The Study of Idea Generation and New Product Design Based on Human-Based Genetic Algorithm

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Abstract

In the past, we only care about the company's view point when designing a new product. However, in the new age, more and more companies understand the importance of customer relationship management (CRM). Based on CRM, companies should focus on customer's needs and take customer's value into consideration while designing new products. Therefore, the study applies the characteristic of intelligent agent within Human-Based Genetic Algorithm in the system to evolution new products and improves the rate of success when new products enter the market. The study proposes three models for TV-cabinet design. First model is an idea generation model. It allows the marketing staff, design staff, and the decision maker in the company to make a group decision interactively through Value-Focused thinking. Second model is a product design model. A huge group of users can make the decision through the interactive interface. It allows the company to provide customer's personalized TV-cabinet directly based on customer's thoughts and needs. Through the third AHP-like evaluation model, the staff can evaluate all personalize TV-cabinet candidates designed by the customers and evaluate the possibility for mass production. This system will create product's value for customers and improve customer satisfaction. Furthermore this system will also increase the chance of success when new products enter the market.

Keywords New Product Development Process (NPD) Quality Function Deployment (QFD) Group Decision Support System (GDSS) Human-Based Genetic Algorithms (HBGA).

1. Introduction

In the whole process of new products R&D, the idea generation and management activity is a very important step. For creating a new product, design stage is consuming much time and human resources. To face the fierce competition, company has to shorten the product development time and to provide complex and a variety of products. Therefore, most companies are designing products by teams instead of by individuals.

Although important to listen to company's customers, it is a complexity difficult problem to refer to all customers' thoughts in the new product development process. This study investigates the possibility to takes advantage of Human-Based Genetic Algorithm (HBGA) in the idea generation stage and design stage of new product development process. We hope this study can help companies to solve this problem and create more and more business opportunities.

2. Literature review

2.1. New Product Development

In order to face the complex business environment, companies must have their own core capabilities. New product development is one of the important core capabilities. Cooper (1983) indicates that a typical new product development process includes ideas generation, initial estimate, concept examine, product develop, prototype test, .trial marketing, and enter the market. During the process of new product development, the most used technique is the Quality Function Deployment (QFD). It is important to acquire customer requirements for assessing the market and ensure customers' needs are reflected in the products design. QFD is a method for collecting quality requirements from the market by surveys and deploying requirements in the design work.

2.2. Group Decision Support Systems

GDSS have been defined as a combination of computer, communications and decision technologies working in tandem to provide support for problem identification, formulation and solution generation during group meetings (DeSanctis and Gallupe, 1987). Valacich and Dennis

(1994) presented a simple mathematical model of electronic brainstorming using GSS. Their model presents GSS brainstorming as the ideas generated by a group of individuals, each working alone, accounting for process losses and process gains. Certain tasks undertaken by groups using GDSS can be viewed as search problems. These tasks involve arriving at a solution or decision where the problem is complex enough to warrant the use of computerized decision support tools. Groups of individuals meeting to solve particular problems can be viewed as searching for a solution within some sort of solution space. This search space is most likely highly complex, otherwise the collective expertise of a group would most likely not be required (Rees and Koehler, 2002).

2.3. Human-Based Genetic Algorithm

Genetic Algorithm (GA) was proposed by John Holland in 1975. GA is a model of machine learning derived by the theory of natural evolution mechanisms like crossover, mutation, and survival of the fittest (Holland, 1975). Through the evolution, GAs can find the global best solution.

However, sometimes the solution has to be based on human's subjective evaluation. Interactive Evolutionary Computation (IEC) is a technology that embeds human preference, intuition, emotion, psychological aspects in the target system (Takagi, 2001). IGA adopts user's preference as fitness, when fitness function cannot be exactly determined. Caldwell and Johnston (1991) take the lead in applying it to tracking criminal suspect system.

Fatigue problem is a known problem to interactive evolutionary computation and human computer interfaces in general. Takagi (1998) considers fatigue problem as the biggest problem of IGA. Kosorukoff (2001) proposes that when we address this problem in IGA, we can embed human knowledge into evolutionary procedure. HBGA can be viewed as extension of IGA. While IGA uses only human judgment, HBGA uses a balanced approach allowing and encouraging both judgment and creative potential of participants in the form of evaluation and recombination, correspondingly. In HBGA, all genetic operators are outsourced and delegated to humans.

GSS used by groups is in the format of a search problem with a very large search space. GAs are search tools with share many GSS characteristics. Rees and Koehler (2002) suggest that a GSS operates just like a GA. Since GA is an excellent tool for search problems, this study will investigate how to use GA along with GSS.

3. Research Method

3.1. System Design

Fig 1 shows the overview of the system. The study proposes three models for TV-cabinet design. First model is an idea generation model. It allows the marketing staff, design staff, and the decision maker in the company to make a group decision interactively through Value-Focused thinking. Second model is a product design model. A huge group of users can make the decision through the interactive interface. It allows the company to provide customer's personalized TV-cabinet directly based on customer's thoughts and needs. Through the third AHP-like evaluation model, the staff can evaluate all personalize TV-cabinet candidates designed by the customers and evaluate the possibility for mass production.

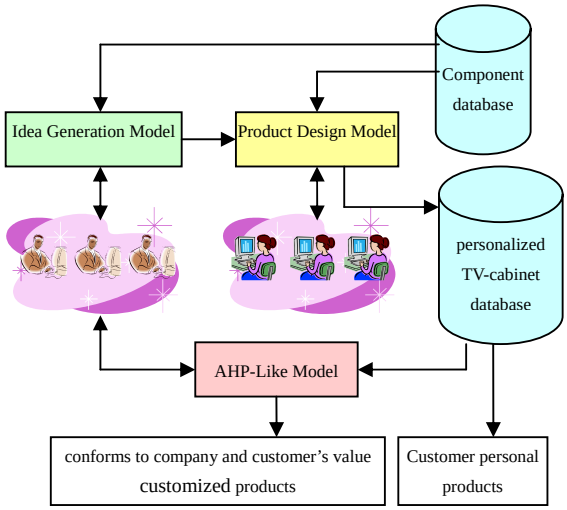


Fig 1. System overview

3.2. Model phase

- Idea Generation Model

This model is operated by staff include designer, marketing staff, and the decision maker. System provides several kinds of cabinet component in various types and material. Then, system shows the cost and the whole combination. Users can evaluate the solution based on the cost and the whole combination.

- Product Design Model

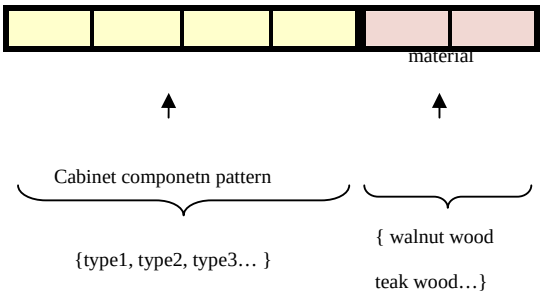
This model is operated by customers and company's designer. They can choice left, middle, and right cabinets in the frame and become sectional furniture. The frame also shows their last choice, one choice from others, and a random choice. Users can evaluate based on the all the choices in the frame.

- AHP-like Model

Through product design model, customers have their personalized products. All personalized products will show on the AHP-like model. Staff evaluate products one by one. Finally, products corresponding to company's and consumers' value will enter the market.

3.3. Chromosome encoding

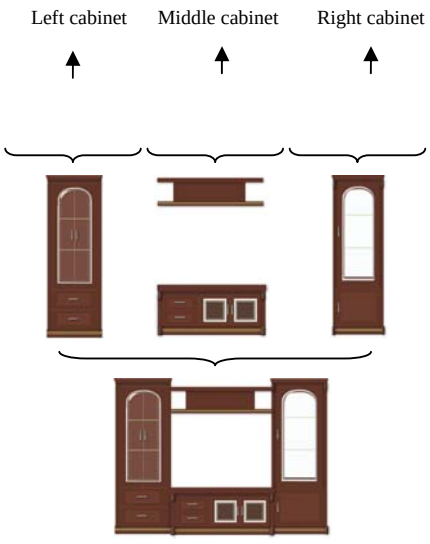
In idea generation model, the cabinet component is determined upon pattern and material. The chromosome total lenth is six bits(see Fig 2). There



are sixteenth patterns and four kinds of wood.

Fig 2. Idea generation chromosome encoding

Our bundle design systems generate images of a bundle by combining five different part-images: MP3 player's panel, MP3 player's monitor, MP3 player's button,



earphone, and lanyard(see Fig 3).

Fig 3. Product Design chromosome encoding

4. Experiments

In order to evaluate how HBGA can improve the performance and convergence speed, and reduce human fatigue, we design two different experiments.

- Experiment I IGA
- Experiment II HBGA

4.1. Procedure

- Idea Generation Model
  - ✓ The researcher will explain the procedure of the system.
  - ✓ User inputs basic data.
  - ✓ User follows the instruction to operate the Idea Generation Model.
  - ✓ The system automatically collects user's choice.
- Product Design Model
  - ✓ The researcher will explain the procedure of the system.
  - ✓ User inputs basic data.
  - ✓ User follows the instruction to operate IGA model.
  - ✓ For human fatigue, the same group in different date will operate HBGA model.(see Fig 4.)
  - ✓ The system automatically collects user's choice.
  - ✓ User answers a short questionnaire.
- AHP-like Model
  - ✓ The researcher will explain the procedure of the system.

  - ✓ User inputs ID data to identify if the same people as the idea generation model.
  - ✓ User follows the instruction to operate AHP-like model.

Fig 4. The user interface of HBGA system.

4.2. Experiment evaluations

We will compare two experiment results from convergent performance and efficiency aspects.

- Performance analysis

System will record the operation time automatically per generation.

- Efficiency analysis
  Through the finally questionnaire, we can analysis customers' satisfaction.

5. Discussion

Most company produce goods just consider company's view, usually ignore customer's voice. Most papers emphasize on idea generation step or product design step alone. This study focuses on integrating these two steps. The characteristic of human judgment and creativity within HBGA suits to apply to the new product development process. We expect that this study can provide evidence that use HBGA can improve performance and customer's satisfaction. It can reduce human fatigue and get faster convergence. To apply HBGA to new product design of sectional furniture through group decision is a new domain. As an exploratory study, there must be many unsolved problems. Further studies will be necessary to solve those unsolved problems.

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