reflection light, mirror light and radiation light. Users can create multiple light sources in applications to achieve the required lighting effects. This process is divided into two steps: create the light source and determine the optical properties. In this system, created three light sources, users can be selected in the dialog box, and can see the different three-dimensional carton transformation effects under different Lighting.

4.5 Texture mapping

Texture mapping is important means to enhance the realistic 3d graphics. First, program define a texture which is one-dimensional, but also 2d texture described each pixel up to four elements by glTexImage1d ( ) . glTexImage2D ( ) function. Then the program apply the texture by the GLubyte*pTextureBits=(GLubyte*) m_pDib->GetDibBitsPtr ( ) function of OpenGL. In this process, program read off mapping way function glTexEnvi ( ) to determine mapping method. Finally, program define the texture coordinates which decide texture image endowed to a specific coordinate geometry point by the glTexCoord ( ) function. Texture mapping process is given object coordinate geometry to texture coordinates.

4.6 interactive animation

The double caching techniques of OpenGL make it possible to graphics animation effects. The animation of folding carton process can be stored into .avi format which designer can transmit to users, they can understand the specific process of molding box by playing the menu. The animation show can be executed before chart or after.

4. Conclusion

The folding carton design system bases on spelling legitimate parametric design, using box-type database and box element database technology to complete two-dimensional structure graphics; According to 2D (two-dimensional) structure graphics, OpenGL technology will accomplish 3D (three-dimensional) molding, three-dimensional transform for three-dimensional display. Implementation of tubular shaped box from 2D to 3D conversion, which makes designed products more standard, more accurate, has solved the problem of proofing, saved cost and improved efficiency.

References


