

Research of Product Design based on Improved Genetic Algorithm

Li Ma

*(Zhejiang Industry Polytechnic College Shaoxing Zhejiang 312000 China)
zjsxmali@sina.com*

Abstract

On the basis of researching combination principle and genetic algorithm, this paper proposed connecting combination principle and genetic algorithm to innovate design of products, apply combination principle to determine the general shape of products or size range, and apply genetic algorithm to make detailed improvement or innovation to the form of product. The feasibility and practicality of algorithm is verified through describing television. This algorithm can generate product form with certain innovation.

Keywords: *combination principle; genetic algorithm; product design*

1. Introduction

With the rapid development of China's economy and the acceleration of global economic integration, innovation of product design has already become one of the standards as whether enterprises can develop rapidly. Modern technologies are systematic and complicated, resulting in that most of today's products differ little from each other in technology level and using function, so design of product form has already become the decisive factor to whether consumers choose the product.

In research of product form design, the intelligent algorithms are used to carry out conceptual design ideas and all kinds of creative techniques, especially the use of genetic algorithm for product form innovation design research opens up a new way. In recent years, there have been many researches on the two kinds of theories for innovation design. A genetic algorithm based product modeling design optimization method is proposed in the paper, and a semantic based product modeling evolutionary design model is constructed. Through the product structure modeling gene and the genes that encode strings and fitness function, to product design scheme was optimized and the formation of a new plan, application of panel furniture design to verify the method of suitability. Literature [2] proposed to code the product modeling, the weights of target customers involved in the evaluation of modelling parameters; product design modeling code level according to the sequence of weights; through the level of degradation of the original solution space for data processing, each drop level using an interactive genetic algorithm to search the optimal solution, step by step to complete design detailed design. [3] proposed the concept of quality structure, quality structure model to characterize the complex product quality characteristics and based on the quality of the product structure design model of complex product and system parameters was established, call improved particle swarm optimization algorithm to solve, thus completing the complex structure product parameter design process, quality products with complex structure parameter design provides a new way of thinking. The global optimization ability of genetic algorithm is proposed to optimize the BP neural network, and the hybrid GABP algorithm is constructed and applied to the design of notebook product modeling and [4]. A product image modeling optimization design method based on support vector machine and particle swarm optimization is proposed in [5]. Literature [6] the weight of product target users to participate in the evaluation of shape parameters; product design of shape coding step graded according to the sequence of weights; through the ladder downgrade the

original solution space for data processing, each degradation using interactive genetic algorithm method to search for the optimal product design solution, step by step to complete design detailed design.

On the basis of the above research, this paper proposes an innovative design method of improved genetic algorithm, and this design method can effectively consider external and internal influence during the process of designing products, thus it has certain significance of promotion.

2. Morphological Innovation Method Combined with Improved Genetic Algorithm

Morphological combination innovation method is based on the analysis of existing forms of products, and the basic feature model of calculation is the basic information feature extracted from product innovation. Therefore, the form innovation method can make full use of existing knowledge and existing product form feature information to them as the basis for combined operations can in great extent inherited its own advantages, operation generated form design scheme usually practical higher and has certain innovation. However, for some of the overall morphology of high, not easy to effectively partition of combination operation of the independent components products, such as a washing machine, form Combinatorial Innovation method is stretched. The process of the form combination is shown in Figure 1.

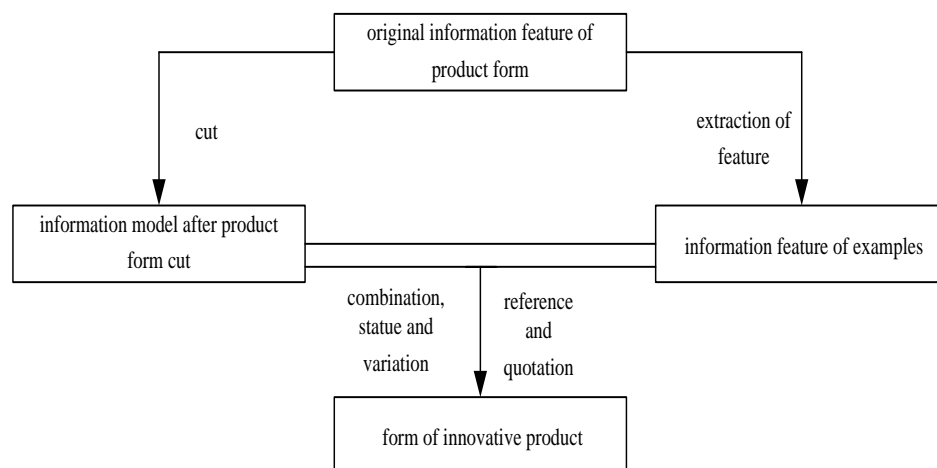


Figure 1. Process of Combination Innovation

3. Morphological Innovation Method Combined with Improved Genetic Algorithm

Composite genetic algorithm principle and the need for different products, based on the analysis of the morphological characteristics, determine how the combination of principle and application of genetic algorithm. Based on this, we apply the combination theory to determine the overall shape or size, a genetic algorithm is used to product detail improvements or innovations, and an improved genetic algorithm.

3.1. Application Methods of Combination Principle

For easily divided into independent parts of products on the form, can be determined through calculation combined first overall product form, and by the use of genetic algorithm for single parts or local form of evolutionary computation; For forms is not easy to split into independent components of products, we can determine the impact on its

external form larger internal components, combination operation, to determine product general form, and then through the genetic algorithm to the external form of evolutionary computation, resulting in the final product form. The basis of the principle of combination of the specific steps are as follows:

- a) Choosing products' type. The system can determine components to be chosen next step according to the chosen products.
- b) Choosing products' components. For forms easily divided into independent components of products, is to choose a product parts in the form of external; For forms is not easy to split into independent components of products, is to choose an effect on its external form of the internal components.
- c) Carry out combination calculation. Combination calculation is conducted according to the previously determined components and positioning of components, and generate product model after combination.

3.2. Application Way of Genetic Algorithm

(1) Chromosome coding scheme

Because patterns can be controlled by the control points of a curve, so you can change by changing the coordinates of the control points of the curve to the shape of the curve. At the time of product form design based on genetic algorithm, encoding the individual must be able to contain a product outline coordinates of the control points of the curve, the only way to describe the feasible solution and converted to feasible solutions of genetic algorithms in the search space. Proposed coding structure as shown in Figure 2

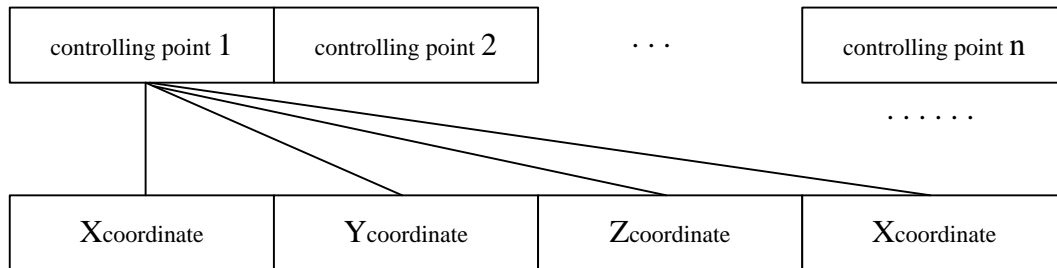


Figure 2. Product Form and Chromosome Structure

This chromosome structure has two layers, top representative of chromosomes, each gene is a single point; below represent the control points, each gene is a coordinate it. Through this structure, each form control points for the curve is encoded into the product code of an individual.

(2) Set Genetic Operators

Individual code in this article uses two-tier structure, which correspond to the different points with different product forms. Design process of mutation, crossover operation is shown in Figure 3, 4.

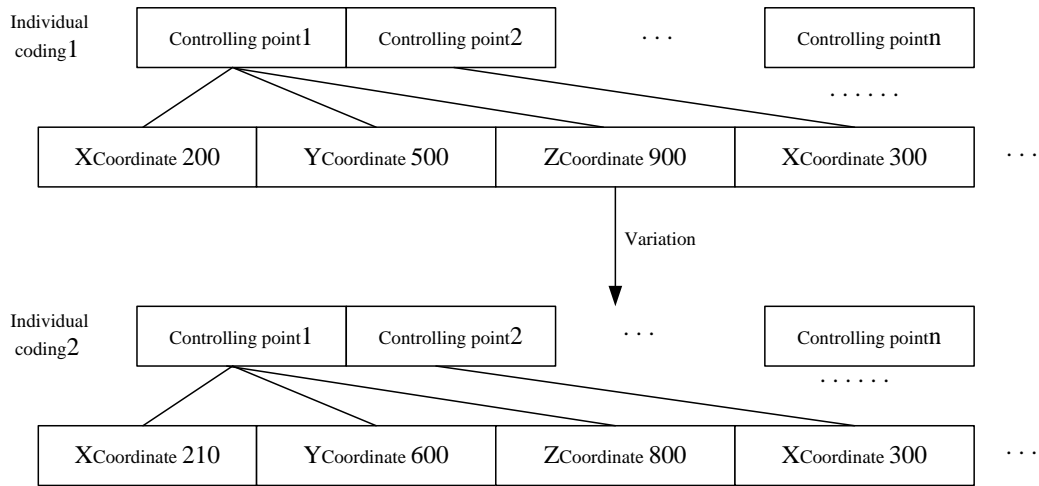


Figure 3. Variation Operation

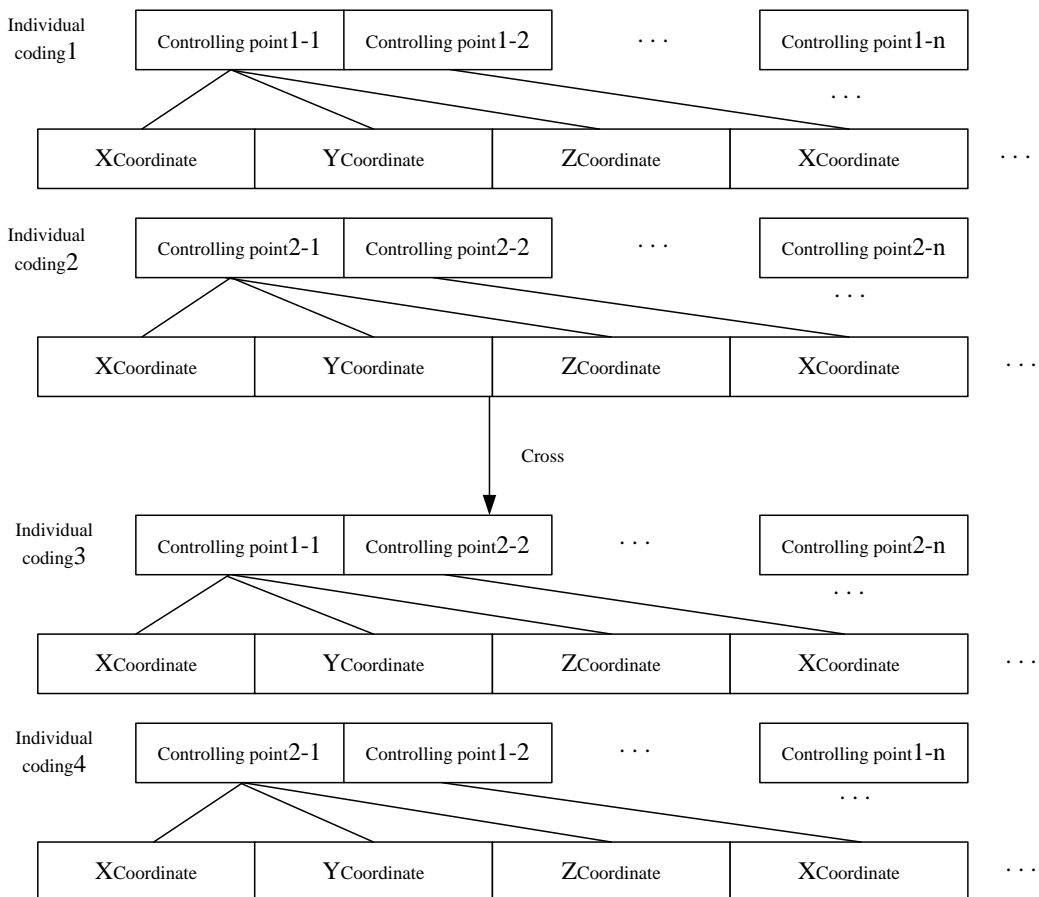


Figure 4. Cross Operation

(3) Select individuals: It is hard to determine whether the form of a product is innovative with a unified formula, so this paper adopts agent technology of artificial selection for the evaluation. In the course of execution, designer fitness values are given as knowledge is stored in the repository, if you encounter a similar situation, the system will remove the fitness values directly from the repository to reuse. As the system

continues to run, human-computer interaction will be reduced gradually.

(4) Specific Calculation Steps

a) Choose components for evolutionary computation. Omit this step for products that cannot be divided into independent parts morphologically.

b) Set parameters of genetic algorithm, begin the computation and generate initial population.

c) Obtain the fitness value of individuals in the initial population through interacting with the designer.

d) Form new population according to the fitness of current population, during the process of which the cross and mutation operation will be run.

e) repeat c) and d) until the operation meets the termination condition or the computation is stopped artificially.

The process of complete algorithm is shown is Figure 5.

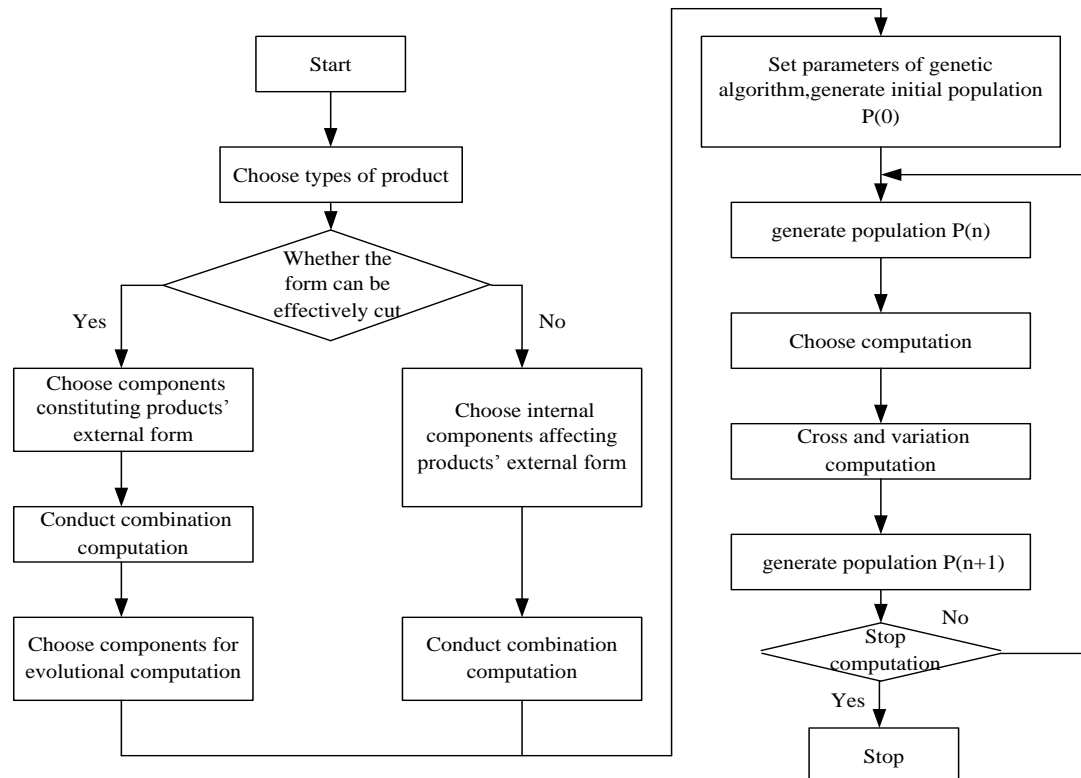


Figure 5. Innovative Design Process of Improved Genetic Algorithm

4. Process of Describing Design Cases

Herein, a design case of television is introduced to show how to use combination and genetic mixed algorithm to design product form.

Step 1: choose type of products. The washing machine is not easily divided into independent component in its form. And the great impact on its external form only a part of a part, the system according to the set directly in the washer back-calculate the dimensions of each part of the product range, and save it as parameters of the subsequent calculations.

Step 2: set product parameter and genetic algorithm parameter;

Step 3: generate the initial population and get individual's fitness through interacting with designers;

Step 4: Form new population according to the fitness of current population, during which cross and variation computation will be conducted. After cross computation to the

circled controlling point, get the overlooking outline of the two new washing machines, and generate a new individual after variation operation to the controlling point in the box;

Step5: repeat c) until the user chooses to stop the computation;

The generated model can help designers produce innovative design thoughts and facilitates the subsequent detailed design.

Innovative design of computer support is a multidisciplinary research topic, and aiming at different fields and products, there are various new methods and new theories. However, any single theory and method is always limited, but innovative design of products is usually a process with the joint function of various factors. Therefore, to enhance advantages and avoid disadvantages of various innovative design theories and comprehensively applying them will become an important means in the future to improve the efficiency of computer aid design.

References :

- [1] Y. Yang, S. Yu and D. Chen, "Product design optimization method based on genetic algorithm", *Modern Manufacturing Engineering*, vol. 9, no.3, (2012), pp.127-131.
- [2] X. Deng, "Interactive genetic algorithm based method for product shape design", *Modern Manufacturing Engineering*, vol. 16, no.5, (2012), pp.55-59.
- [3] L. Xu, "A Method of Parameter Design for Products with Complex Quality Structure Based on Particles Swarm Optimization Algorithm", *Industrial Engineering and Management*, vol. 17, no. 4, (2012), pp. 43-47.
- [4] L. Lin, Z.H. Zhang and R.X. Zhang, "Rui-xin.Evaluation of product form design based on BP neural network trained by genetic algorithm", *Computer Engineering and Design*, vol. 36, no. 3, (2015), pp. 789-792.
- [5] J.N. Su, H.J. Zhao and R.H. Wang, "Product image form optimization design based on support vectormachine and particle swarm optimization", *Journal of Machine Design*, vol. 32, no.1, (2015), pp. 105-109.
- [6] J.F. Wang, "A Ladder-type Method based Genetic Algorithm for Product Shape Design", *Journal of Engineering Graphics*, vol. 52, no.1, (2011), pp. 5-9.

Authors

Li Ma (1978.10-), female, teaching assistant, research direction: design of industrial products