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# Based on the cross section contour surface model reconstruction

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**Abstract**—Based on the characteristics of the reverse engineering modeling technology, can effectively restore the original design intent of products, to shorten the development period of industrial products, improve the industrial fields of product innovation design ability of major significance and value. This paper STL Viewer software to obtain the section curve of refactoring, obtaining high quality of reconstruction model, through cross section data preprocessing in the first place, the cross section data are the initial segmentation; Secondly to add constraint section curve reconstruction; The last generation CAD model. Examples prove that this method is feasible and effective.

**Key words**—cross section curve; Reverse engineering; Surface reconstruction

## I. The Introduction

Facing the rapid development of science and technology and increasingly fierce market competition, product update cycle is more and more short. In society, therefore, the company's market competitiveness mainly reflected in the technical innovation ability, for the new product development ability and speed of development. However, win the market competition, the key point is that how to lower costs and higher efficiency of develop new products. Due to the traditional development mode is hard to meet the demand of market competition, and reverse engineering technology is very important in product rapid development advantages, therefore obtained the widespread attention and rapid development.

In recent years, in the actual process of the section curve of reverse modeling of the commonly used method is: the cross section data are segmented according to the discrete curvature of cross section data information and the experience of the engineers, segmentation points extraction and cross section data, thus the data segments of single feature reconstruction. Tai and Huang [1] based on the cross section data of discrete curvature information for cross section data block, and every piece of data for b-spline curve fitting with boundary constraint; LV [2] in the object structure can be divided into regular and irregular basis, put forward the improvement of the positive and negative curvature factor analysis method and a polygon approximation method, the cross section data are roughly segmented to reconstruct cross section data; Xu Jin[3] logarithmic stronghold even arc length after resampling process, using the discrete curvature between adjacent point symbol value and the changes of curvature and curvature difference, to automatic identification of feature points; Wang Yinghui [4]in this paper, a approximate curvature method to identify the characteristics of the planar contour points, the method to solve the linear and circular cross section data refactoring; Hai-bo Zhang[5]improved optimization reconstruction method is proposed, first by curvature analysis for determining the ideal section area, within a certain range is of high precision after reconstruction.

Combining above on the research of the cross section curve segment and reconstruction, this paper STL Viewer software to obtain the section curve of refactoring, obtaining high quality of reconstruction model, through cross section data preprocessing in the first place, the cross section data are the initial segmentation; Secondly to add constraint section curve reconstruction; The last generation CAD model.

## II. Cad model reconstruction strategy

STL Viewer reverse engineering software is oriented feature 3 d CAD model reconstruction software, software is zhang xu, Shanghai engineering technology university group independent development of reverse engineering CAD modeling software, not for commercial use, mainly to serve the scientific research of the laboratory team. STL Viewer software based on imitation of leaf blade body parts reverse CAD model reconstruction.Figure1 is imitation of leaf blade body is designed after the processing of physical parts, part is the blade body parts, parts is easy to measure and design a portion of the base, the bounding box the size of 140.00 mm x 140.00 mm x 35.00 mm, the machining accuracy of 0.02 mm.

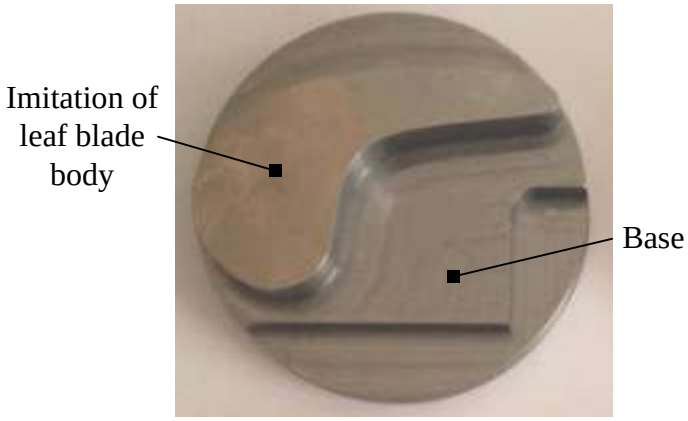



Fig.1 Actual part after forwarding design machining

On the base of imitation of leaf blade body part, is the object of this reverse CAD modeling. Clearly, this is a stretch. So you just need to cross section measurement data and extract the tensile thickness. Using STL Viewer reconstructed section sketch, then import the UG software, will cross section sketch in perpendicular to the direction of the cross section, namely the drawing direction, stretching a certain thickness. In this way, the imitation of leaf blade body CAD models can be reconstructed.

## III. Cross section data acquisition and preprocessing

As shown in figure 2, the use of three coordinates measuring machine to measure, set up the workpiece coordinate system, in imitation of leaf blade body parts to measure any section on the point cloud data, in addition to measure the thickness of the stretch.

In general, due to many factors, such as human, environment, machine measuring point cloud data have a certain amount of noise, therefore, to deal with the noise of the point cloud data. But because of the cross section of the data obtained directly by three coordinates, the measuring accuracy is higher, the quality of the data is good, can be used directly, without the denoising of data processing. At this point, by discrete curvature estimation section data of information, on the basis of the cross section data fragmentation. Figure 3 a is to obtain the cross section of discrete curvature information of data, the data determined by human interaction between section, the data can be classified into 4 pieces. After cross section data is segmented point section, the characteristics of the single data segments can be determined, the segmented results as shown in figure 5-4 B, a total of 2 B spline curve, 1 arc line, 1 paragraphs.

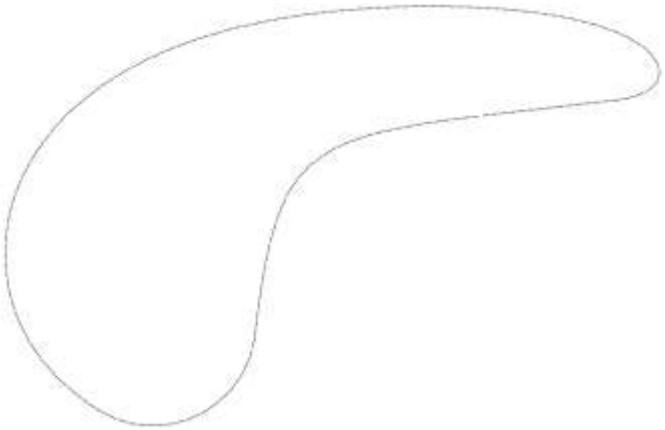
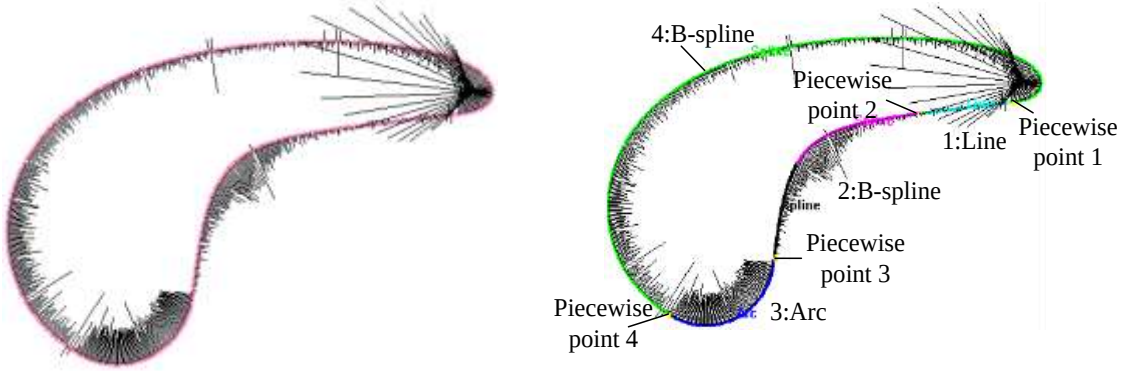


Fig. 2 Section data point measured by CMM

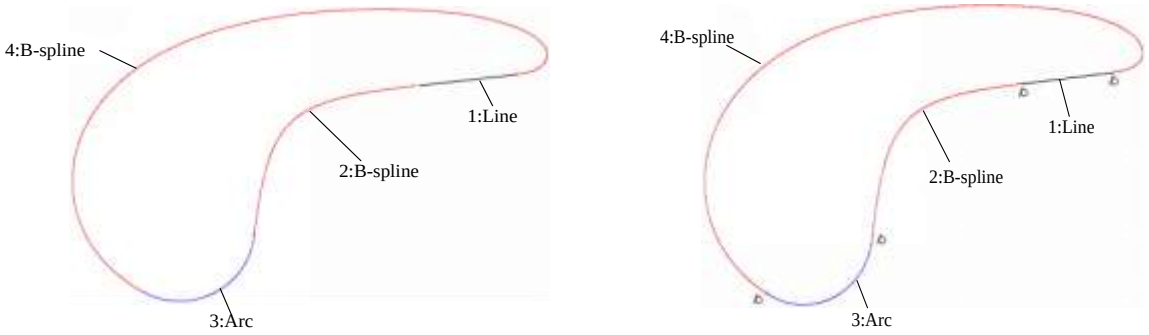



(a) Curvature figure of section data point (b) Segment the data point

Fig. 3 Segment of section data and interactive specify the features

## IV. Section data refactoring

First section in the cross section data after the straight segment, circular piece of data, data free curve data, reconstruct not adding constraints, as shown in figure 4(a);Then as initial value, the golden section method is used to extract feature between high precision segmentation points;To impose constraints between the various features, as shown in table 1 mainly between straight line and B spline curve, arc and b-spline curve between G1 continuity constraint (tangent), using Lagrange multiplier method to solve feature reconstruction model, mainly the G1 continuity constraints of free curve reconstruction model.Cross section data refactoring results as shown in figure 4 b.



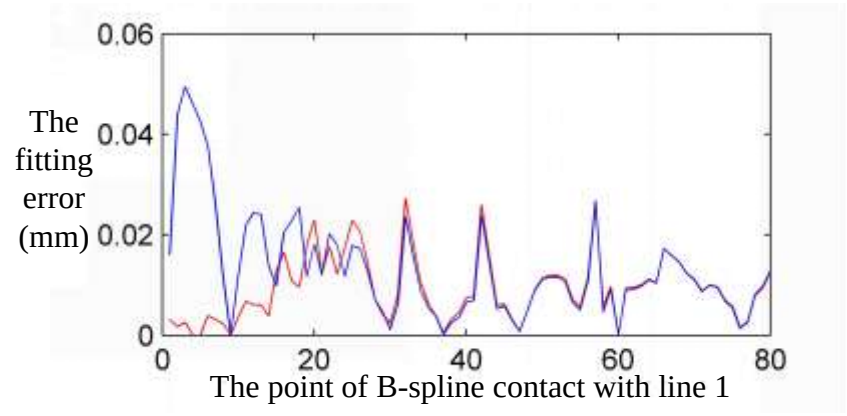

(a) Reconstruction result without constraints (b) Reconstruction result with constraints

Fig. 4 Reconstruction results

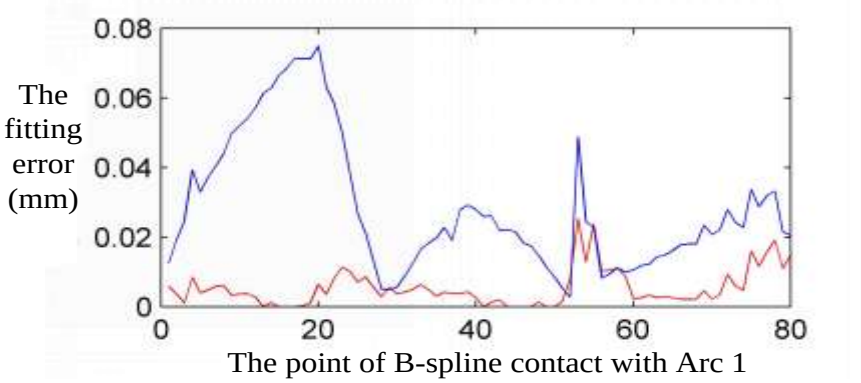
Table 1 Contraints between features

| Constraint features A | Constraint features B | Constraint type | The fitting error comparison chart |
|---|---|---|---|
| Line | B-spline 1 | tangent | Fig5a |
| B-spline 1 | Arc | tangent | Fig.5b |
| Arc | B-spline 2 | tangent | Fig.5c |
| B-spline 2 | Line | tangent | Fig.5d |

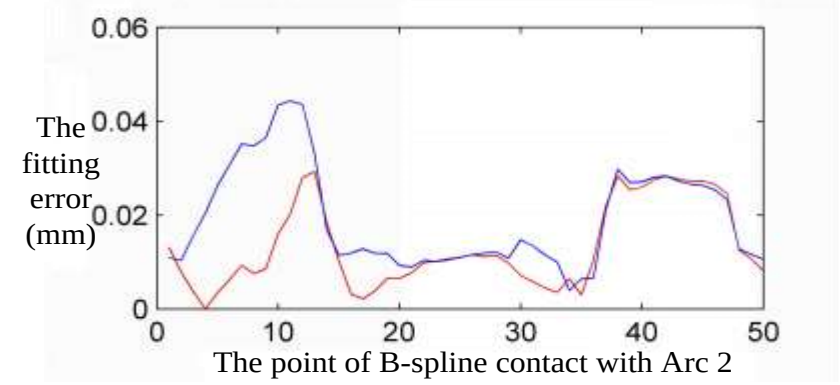
Among them, the red - optimization segmentation point after this method;Blue - staging point without optimization.



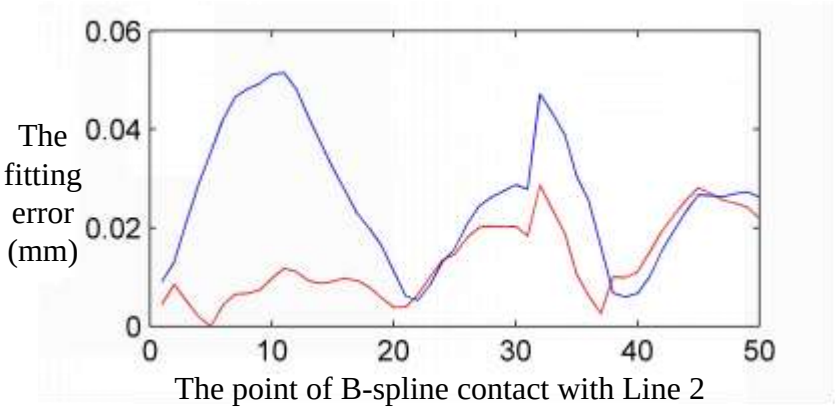

a) The fitting error




b) The fitting error




c) The fitting error

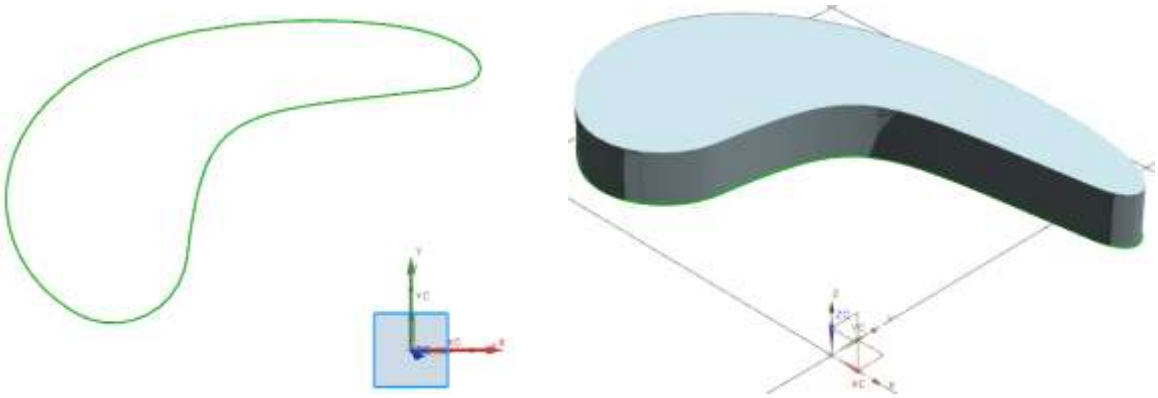



d) The fitting error

Fig.5 The fitting error contrast figures of free-form curve before and after optimizing the segment points

## V. CAD model generation

In STL Viewer software, the completion of cross section data refactoring, the section of curve reconstruction after the save as IGES format file, and enter into the NX UG, through section sketch drawing into surface model, and then through the surface and thicken operation generates the entity model, as shown in figure 6.



(a) Section sketch (b) Solid model

Fig.6 Buliding the CAD model

Using The NX UG7.5 "- Metrics Analysis - Deviation In The Software Measurement Point Cloud Data Refactoring Entity Model And Calculate The Error Between Original Parts CAD Models.As Shown In Figure 7, Is The Solid Model With The Original Theory Of Reconstructing The CAD Model Of The Maximum Minimum Error Between The Calculation Diagram, The Maximum Error Less Than 0.042 Mm, The Average Error Is Less Than 0.022 Mm, Shows That Using Cross-Section Data Of Optimization Reconstruction After The Reconstruction Of The Entity Model, Meet The Actual Requirements On The Reconstruction Quality.

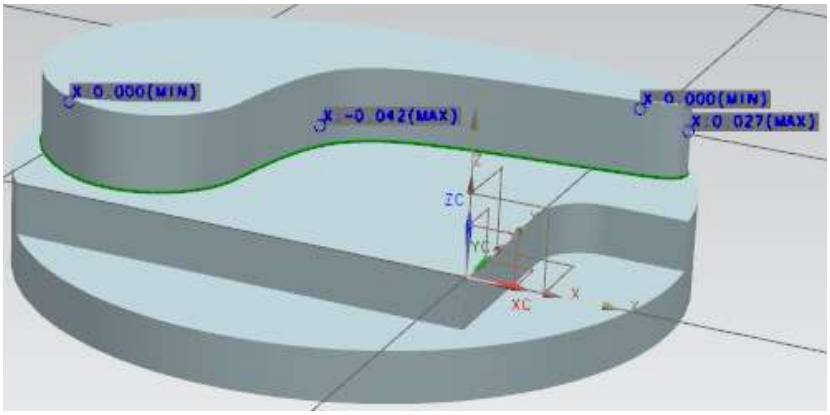



Fig.7 The error contrast figure of rebuilding solid model and theoretical model

## VI. Conclusion

In this paper, using STL Viewer software, on the cross section data obtained by the CMM refactoring, reconstructing CAD model of high precision are obtained. This paper provided by the method has the following advantages:

1. In this paper, by using the software with our own development, innovative model reconstruction;
2. According to the measurement of the original data refactoring, the CAD model precision;
3. In this paper, at the same time to the error analysis of model, model is reliability.

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