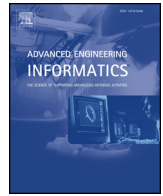




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A methodology for brand feature establishment based on the decomposition and reconstruction of a feature curve

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ABSTRACT

For creative products, maintaining original brand elements and features in a new product is an important issue in the design process as brand features are conceived and generated for longevity. However, current methods rely on designers' abilities, and the size of forms is easily affected when shape morphing is applied, causing limitations in computer-aided design. In order to focus on design while preserving key features, a systematic method for presenting brand features is proposed in this article. In this method, the feature curves of the brand features of a company are decomposed with defined feature parameters, which were then used to reconstruct the feature curve of the designed product in the design stage by using a residual modified gray prediction model. A classic vehicle configuration design is taken as an example to show the implementation procedure of the proposed method. With residual modification, this method can also assimilate other forms from the original form database, and generate new forms based on gray prediction. The results show that brand features can be retained in the newly designed product based on the proposed method. Though vehicle design is taken as the example, this method can also be used to develop designs for many other the brand features. For classic products with historical value, this method can generate new forms that maintain original brand features, thereby satisfying customers' needs for brand authenticity.

1. Introduction

Because vehicles were first invented in the late 1880s, the diversity of the technology used by different automobile manufacturers in terms of manufacturing, product performance, and security has gradually diminished. The style of a vehicle has become the essential factor for sales, and a distinctive style is also the main source of a competitive advantage for vehicle manufacturers in this era of globalisation [1]. Tang et al. [2] agreed that product aesthetics and appearance are key points in new product design and development. Product forms can directly transfer product images and affect a customer's first impression of a product. Moreover, researchers from past to present have considered that the key to selling products has been the form and features of a specific brand, and the product's appearance now has the greatest impact on customers' perceptions of that brand [3–6]. Hyun et al. [7] have developed a style quantification methodology that numerically measured similarities between car design elements to synthesize and analyze car brand styles, thereby finding key design trends among car brands for strategic design positioning. Some researchers have verified that the visual reference and features of a brand are key design elements of the appearance of consumer electronics or vehicles, and that

consumers' perception and recognition of specific brands are based on these key elements [8]. Therefore, in times of fierce competition in the automobile market, when a product needs to do more than display a new form to achieve success, ensuring that consumers recognize their products has become a critical issue for most brands.

Although the subject of product features has been raised in recent brand awareness studies, few studies of features and visual references exist, and there are very few applications or extensions of features and visual references in this field. The last study of a 2D decomposition of features and visual references to construct the recognition of a brand and a database of features was conducted more than ten years ago [9], although Ranscombe et al. [6] proposed that the experiential replacement of visual references of different automobile brands can determine if the features and visual references affect consumers' perception of those brands. In addition, the concept of the parameterization of features is proposed to examine similarities between products. Recently, many studies have combined parameters with design; for example, Kim and Lee [10] developed methods for parametric shape modification and its application to accomplish the validation and verification for morphological biomimetic design, however these researchers have mostly focused on junior applications and database features. For the following

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reasons, this study provides a parameterized method for feature recognition, classification, and preservation.

Currently, no complete research of a more accurate recognition of brand features and further design applications exists in this field. Furthermore, as few references have been made to the prediction of designing a vehicle style, the creation of a systematic, and complete predictive method in the development of the vehicle industry is a challenging task. Finally, designers often depend on their personal design experience when creating new products, despite knowing the importance of innovative design in strategic marketing [11,12]. Therefore, a systematic design process generally plays a vital role in product design. This study presents a new methodology that decomposes the feature curves on vehicle design, and the goal of this research, which is to retain the brand features from visual references based on those feature, can be achieved using the gray prediction model. The gray theory is widely used to deal with vagueness and uncertainty. It has been successfully applied in different fields since 1982; predictions for crop production, climate change, calamity, and energy consumption being a few examples. A prediction system based on the gray theory can be constructed with only four pieces of data to produce an accurate result [13]. Hence, this study chooses the gray theory to investigate vehicle design predictions with limited samples. Using the proposed methodology, product forms can be preserved with the expression of feature values. This numerical method can also be applied to morphing, blending, and computer-aided design. In the past, methods for form data were restricted, and the numerical methods were not easily applied to the product design. However, the proposed gray prediction model can not only preserve the features of the original product in the present, but can also generate new forms. Finally, vehicle form design can be verified via the accessibility of the proposed methodology. This is a new methodology in the field of product design that can increase the possibilities for design automation.

2. Literature review

2.1. Relationship between product and appearance

Many companies continually seek new and accurate sources of competitive advantages as traditional sources diminish. Product design is currently an important source of competitive advantage because of its effect on customers' experience. Srinivasan et al. [14] proposed the total product design concept (TPDC), which is an integrated, customer-based framework for product design. They identified three components of the TPDC of a product, namely aesthetics, functionality, and meaning, each of which arises from more elemental product characteristics. According to their study, the dominant points of a product's attributes and the different aspects of its appearance influenced customers' choices and

purchasing decisions. Appearance is the foundation of product design, and whether it is presented in a functional or minimalised form, it contains many commercial, strategic, and design meanings.

Ranscombe et al. [8] maintain that appearance has a huge effect on product sales and is sometimes the lifeblood of the market. In addition, Forslund and Söderberg [15] regard the relationship between the exterior components to be an important factor of the Visual Quality Appearance (VQA) of a vehicle, which is why so many automotive manufacturers currently go to great lengths to improve the appearance and visual brand identity of their products. Furthermore, a product's appearance affects consumers' shopping behavior and preference to the same degree as price and functionality, and they tend to choose the product that has the most attractive appearance [3,16,17]. In summary, the appearance of a product has a close connection to the brand and reflects the number of sales in the market.

In a highly competitive market, each brand will make a series of products to build its specific features. The brand image and idea can be delivered by highlighting unique features and strengthening customers' sense of the brand, thereby increasing the volume of sales. In the current era of product design, consumer electronics and automobiles are ideal examples of the increasing importance of design as a brand factor [8]. For established brands, a key factor in maintaining market share is no longer just product function, but the trust and connection between the brand and consumers. Research shows that there is some distinction or demarcation in appearance and design, and that this usually used to divide the new from the old or competitors' products [18]. For example, BMW has retained its kidney grille in every vehicle design, and this creates a series of designs with a specific feature to reinforce the consumers' perception of the brand. Moreover, brand strategists often maintain a close relationship with a specific brand, in order to define brand recognition and construct a connection between it and consumers [19]. According to these concepts, this research provides an intelligent design system to assist designers in creating a product that has clear characteristics for the easy recognition of the brand.

2.2. Feature of form

When designing a brand or product, designers will retain and use its features or visual clues, which will help them to develop and increase the perception of the brand. When preparing a design to retain these features, the first issue to consider is how to define it. Most researchers have used a 2D sample to define the appearance and features of a product, and since the goal of this study is to discuss its previous basic usage for product design, we will follow the research on the definition of the 2D method and its use from 1988 to 2012, as shown in Table 1.

In feature research and applications in recent years, features have

Table 1
Researches related to 2D definition and its usage from 1988 to 2012.

| Year | Authors | Concepts |
|------|------------------|---|
| 1988 | Biederman & Ju | Vertices on contours have the most impact on human perception and recognition of products. The product is hard to recognize when vertices are decreased or the middle part of a contour is removed [20] |
| 1998 | Hui & Li | This research of 2D blending is based on a curve and uses a corresponding point [21] |
| 2000 | Chan | Style features are shown as follows: 1. A form or a work could be regarded as a special structure and features a shared connection and relationship. 2. A feature is created by a designer's innovative development or adopted from other sources in order to achieve the functional requirements. 3. A set of obvious shapes or forms repeatedly utilized by designers [22] |
| 2002 | Pugliese & Cagan | The aesthetic features that contain the brand spirit can be generated by shape grammar, which can be utilized to describe and define the geometric rules of appearance, which can in turn be applied to geometric shapes to create a specific style [23] |
| 2003 | Tovey et al. | The method of "de-layering" is applied to decompose sketches of car designs. This defines features by aesthetic lines, component vehicles, formed shading, and non-formed shading [24] |
| 2004 | McCormack et al. | Shape grammar is a set of geometric rules that is applied to generate new shapes of the front view of vehicles. It has three characteristics: 1. It can directly generate geometric shapes (feature). 2. It can directly operate geometric shapes (feature) to generate new contours. 3. Based on geometric shapes (features), new contours can be generated in real-time [9] |
| 2008 | Cheutet et al. | A geometric operation based on shape grammar is offered, and 2D data can be analyzed and parameterized. Vehicle designers can decompose and construct new shapes with geometric parameters acquired from CAD [25] |
| 2012 | Ranscombe et al. | To define the essential features of a contour, geometrics are applied to analyze the positions of feature points – the distance among points on a closed contour. The data of these features is also adopted to calculate the similarity among products, which is beneficial for examining the appearance of a product family [8] |

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