

Research Article

The Research on Improved Design and Drawing of Product Forms Based on Reverse Engineering Technology

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Abstract: In the analysis of the reverse engineering system model based on the reverse engineering system based on local surface reconstruction model based on existing measurement data directly to display 3D images and rapid prototyping, greatly reducing the time required for reverse engineering, eliminates the difficulties of a large number of complex surface modeling. In the study, the improved design of the form of product related to the free-form surface treatment, but the use of the product form the point cloud data to obtain a satisfactory surface reconstruction is difficult. NURBS surface fitting technique, the appearance of the product 1st be classified according to form and then accordingly the product shape reconstruction, it is much easier. Facts have proved that the conditions does not require high precision, the use of NURBS fitting to reconstruct the free surface able to obtain a satisfactory product form. This improved design of the product form is practical.

Keywords: Improved design, product form, reverse engineering

INTRODUCTION

Product form of improved design defects and shortcomings of the original form of product innovation or in part, modify, add beauty products and improve product quality (Wang, 2003).

Reverse engineering technology has a wide application in practice. Mainly due to the shape complexity of many products, covering parts such as motor vehicles (aircraft), artificial limbs, ceramic products, plastic products, glassware, art sculptures and a variety of complex parts, the design of its surface expression or mathematical model are very difficult, the establishment of the existing CAD system is hard to strict geometric description. Therefore, how these physical parts/geometry model after data measurement and graphical image processing, model reconstruction and interactive design, modify, market in order to facilitate rapid prototyping, reverse engineering the key. In this regard, the latest results of the analysis of a typical reverse engineering system models based on (Jin and Tong, 2003) □, the combination of visualization technology (Peng, 2004; YuMing *et al.*, 2005), proposed a system model based on local surface reconstruction in reverse engineering (referred to as local reverse), according to existing measurement data (volume data), direct display 3D images and rapid prototyping. At the same time, principles and impact of the volume rendering based on ray tracing (direct volume rendering) algorithms display efficiency factors (Vani, 2011) proposed a new method to improve the mechanical products of volume rendering efficiency.

Improved product development and design, we must first analyze the product of "bad", i.e., shortcomings, usually targeted for the effect of site components and improvements in materials, processes, structure, but these are not in this study the focus of this study focused on feature-based geometric model reconstruction. The form of product design research, the less precision of the product and therefore do not have much error in the reverse modeling process of the product. In China, the main form of improved design or in the traditional manual state, based on the improved design of product form of reverse engineering is still in its infancy. In fact, the form of improvement is most suitable for reverse engineering.

Reverse engineering to greatly shorten the product development cycle, today, the world in its economic and technological development areas, a large number of application of reverse engineering digestion and absorption of advanced technology experience and put forward some innovative ideas. Reverse engineering technology is now widely used in product improvement, it greatly shorten the product development cycle, improve the accuracy of product.

PRODUCT MODEL SURFACE RECONSTRUCTION

Product form, the shape information, the core problem is that the computer said, addressing suitable for computer processing and effectively meet the shape requirements of the geometric design and easy to shape mathematical methods of information transfer. In reverse engineering, product CAD model reconstruction

is the use of the scattered points of the surface of the product, complete the surface model by fitting these data to generate surfaces or surface patches, the last surface patches, stitching and cutting surface editing operations, Construction the most important characteristics of free-form surface reconstruction.

From the point cloud algorithm proposed synthetic surface a total of 3 categories: the parameters of the 4 sides of the domain surface fitting, surface fitting method of the triangular domain fitting technique, based on the polyhedron surface. Surface fitting NURBS surfaces, the 4 sides of the domain parameter data versatility, the algorithm is stable and strong surface editing, surfaces and good quality, has become the mainstream of the surface fitting. Its mathematical expression (Jin and Tong, 2003):

$$P(u, v) = \sum_{i=0}^m \sum_{j=0}^n d_{i,j} R_{i,k;j,l}(u, v)$$

$d_{i,j}$ $i = 0, 1, \dots, m; j = 0, 1, \dots, n$ Topological rectangular array of control point's grid.

$R_{i,k;j,l}(u, v)$ Bivariate rational basis functions (C2, continuous):

$$R_{i,k;j,l}(u, v) = \frac{W_{i,j} N_{i,k}(u) N_{j,l}(v)}{\sum_{i=0}^m \sum_{j=0}^n W_{i,j} N_{i,k}(u) N_{j,l}(v)}$$

W_{ij} Vertex links the right to re-factor to the initial state to take = 1; appropriately selected value in the adjustment phase, the greater the surface the more close to the control vertices. Corners at the vertex weighting factor for non-negative; surface fitting 1st step is to determine the node vector of the interpolation surface. Will consist of two vectors, respectively, the data points on the surface should be a control vertex. So:

$$U = \{u_0, u_1, \dots, u_{m+6}\} \quad V = \{v_0, v_1, \dots, v_{n+6}\}$$

- $N_{i,k}(u)$ For u l -th specification spline basis. General $l = 3$
- $N_{j,l}(v)$ Of v to l times specification spline basis. General $l = 3$
- Take the repeat is $r = 4; u_0 = u_1 = u_2 = u_3 \quad u_{m+3} = u_{m+4} = u_{m+5} = u_{m+6}$

Node value of the accumulated (u_0, u_{m+3}) chord length parameter Method, get cut point value of the vector can be controlled according to the Equation obtained vertex:

$$P(u_{i+3}) = \sum_{j=1}^{i+3} d_j N_{j,3}(u_{i+3}) = P_i$$

Non-Uniform Rational B-Spline (NURBS) can used to represent the analytic geometry shape (conic) can also be used to represent the freedom of curves and surfaces, it has become the standard curve and surface representation in CAD/CAM system. NURBS method is the most important advantage is the uniformity in its ability to express freedom of curves and surfaces and analytic curves and surfaces. Therefore, when the geometry at the same time the freedom of curves and surfaces and analytic curves and surfaces, the application of the NURBS method is most effective.

RECONSTRUCTION METHOD OF PRODUCT MODEL BASED ON FEATURE

The appearance of the product by a certain geometric characteristics of geometry is characterized by the geometric shape of the key elements of design and manufacturing, at the same time has to determine the geometric relationship between the geometric characteristics. In product form reverse design process is to restore these features, as well as the constraints between them. In general, the CAD model of the form of product by the different geometric shape of the surface after extension of the transition, cutting mixture. This study discusses the product form characteristics are divided into two categories, namely, the basic classes and free-form surface. The basic class of geometric features can be divided into a prism, pyramid, cylinder, cone and ball, freeform surfaces in the CAD software, the formation process is divided into a boundary blend surface and variable scanning surface. The free surface of this classification is to better and CAD software interface shown as in Fig. 1.

The digital product is reverse engineering, we must 1st solve the problem. At present, digital methods are mainly divided into contact and non contact measurement. Contact measurement refers to the measurement head and the physical surface contact, the use of equipment: Coordinate Measuring Machines Coordinate Measuring Machine (CMM); CNC machine

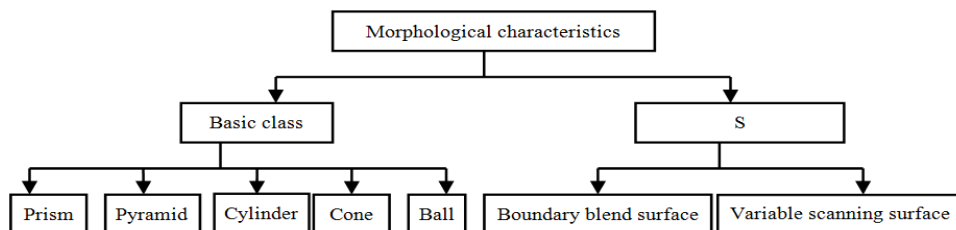


Fig. 1: Classification schematic of morphological characteristic

tools (NC) plus measuring device; dedicated digitizer (digitizer was). This way more mature, but the measurement speed and accuracy are relatively low, but not suitable for the measurement of the soft kind. With computers and the development of photovoltaic technology, computer image processing as a primary means of non-contact measurement techniques have developed rapidly, such as the grating method, holography, 3-dimensional measurement of the depth image and laser triangle. The projection grating and laser triangle are generally used for the external shape of the physical prototype measurements; the measurement cannot do anything inside the object contour. The use of computed tomography machine (Industrial Computed Tomography, ICTs) can produce a very thin tomography images (thickness less than 1 mm), higher image resolution, very fast, direct access to the cross section of objects the data. While the industrial CT is higher cost, but does not damage the physical, no spare parts and copies of the complex shape of the physical measurement. □ Volume data (volume data) is limited space on 1 or more of the physical attributes of a set of discrete sampling, when the space dimension is 3 o'clock, known as 3-dimensional volume data voxels is composed of volume data the basic unit. Therefore, the volume data by a large number of voxels. Different representation of the body of data in a computer, it will directly affect the subsequent volume rendering algorithms, in order to ensure the accuracy of image display, we use the structure of the array represents the three-dimensional volume data (other methods include polygon edge of the table, eight tree, etc.). This intuitive way corresponding to the voxel gray value and structure of the array subscript. The voxelization task is continuous geometric description of the object converted into voxels closest to the object representation of the discrete data set. Inevitably result in loss of information, the voxelization algorithm design, precision (reduce or eliminate aliasing) is the primary consideration, followed by the invariance of the topological relations and algorithm efficiency in the conversion process (Zhou, 2011; Li *et al.*, 2011).

Electrolux Zoe drum washing machine, for example the characteristics of product form classification. First from the scanned point cloud shown in Fig. 2 and 3 is a exploded view of the exterior surface of the washing machine in the treated products; A shape characteristic of a number of shape elements. For example, a circle, which consists of 2 round face and a cylindrical surface? In most of the feature modeling system and they are based on the existing geometric modeling techniques, such as the CSG, the BR and scanning transform method to generate the shape characteristics.

Boundary blend surface is often used in surface modeling, it is based on the reference curve to create

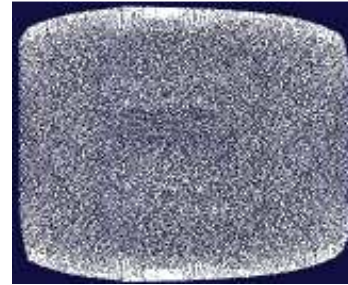


Fig. 2: Point cloud on the surface part of electrolux washing machines

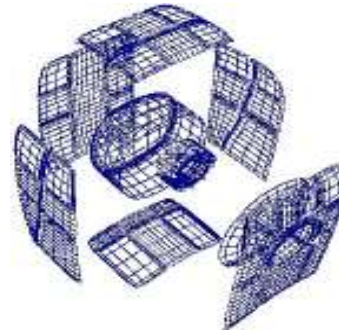


Fig. 3: Classification schematic diagram of product form feature

these reference curves define the curve in 1 or both directions. In each direction to determine the 1st and the last curve to define the boundary of the surface, increasing the reference surface can make the shape of the surface more accurate (Fig. 2 and 3).

It is assumed, based on point cloud to determine the 2 boundary curves and guides for this surface can be formed through the following transformation:

$$Q^b(u, v) = P^h(u, v)[T(v)]$$

$$P^h(u, v) = [1 - a(v)]P_0^h(u) + a(v)P_1^h(u)$$

$$P_i^h(u) = [p_{ix}(u) p_{iy}(u) p_{iz}(u) 1], i = 0, 1$$

$$Q^h(u, v) = [q_x(u, v) q_y(u, v) q_z(u, v) 1]$$

$a(v)$ = A mixed function

"h" = A homogeneous transformation

$[T(v)]$ = The homogeneous transformation matrix can be expressed as:

$$T(v) = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ c_x(v) & c_y(v) & c_z(v) & 1 \end{bmatrix}$$

where, respectively, to guide the line x, y and z unit.

Feature lines either in the point cloud at the edge of, or in the curvature changes sharply at these two

types of feature lines are basically constitute the "appearance of the skeleton of the surface model, surface model is divided into a geometric characteristics of a single surface patch, as shown in 3 shows. Rely on the feature line can be divided into point cloud area of the original point cloud base, by the relative characteristics of single curvature change regularly and roughly 4 sides of the domain distribution, the point cloud segmentation to ensure the quality of the leaflet surface fitting:

```

Calculate Intersection_Min (); CalculateInter
section_Max (); the/* calculate the light and
surrounded by objects of cuboid 6 intersection
(where 4 is the minimum and maximum values of
the false intersection) */sort (); /*6 intersection
along the ray direction from small to sort
*/Voxel_struct Intersection; /*only two true point
of intersection */for (i = 1; i <= 6; i++) {
    Intersection_Reverse_Translate ();
    Intersection_Reverse_Rotate ();
    /*the intersection of the cuboid (0, 0, 0)
reverse translation and rotation transform */
    Voxel [z] [x] [y] = (0, 0, 0) of the difference of
the intersection with the cuboids;
    If ((z <= z-max), && (x <= x-max) && (y <=
y-max)) or {
        Voxel [z] [x] [y] is the intersection;
        Intersection of [number] = Voxel [z] [x] [y];
        number++; of
    }
    else Voxel [z] [x] [y] is not a point of
intersection, discarded;
}

```

Seen, this judgment is clear and simple programming easier to achieve. Slightly more part of the computation lies in the intersection of the reverse translation `Intersection_Reverse_Translate ()` and the rotation `Intersection_Reverse_Rotate ()`, but only a maximum of six such operations, this computation is acceptable. In this study, the Visual C++ developed an experimental system, the above algorithm. Its main interface used 2 windows (view), the left-most window is equivalent to a navigator (navigator) and the right of the window used to display various results of these 2 windows is managed by a separate window (CSplitterWnd) support the popular split-window style. In order to verify the correctness of the above algorithm, by the MDT design solid model of 3-dimensional end cap and then computer-generated 60-

storey 2-dimensional tomography images. End of 183×135×60 voxels and draw the results. Experiments show that the method greatly improves the speed of the intersection, to improve display efficiency of the body drawn to a certain extent.

CONCLUSION

The combination of surface, the combination of surface contains a large number of free curves and surfaces, but also the existence of analytic curves and surfaces. Thus, full use of the method has the advantage of NURBS curve and surface reconstruction to get a good effect, reverse engineering technology and NURBS reconstruction of Electrolux Zoe drum washing machine instance and reconstructed on the basis of the product of the improved design. The reverse design of the product form a high starting point, low cost, short cycle, easy modification, easy and innovative features, has been since the emergence of modern industrial designer's attention.

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