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DELIVERING QUALITY SCIENCE TO THE WORLD

Application of Reverse Engineering in Industrial Design Based on Mouse Shell Research

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Abstract: Reverse engineering is measured from the physical model of the data to construct the CAD model of the object, and then use these models for product analysis and manufacturing. Compared with the traditional forward design method, reverse engineering is applicable to the manufacture of products with only product or in-kind models without product drawings. This dissertation starts with the use of reverse engineering to manufacture mouse housings and studies the feasibility of using reverse engineering to innovate industrial designs. It studies the positive impact of reverse engineering upon the introduction of industrial designs.
Keywords: reverse engineering, industrial design, mouse shell.

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1. INTRODUCTION

Reverse engineering is based on the measured data of the physical model and reconstructs the physical CAD model through 3D geometric modeling. Using models and designs for product analysis and manufacturing. Compared with the traditional positive design method, product manufacturing can be achieved without product drawings by reverse engineering. The development of conventional industrial products begins with the determination of expected functional and specification objectives with product structure. Each part has a design drawing and is processed according to the determined craft file. Such development work is called forward engineering or forward design.

Reverse engineering mainly includes the following steps: digitization of part prototypes, feature recognition, reconstruction of part prototype CAD models, and revision of CAD models. The main components of the reverse engineering system include measuring probes (sub-contact and non-contact), measuring machines (coordinate measuring machines, multi-axis articulated robots, laser tracking stations, etc.), and data processing software, and model reconstruction software, CAE software, CNC machining equipment, rapid prototyping machines. The model processing software mainly includes three types, one is a CAD/CAE/CAM software for forward design, but the data processing and inverse modeling functions are limited; the second is a forward CAD/CAE/CAM software integrating an inverse function module; the third is dedicated product data management (PDM) software.

2. RECONSTRUCT MOUSE SHELL PROCESS

The first impression of consumers on products often comes from the appearance of the product. Although the functions of CAD systems have been very powerful, due to many reasons like algorithms, they can only be modeled based on the limited information provided by designers. There are many information designers unable to express and input into traditional methods. This leads to the deviation of the CAD model and the original idea of designers. On the other hand, it is difficult for the designer to obtain the precise data of the product based on the existing products. Creating a three-dimensional model in a CAD system is also very difficult. Reverse engineering can obtain useful information from the physical model, accurately reproduce the physical model as a digital model, and make further design [1].

The first and most critical step in the reverse engineering process is to use various means to collect data on physical models. If you do not collect enough data or sufficient accuracy, reverse engineering will not continue. At present, there are many kinds of measuring methods and measuring equipment for obtaining product appearance data. Their principles are different, and they also have advantages and disadvantages [2]. In order to achieve the best effect of the reverse process, appropriate reverse methods and equipment must be used according to specific needs.

2.1 Obtain data

To meet people's requirements, the design of the mouse is increasingly focused on ergonomics. The shape changes from a simple geometric shape to a complex free surface. Use the scanner to scan the mouse. There are several ways to fix the mouse on the workbench. The measuring probe is divided into contact type and non-contact type [3]. Measuring machines include coordinate measuring machines, multi-axis articulated robots, and laser tracking stations. Measure the mouse using a non-contact laser scanner (Fig. 1) to obtain surface point data.

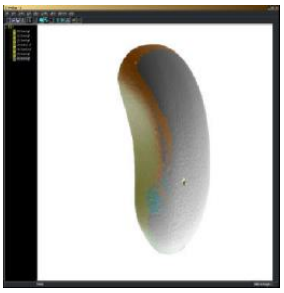


Fig.1 Non-contact laser scanning Fig.2 Completely chimeric point data

2.2 Measurement data preprocessing

In the process of reverse engineering, reverse measurement equipment provides a lot of redundant information to the CAD system. This exceeds the need for modeling and even exceeds the processing power of the CAD system. From the previous analysis, it can be seen that the measurement system can collect a large amount of original data of complex surfaces. These data are object surface point coordinates or cross-sectional images. Conventional CAD systems cannot handle this data completely. Therefore, it is necessary to perform a series of data processing on the obtained point cloud data. These tasks include data smoothing, data reduction, data segmentation and data fusion,

coordinate transformation data derivation and reorganization, and feature extraction. The preprocessing of measurement data includes: the combination of measurement data, noise point removal, and coordinate correction, acquisition of cross-section data points, re-sampling of data points, and reordering of cross-sectional data points.

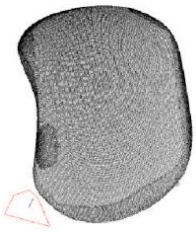


Fig.3 Delete surrounding noise data

First of all, we combine the measurement data. One method is to select the overlapping part of data in the point group. The other method is to use the basic pixel to determine the location. The point fusion data obtained by the latter measurement is shown in Fig. 2. The point data of the fixture or the surface roughness of the workpiece will interfere with the point data. The surrounding noise point should be removed. The processing result graph is shown in Fig. 3. During the measurement process, in order to facilitate scanning, we avoid interference with laser scanning and CCD data. The point cloud will not be aligned with the standard coordinate system. In order to facilitate the follow-up work, we need to use the positioning function of surfaced software to perform point cloud coordinate correction. The adjusted point cloud position is shown in Fig. 4(a) (b) (c).

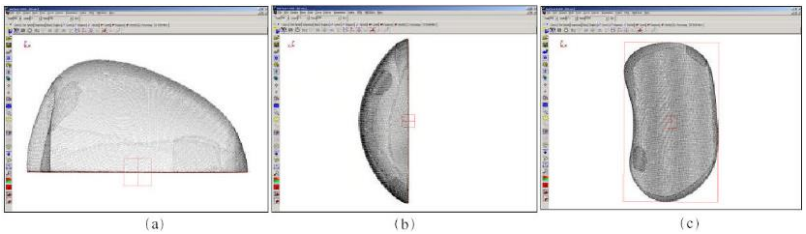


Fig.4 adjusted point cloud position

The curve of the construction surface can be used to specify the plane normal vector and interval in section and the required section point data can be extracted. Sections can be selected in parallel, circular, radial and so on. This example cuts 30 sections in parallel along the Z axis to obtain the data points of the section, as shown in Fig. 5(a) (b).

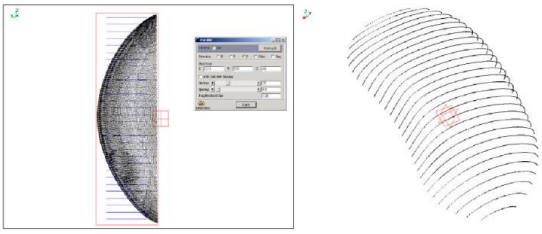


Fig.5 Point cloud section

Due to the defects in the surface of the mouse model , the laser scan results is in a partial damage, and the interpolation point data needs to be corrected. Fig. 6 shows the comparison before and after the software interpolation. Rearrange the cross-section data points to obtain Fig. 7.

2.3 Data processing

First we need to fit the curve. The parameters are set so that the mouse shell model could produce a feature construction line and its surface is segmented. Fit the surfaces separately. Make sure that there must be no gaps between the segments. By setting the number of control points and the curve smoothing value, the software automatically performs curve fitting, as shown in Fig. 8. Based on the generated curves, the lifting surface shown in Fig. 9 is constructed, that is, and the surface creation process.

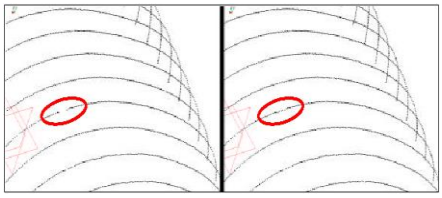


Fig.6 comparisons before and after the software interpolation

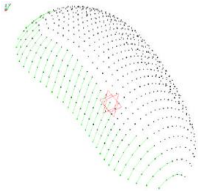
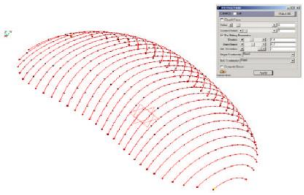


Fig.7 Section data rearrangement diagram



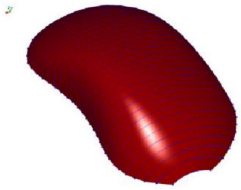
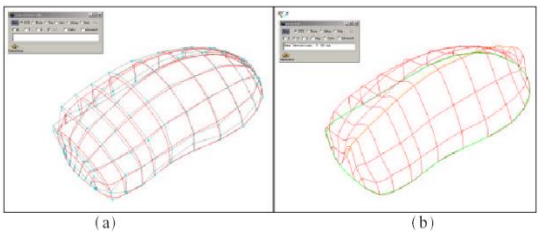


Fig.8 Curve fitting Fig.9 the lifting surface

Incomplete section data can lead to incomplete surface descriptions. You can create a boundary curve from the original point cloud data, reconstruct the surface, and merge it with the original surface to form a single surface. If the error between the curves is too large, the surface may form wrinkles and other non-smooth conditions. It can be edited by adjusting the control point of the surface or directly adjusting the mesh of the surface, as shown in Fig. 10. The edited surface is shown in Fig. 11.



(a) The control point of the surface (b) the mesh of the surface

Fig.10 adjust the surface map

The curvature can be used to analyze the smoothness of the surface and evaluate the quality of the surface. Fig. 12 shows the results of the Gaussian curvature analysis. Green indicates smoothness, and red or yellow in some areas indicates that the curvature of the area changes greatly. If an area of the surface is not smooth, you need to re-edit the surface for local adjustment.

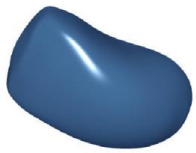


Figure 11 Complete surface map

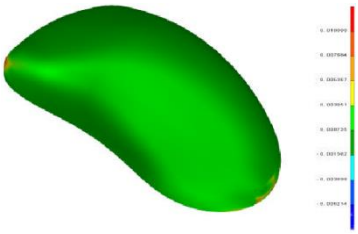


Fig.12 Gaussian curvature smoothing surface Fig.13 Three-dimensional solid model figure

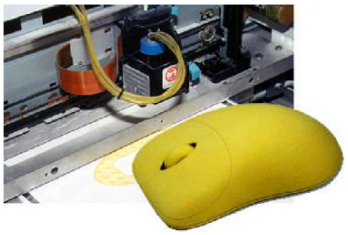


Fig.14 Rapid prototyping

Fig. 13 shows a 3D solid model created from a surface model. Fig. 14 shows the solid model. The model can also be used for further analysis (CAE) or the model can be used directly for the development of the mold.

3. CONCLUSION AND OUTLOOK

According to this analysis, reverse engineering can efficiently complete the reconstruction of the mouse shell. It can be successfully extended to industrial design. At present, most of the products in the market are based on the improved design of previous generations of products, and there is ample room for improvement. Using reverse engineering, you can learn from each other. At a time of rapid development, any highly efficient design method suitable for product introduction and innovation will be welcomed by companies and designers. Reverse technology will no doubt be used.

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