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Research on Synthetic Design Method of Mechanical Product Shape

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Abstract

Objective, in order to better design the mechanical product shape, improve the satisfaction of users, and improve the efficiency of scheme design. Methods, this paper presents a comprehensive design method based on genetic algorithm to design the modeling of mechanical products. First complete the product positioning; The mapping relationship between user requirements and actual parameters is established based on aesthetic principles, and the evaluation model is established. Using genetic algorithm to seek the optimal solution of evaluation model, based on Visual Basic language to optimize the data in SOLIDWORKS quickly generate 3D model. In conclusion, this paper quantifies user requirements through aesthetic principles, and quickly completes the modeling process based on secondary development, which provides a new comprehensive design method for modeling design.

Keywords

Modeling Design; Aesthetic Principle; Genetic Algorithm; Secondary Development.

1. Introduction

As the application process of intelligent manufacturing accelerates, design, as the first stage of intelligent manufacturing, integrates with manufacturing technology and provides important support for subsequent processing and assembly [1]. Customer demand drives modern design, with knowledge acquisition as the center, and modern design ideas, methods and modern technical means as tools. Design changed from production oriented to market oriented and finally to customer oriented [2]. At this stage, the product becomes more and more user centric. Only the products that can effectively grasp the needs of users can have a broader market. Mechanical products, as complex industrial products, traditionally take safety and reliability as the starting point, but users also have new expectations for product aesthetics.

In terms of comprehensive evaluation methods, the use of genetic algorithm for optimization operation has also been applied in many fields. Fan Kejian [3] used genetic algorithm to optimize injection molding process. Zhang Lei [4] adopted non-dominated sorting genetic algorithm to select the product design scheme with the optimal green attribute. Yin Fengfu [5] optimized the disassembly sequence of mobile phone by two-population genetic algorithm. Compared with the comprehensive evaluation in the later stage of the product, the multi-objective comprehensive design process in the early stage of the product is more complex. In this stage, it is not only necessary to obtain the main needs of users, but also to accurately analyze the needs of users and quickly complete the presentation of the design results.

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2. Basic Theory of Integrated Design

2.1 Elements of Aesthetics

The PRINCIPLE OF FORMAL BEAUTY can be summarized in eight aspects: unity and change, symmetry and balance, contrast and harmony, rhythm and rhythm, emphasis and echo, gradual change and transition, proportion and scale, stability and lightness. Birkhoff[6] was the first to quantify aesthetics. In the Birkhoff aesthetic measure equation, the result value of order number divided by complexity number was used as the evaluation of aesthetics.

$$M=O/C$$

Where M represents aesthetic measure, O represents order degree, and C represents complexity.

2.2 Genetic Algorithm

Genetic algorithms are based on computer simulation studies that imitate the basic principles of biological genetics. In this paper, MATLAB genetic algorithm toolbox for data operation, the steps are as follows:

(1) determine the objective function.

(2) Write M files.

(3) Enable GUI graphical user interface, input unknowns and constraints, complete the setting of crossover, mutation and other attributes.

2.3 Solidworks Secondary Development

Solidworks provides users with powerful secondary development interfaces (API), which include a large number of functions to be recognized and used by VBA,VB.NET,C#,C++ and other programming languages [7]. This article is developed based on SOLIDWORKS built-in macros. The operation steps are as follows:

(1) complete macro recording by creating a new part;

(2) edit the recording code;

(3) Insert the user form to complete the interactive interface;

(4) Edit window text box and other command buttons to complete code input;

(5) Debug the code and test whether the form is used normally.

3. Comprehensive Design Model Construction

One of the essential attributes of industrial design activities is "synthesis". According to the design characteristics of product modeling design problems, this paper carries out process design on the basis of comprehensive design. The specific process is shown in Figure (1) :

3.1 Demand Analysis

The vocabulary related to morphological design was collected from product catalogs, related websites and books as well as previous relevant research literature, and the KJ method was used to screen the vocabulary. The screened perceptual vocabulary was classified by questionnaire survey conducted by relevant professionals. On the premise of ensuring that each word can be classified, the words with similar properties are not repeatedly assigned to the same class, and the frequency of pairwise words appearing in the same group is counted to obtain the similarity frequency matrix. SPSS was used for multi-dimensional scale analysis and cluster analysis, and representative words were obtained.

3.2 Determine Evaluation Relationship

Define the main design parameters of design modeling, and complete the evaluation relationship according to the determined design parameters and different design element formulas.

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3.3 Optimized Objective Function

Based on MATLAB genetic algorithm tool, the comprehensive evaluation model was optimized and analyzed, and the fitness function formula was established:

$$f_{OM} = -y$$

$$-y_{max} = y(x)_{min} = -\frac{M1 + M2 + M2 + \cdots + Mn}{n}$$

Mn represents the evaluation value of the NTH design element, and n represents the number of all design elements. In this way, the objective function is summarized and the M file is prepared. Set the default value of initial population and the default value of termination conditional evolution algebra.

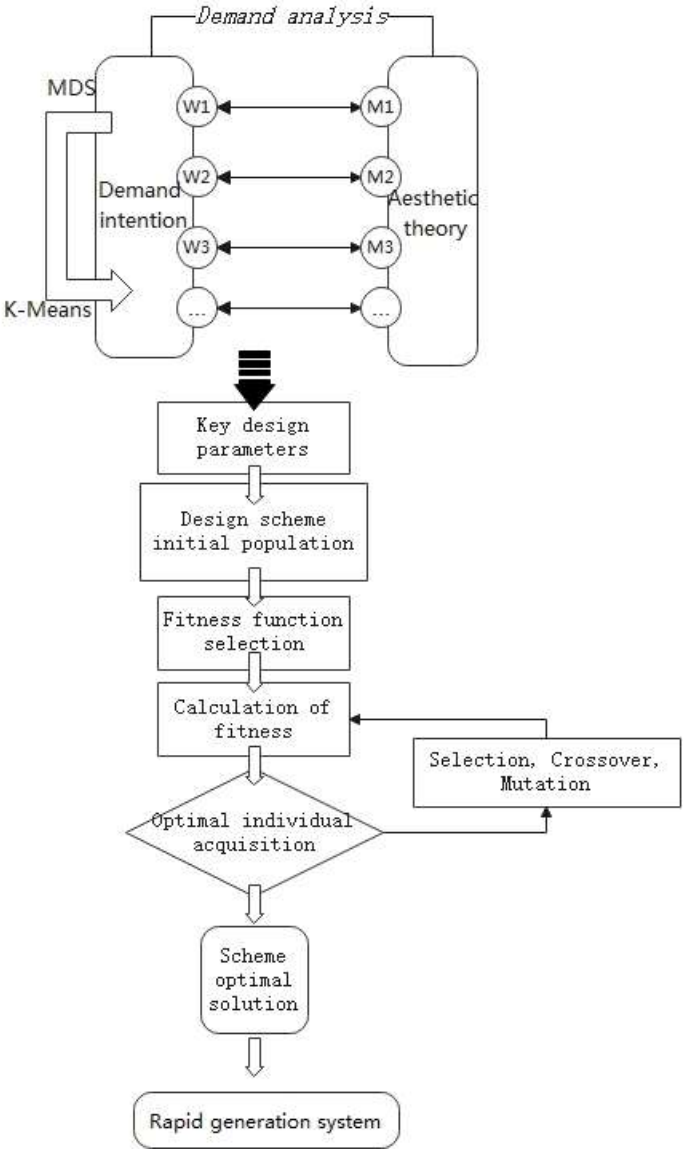

Fig. 1 Construction flow of comprehensive design model

3.4 Rapid Model Building

Open SOLIDWORKS macro recording, sort out the obtained code, delete some code that is not functional and some unnecessary interface movement operation code, debug, and complete the code

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editing. Create the user form, and set the required command button and input text box in the form, and set each attribute in the form, get the user form.

4. Conclusion

In this paper, the user demand as the main goal, determine the orientation of the design, combined with aesthetic principles, establish mapping evaluation relationship to the demand target, and get a comprehensive evaluation model. Based on the comprehensive evaluation, the objective function is established by genetic algorithm, the evaluation model is transformed into the optimization model, and the optimization scheme of parameters is measured. The recovery 3D model is established by the secondary development of SoliWorks. This method improves the design efficiency and accuracy.

Acknowledgments

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