

Acquire 3D Print Three-dimensional Data Field and Filling Optimization 2D Contour Lines

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Abstract—With the development of rapid prototyping technology and computer technology, the rapid molding technology and the computer technology is more and more close. Based on the model of 3D data field capture, then according to the software conversion of STL format entity triangulation of 3D data and stratification, obtain 2D contour lines by layering, fast fitting algorithm utilizing metaball modeling technology. To transform the design of the existing model and modify the source file through a series of algorithm and the measures using 3D software, thus conducive to the formation of a 3D file to print. First of all, design task and functional requirements of the 3D model are analyzed, then, through a series of approximation algorithms and knowledge to determine the overall scheme of model 3D printing, including three-dimensional design of the model, the three-dimensional manufacturing feature recognition, the original model entity triangulation, hierarchical modeling. Finally, through rational analysis, temperature control, layout model, through the 3D printer to print out the entity model, and the structure of the model is analyzed.

Keywords—*rapid prototyping manufacturing technology; feature recognition; entity triangulation; layered; 3D printer*

I. INTRODUCTION

The core manufacturing idea of 3D printing technology originated in the late nineteenth Century American, in late twentieth Century, with the development of rapid prototyping technology [1], the appear of automatic information processing, data processing and electronic computer, bring a new concept of rapid prototyping technology, the traditional printer and process control with digital three dimensional design, promote development of 3D printing technology.

At present, the development trend of 3D printing technology abroad shows: printing system to the development of PC and mass direction, driving device to the development of digital and communication, document

acquisition approach to the development of the network, the printer to the development of intelligence in the control operation. 3D printing technology in China has experienced the early stages of a closed development, now has basically mastered the 3D printing technology. But because of the technical content is low, the system is running slow, cumbersome software algorithm, forming precision is low, thus the production efficiency is low, do not have the ability to compete with imported system, only in the low-end market.

Therefore, to improve the 3D printing technology in China must start from the printing system software and hierarchical, construct the model of 3D data field, reasonable stratification and optimization of contour curves and use the filling path reasonable, in order to improve the performance of the printer.

II. OBTAIN 3D DATA FIELD

A. The Extraction and Classification of 3D Data Field

Three dimensional data field obtained mainly through calculation data and measurement data, which include contact and non contact type. Solid triangulation refers to the surface of entity through the contact measurement method (planar and curved surface) into triangle method. Write out a triangulation algorithm as the following [2].

(1) All vertices of polygon are preserved by circular linked list, judge convexity of each vertex in the list.

(2) In the list to select three vertices a , b , c in accordance with the order, if b is a convex point, a , b , and c form a triangle no contains other vertex, then the calculated minimum angle ΔABC . Find out all such triangles; choose the largest angle from ΔABC , save the triangle, and deleting a vertex b from the list.

(3) If the list does not contain three or more vertices, then repeat step 2.

(4) Until the list include the last three vertices, then the three vertices of a triangle formed at last [3].

Fig .1 is the triangles facet form cuboid, spherical, concave polygon and pentagram.

B. Transformation and Stratified STL Format

The STL file is a file format, it is based on the CAD entity model created or surface of CAD surface model of triangular cover and get, which is used to approximate the arbitrary polyhedral representation of a 3D entity. Polyhedron and composition by triangles, triangles are represented by a method of vector coordinates and mesh the 3 vertex [4].

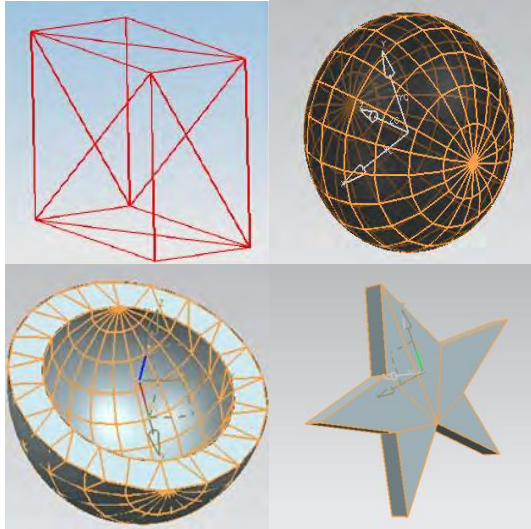


Figure 1. Triangles facet

Hierarchical processing of STL format is often called the slicing, refers to the entity triangulation of the model according to certain thickness segmentation, layer thickness determined by the specific accuracy, using two-dimensional data for storage instead of 3D data. Before stratification determine the direction of stratification at first, usually in the positive direction of axis Z for layered direction, start at the bottom of the stratified along Z axis, each layer and the model of intersection processing, get the intersection of each layer and the STL model, and then through a certain sequence link up the intersection form an 2D contour lines [5].

Fig .2 illustrates for the specific cuboids, slicing situation in the corresponding position, the black dots wherein said triangle facets and the intersection of the corresponding.

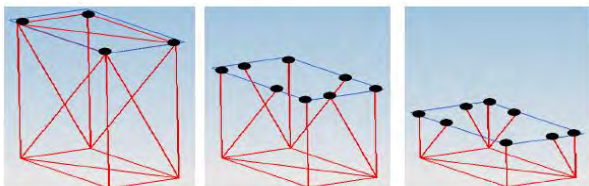


Figure 2. Layered slices of different stories

As shown in Fig .3, we can see that some points in the curve linking process has no effect, but it will take up storage space, thereby The amount of calculation increase, slows down running speed, we call this point the redundant

sink point [6]. For redundant sink point we can through a certain method to judge and eliminate.

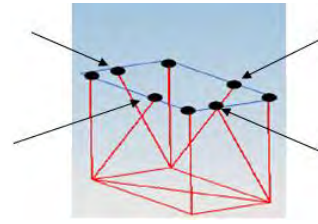


Figure 3. The redundant sink point

Theoretically speaking, the mutual relationship between stratification plane and triangle, there are several general forms as shown in Fig .4.

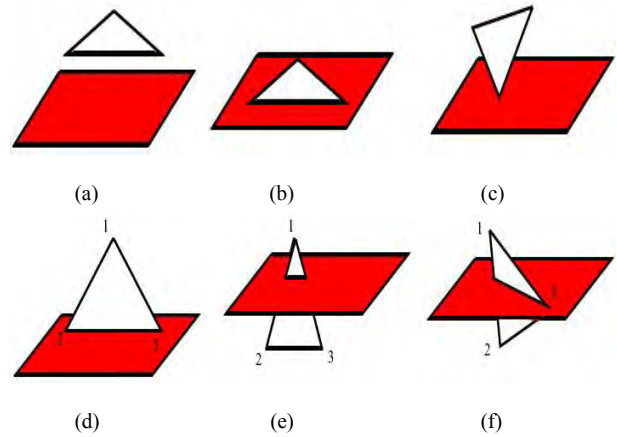


Figure 4. Relationship between stratification plane and triangle

- (a) Triangle outside of the stratified surface;
- (b) Triangle in stratification plane;
- (c) Triangle with one vertex in the stratified surface;
- (d) Triangle with two vertex in the stratification plane;
- (e) Triangle three vertexes outside of the stratified surface (different side);
- (f) A vertex of a triangle in the stratified surface with the other two vertices of different side.

First of all, due to vertices in (a), (b), (c) three figures have no impact on the contour, so on these points are ignored.

Second, as shown in (d), only 2, 3 points are the points of intersection.

Third, as shown in (e), line 1-2 and line 1-3 intersection with stratification plane are the intersections.

Fourth, as shown in (f), demand the intersection of stratification plane with line 1-2, while the other point of intersection points is 3 vertices [7].

Finally, the intersection of all sequentially link achieve hierarchical contour of STL model, as shown in Fig .5.

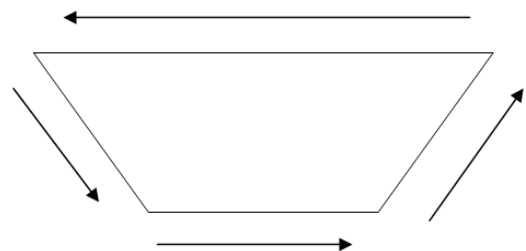


Figure 5. Cross section intersecting line finishing diagram

III. OPTIMIZATION OF LAYERED CONTOUR CURVE

It may have a hollow structure, for a complex product, so it produces many contour lines and it may be nested inside and outside, so it should be classify and judge. Tell it is inside the boundary or outer boundary.

The outer boundary refers to the number of its boundary is an even numbers (including 0) of polygon contour.

The inner boundary refers to contain the number of its boundary is an odd number of polygon contour.

The contour of the cross section may be composed of a plurality of inner boundary and the outer boundary, as shown in Fig .6.

To judge the inner and outer boundary can use the following method to judge.

Contour have limit points must be outside the boundary. Through any limit feature points on the boundary of a polygon, do ray along the positive direction, for the number of the ray intersection with all cross section polygons, if the intersection number is odd, the polygon is inner boundary; if the intersection number is even, for the outer boundary.

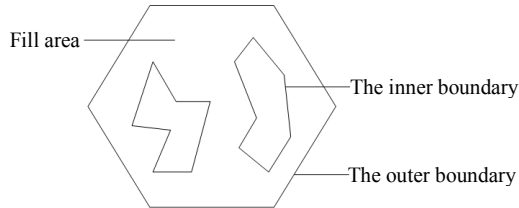


Figure 6. Fill area diagram

First of all, for the inner boundary should be filled in the external. The outer boundary to fill in its internal. Filling mode is divided into circular spiral filling and reciprocating filler, as shown in Fig .7.

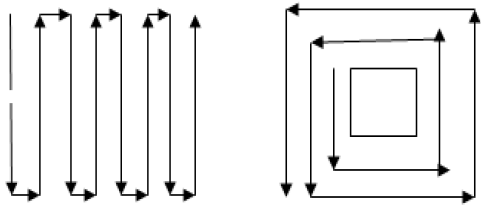


Figure 7. Reciprocating filler and circular spiral filling

Because the STL file is a file Cover the surface with triangulation, so the obtained 2D contour lines is also a kind of contour curve with approximate instead of straight line, and can not fully reflect the really a contour of object, therefore need to be optimized to complete.

First of all, the simple polygon CDT processing. Then find each triangle of the circumcenter, connected according to the connection between the triangles, to obtain a skeleton generated by less circumcenter [8]. This skeleton generated by less circumcenter known as the central axis, the circumcenter point of the central axis is called node.

For example, a certain level of the school badge, as shown in Fig .8.

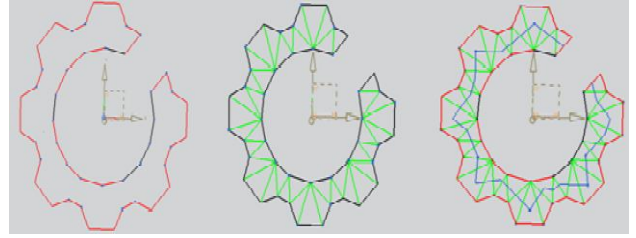


Figure 8. A certain level of the school badge

Then, classify the triangular plate. Simple polygon original edges are called external boundary, and triangulation of new edges are called internal edges. Divided triangle according to the number of internal boundary. the triangle with three internal side is called intersection triangles, with one or two external edges called boundary triangle, we only optimize on the external boundary triangle edge, first calculate the Circumcenter, also is the heart of the triangle circumcircle.

Then, search through the relationship of triangles patch. Obviously, the intersection triangles will have at least three triangles adjacent to, therefore, we start from a confluence triangle patch, along the direction of three edges search for the adjacent triangle [9]. Suppose that in the search an adjacent triangular circumcenter is R , if the triangle is a boundary triangle, then we will be added to the list of R optimization, and the search operation of the direction is suspended. If the triangle is the intersection triangles, then R will be added into the search list, and began a search operation put R as a new starting point [10].

Axis nodes gated through the above algorithm plays a very important role in our place ball strategy. First, we put a ball in each of the axis of the element node; the radius of the ball is the shortest distance between the nodes to node for three edges a triangle.

Adjust the number of ball, assume node A, B are two adjacent nodes on the axis, if A, B distance is too large, then joining new element ball between A, B fitting better, position and radius information can take interpolation of A and B information simply.

We through the $|A - B| > 0.06 \times (rA + rB)$ to detect distance of A, B if too large, the 0.06 is the empirical parameters, in the system also can be setted, as shown in Fig .9 and Fig .10.

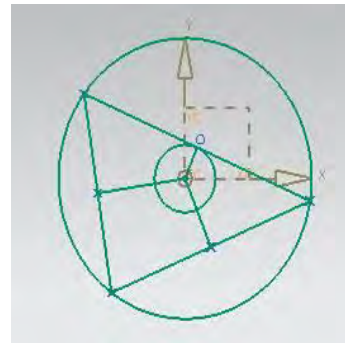


Figure 9. Ball placed schematic diagram

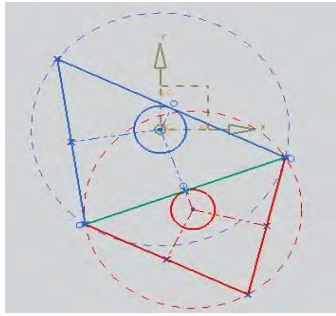


Figure 10. Schematic diagram of element ball adjustment

Since then, use function of the energy to compute the minimal to adjust the part parameter element of ball system, finally implicit surfaces were drawn using Blumenthal polygon method. This algorithm greatly reduces the determination of parameters of meatballs system complexity; it is very suitable for rapid modeling. Two profile after finally repaired, and compared with the previous contour map (Fig .11 and Fig .12).

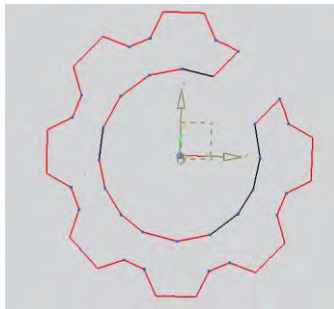


Figure 11. Zigzag curve before repaired

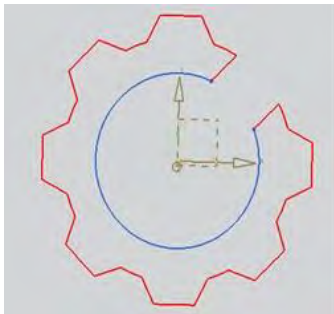


Figure 12. The smooth line after repaired

Recording layered curve data repaired down, you can print through 3D printer, as shown in Fig .13.



Figure 13. Entity graph

IV. CONCLUSIONS

Based on capture the model of 3D data field, and then according to the software conversion of STL format entity triangulation hierarchical of 3D data and 2D contour lines were obtained through layered, optimized using model meatball modeling technology. In the optimization process, first of all, we first extract the approximate axis according to the 2D contour lines of the object. Then, we walked along the axis according to certain rules placed element ball, then, we make use of the energy function to get the minimum to adjust the part parameter element ball system, finally using the polygonal method on blumenthal implicit surfaces are drawn. This algorithm greatly reduces the determination of parameters of Meatballs system complexity, easy to store data, very suitable for rapid modeling.

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