3L-7

A 3D Interpreter Sketch System for Constructing Solid Models

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1. Introduction

This paper discusses a 3D interpreter sketch system for constructing solid models. The idea comes from a template topology library called T-LIB. The input strokes are analyzed as a 2D edge graph. Once the edge graph can be matched to a template of T-LIB, the 3D object can generated or modified.

The application interface of this interpretation is also presented. We are interested only in interpretation, where the computer creates the 3D objects step by step. The related research works can be referred from S. Sugishita'94[1], K.Matsuda'97[2], P.A.C.Varley' 2002 [3] and so on.

2. Interpretation of Sketch Input

2.1 Sketch Plane

The strokes are drawn on a plane which is called Sketch Plane. Referring to Fig. 1, it can be regarded as a plane between 3D scene and screen of user interface.

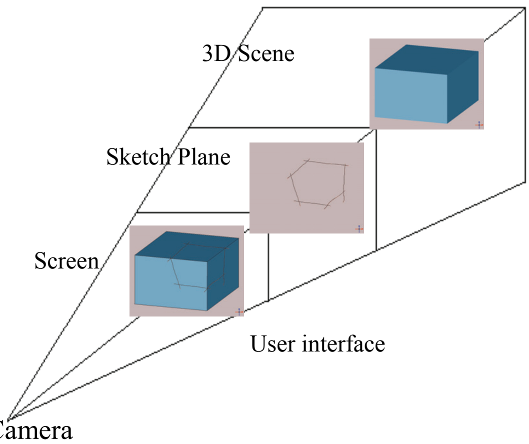


Figure 1: Sketch Plane.

2.2 Edge Graph

Edge Graph is a 2D topology graph. It is calculated from the strokes and the projected edges of 3D mesh which intersect with the strokes.

Referring to Fig. 1, we input six strokes on the sketch plane. Then we select the edges from 3D cube which intersect with the six strokes. We project the selected three edges to sketch plane and regard them as three new strokes. From these nine strokes, we can build a 2D cube edge graph as shown in Fig. 2.

2.3 T-LIB

T-LIB is a template topological library. It consists of 2D Edge Graph and the corresponding algorithm to create and modify 3D objects. Fig. 2 illustrates the templates of cube, triangular prism and triangular pyramid.

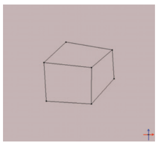
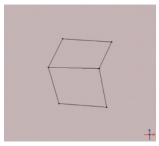
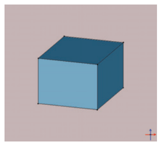
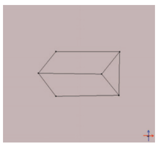
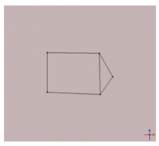
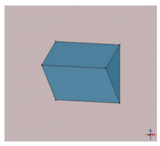
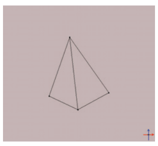
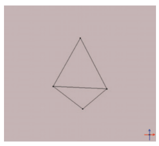
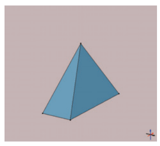
T-LIB	2D Edge Graph		3D Shape
Cube			
Triangular Prism			
Triangular Pyramid			

Figure 2: T-LIB.

3. Application interface system

3.1 System procedure

The system is shown as the following Fig. 3.

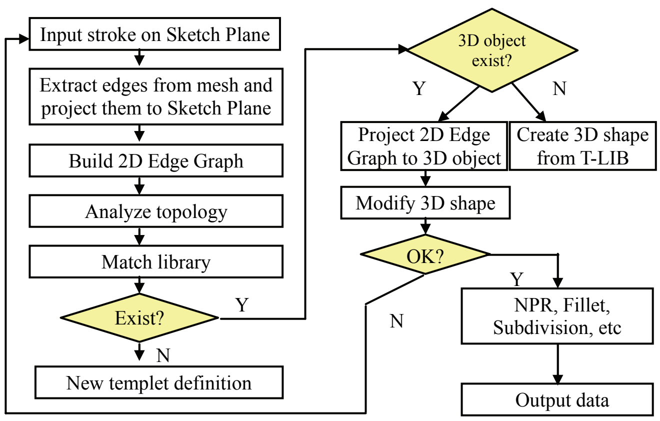


Figure 3: Application interface system

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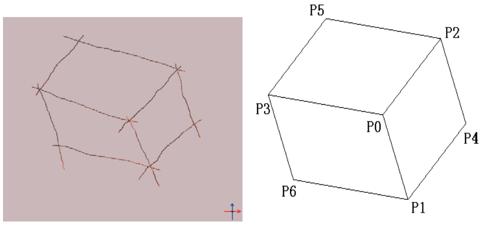
3.2 3D shape reconstruction from T-LIB

The algorithm of cube shape reconstruction is discussed in this section. The strokes are shown in Fig. 4(a), while the extracted 2D edge graph is shown in Fig. 4(b). The 3D cube is calculated by evaluating a camera normal and using parallel projection.



(a) (b)

Figure 4: 3D cube shape reconstruction from T-LIB

Let vector n={n_x, n_y, n_z} be the camera normal, V_i= { v_i^x , v_i^y , v_i^z } be the vertex of the 3D cube, while P_i= { p_i^x , p_i^y , p_i^z } be the vertex of cube edge graph.

Let v_0=(0,0,0), a=n_x/n_z, b=n_y/n_z, c=(a p_1^x+b p_1^y)/(a^2+b^2+1), d=(a p_2^x+b p_2^y)/(a^2+b^2+1), e=(a p_3^x +b p_3^y)/(a^2+b^2+1), f=($p_1^x p_2^x + p_1^y p_2^y$)/(a^2+b^2+1), g=($p_2^x p_3^x + p_2^y p_3^y$)/ (a^2+b^2 +1), h=($p_3^x p_1^x + p_3^y p_1^y$)/(a^2+b^2+1), with the principle of parallel projection, we get the following equations:

$$v_1^z v_2^z + d\, v_1^z + c\, v_2^z + f = 0 \quad (1)$$

$$v_2^z v_3^z + e\, v_2^z + d\, v_3^z + g = 0 \quad (2)$$

$$v_3^z v_1^z + c\, v_3^z + e\, v_1^z + h = 0 \quad (3)$$

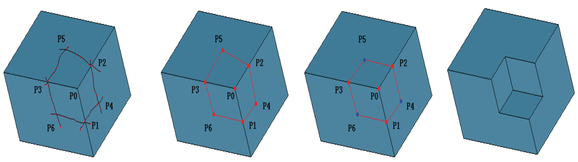
From equation (1), (2) and (3), we can deduce the equation (4):

$$(g-de)(v_1^z)^2+2(cg-cde)\, v_1^z+(fh+gc^2-cdh-cef)=0 \quad (4)$$

Then v_1,v_2,v_3 can be calculated, other vertices can be calculated with the parallel projection. In such a way, the basic 3D shape can be generated.

3.3 3D shape modification

The 3D shape modification process is illustrated as the following figures in Fig. 5:



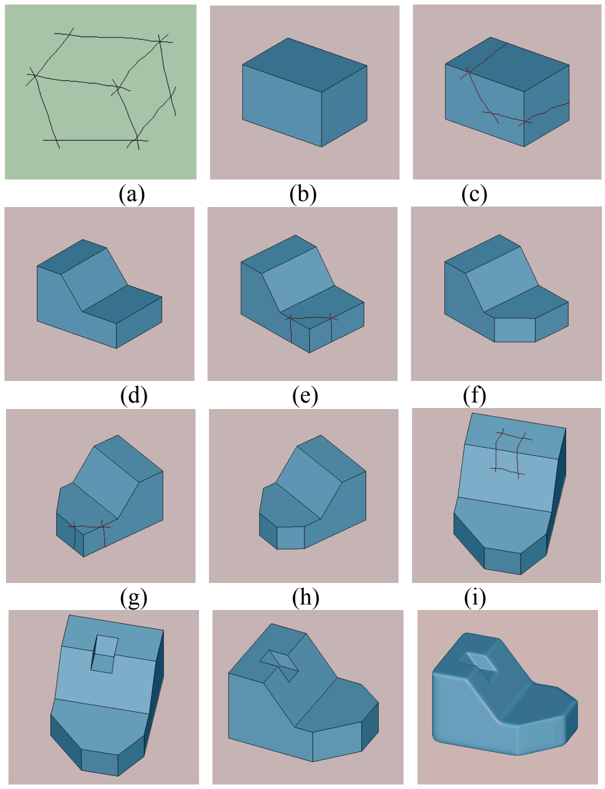
(a) (b) (c) (d)

Figure 5: Modification process. (a)Input stroke. (b)Extract edge graph, (c)Adjust edge graph, (e)Modify 3D shape.

Here the angle between the stroke and edge of 3D shape is used as a threshold to adjust the edge graph for getting the parallel information.

4. Examples

Fig. 6 is an example we made by using our sketch system for constructing a solid model.



(a) (b) (c) (d) (e) (f) (g) (h) (i) (j) (k) (l)

Figure 6: An example for constructing a solid model. (a)Input strokes. (b)Create basic 3D shape. (c-k)Input strokes on the 3D shape and modify the 3D shape. (l)Implement Fillet operation and adaptive subdivision.

5. Conclusions

This paper discusses an interpretation of sketch input. The idea comes from a template topology library which consisting of 2D edge graph and the algorithms of 3D reconstruction and modification. With this interpretation, the complex 3D shape can be generated step by step by analyzing the edge graph successfully. An application interface is also presented. Future work should be proposing more templates and considering of curve graph interpretation.

References

[1] S. Sugishita, K. Kondo, H. Sato, S. Shimada, *Sketch Interpreter for geometric modeling*, International Conf. of Computer Aided Geometric Design 1994, 1994.7.

[2] K. Matsuda, S. Sugishita, Z. Xu, K. Kondo, H. Sata, S. Shimada, *Freehand Sketch System for 3D Geometric Modeling*, Shape Modeling International, pp. 55-62, 1997.3

[3] P.A.C. Varley, H. Suzuki, J. Mitani, R.R. Martin, *Interpretation of Single Sketch Input for Mesh and Solid Models*, International Journal of Shape Modeling, Vol. 6, No. 2(2002) 207-241.