Semantic Recognition and Visual Generation Mechanism of Public Brand Packaging Design in AIGC Empowerment Area

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Abstract: Under the background of the development of regional public brands and the increasing demand for digital design, it is of great significance to explore the semantic recognition and visual generation mechanism of artificial intelligence generated content (AIGC) to empower regional public brand packaging design. Firstly, this article expounds the relevant theoretical basis, including regional public brands, packaging design and AIGC theory. Then, the semantic recognition mechanism of AIGC-enabled regional public brand packaging design is analyzed. The semantics are divided into three categories: product information, regional culture and brand concept. It is analyzed by natural language processing (NLP) and image recognition technology, which is influenced by data quality and model algorithm. Then, the mechanism of visual generation is studied, and the corresponding visual elements are generated according to semantics, which are combined according to central focus, symmetry and dispersion. The study reveals the inherent law of semantic understanding and visual transformation of AIGC in the packaging design of regional public brands, which provides support for improving the design level and promotes the innovative development of regional public brands with AIGC.

1. Introduction

Under the dual impetus of economic globalization and digital wave, regional public brands, as an important symbol of regional characteristic products and culture, play a key role in promoting regional economic development and inheriting regional culture [1]. As a direct carrier of brand image, packaging design not only undertakes the basic functions of protecting products and facilitating transportation, but also becomes an important means to convey brand value and attract consumers [2-3]. However, in the face of increasingly diversified consumer demand and fierce market competition, the traditional regional public brand packaging design has gradually exposed problems such as insufficient innovation ability and difficulty in accurately conveying brand core values [4].

At the same time, AIGC technology is developing at an unprecedented speed, and it shows great ability in the fields of image, text, audio and other content generation [5]. AIGC can automatically generate creative content that meets specific requirements by means of deep learning, model generation and other technologies, which brings brand-new ideas and methods to the design field [6]. The introduction of AIGC into regional public brand packaging design is expected to break the limitations of traditional design and realize the intelligence, personalization and efficiency of packaging design [7].

At present, the application research of AIGC in the design field is still in the development stage. Although some achievements have shown its potential in creative inspiration and aided design, the in-depth research on the packaging design of public brands in AIGC-enabled areas is relatively scarce [8]. Especially in terms of semantic recognition and visual generation mechanism, how to make AIGC accurately understand the unique semantics of regional public brands and transform them into creative visual designs that fit the brand image still needs systematic exploration.

Based on this, this study focuses on the semantic recognition and visual generation mechanism

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of public brand packaging design in AIGC-enabled areas. Through in-depth analysis of relevant theories and technologies, this article aims to reveal the inherent law of the application of AIGC in this field and promote the sustainable development of regional public brands in the new era.

2. Related theoretical basis

Regional public brand refers to a brand with unique regional characteristics, product quality and cultural connotation, which is used by many producers and operators in a specific region. Based on the name of the place of origin, it represents the overall image of the region and has the attribute of public goods [9]. Regional public brands can not only enhance the market competitiveness of regional products, but also promote regional economic development and cultural heritage. For example, West Lake Longjing has become a regional public brand with high popularity and market value by virtue of the specific geographical environment and long tea culture of West Lake in Hangzhou. The formation of its brand value not only stems from the quality characteristics of the product itself, but also can not be separated from the profound accumulation of regional culture.

Packaging design aims to achieve multiple goals of product protection, information transmission and aesthetic promotion through the combination and arrangement of graphics, colors, words and other elements. Functionality is the basis of packaging design, which requires packaging to effectively protect products from damage and facilitate storage, transportation and use [10]. Beyond this functional core, the integration of traditional cultural elements into the packaging design of regional public brands in China, a practice emblematic of the broade‘National Trend’ phenomenon, embodies the innovative application of cultural heritage and manifests rising local cultural confidence [11].

At the same time, packaging needs to accurately convey product information, such as name, composition and usage, so as to satisfy consumers' right to know. Aesthetics is also an indispensable element of packaging design, and unique visual design can attract consumers' attention and stimulate their desire to buy. The packaging of some traditional products, through the use of graphics and colors with regional cultural characteristics, not only shows the unique charm of the products, but also enhances consumers' sense of identity with the brand.

Based on deep learning technology, AIGC realizes the automatic generation of content by building a generation model. Among them, the generative countermeasure network (GAN) is composed of a generator and a discriminator, which play games with each other, prompting the generator to generate more realistic images or other contents. Variational self-encoder (VAE) learns the potential distribution of the input data by encoding and decoding it, thus generating new samples similar to the training data. These technologies have laid the foundation for the application of AIGC in image generation, text generation and other fields, enabling AIGC to generate creative design contents according to given conditions or semantic descriptions, and providing new technical means for packaging design.

3. Semantic recognition mechanism of AIGC-enabled regional public brand packaging design

3.1. The semantic composition of regional public brand packaging design

The semantics of regional public brand packaging design are rich and diverse, covering product characteristics, regional culture, brand concept and other information. Accurately identifying these semantics is the primary task of AIGC to realize accurate empowerment packaging design. The semantics of regional public brand packaging design can be summarized into three categories, as shown in Figure 1.

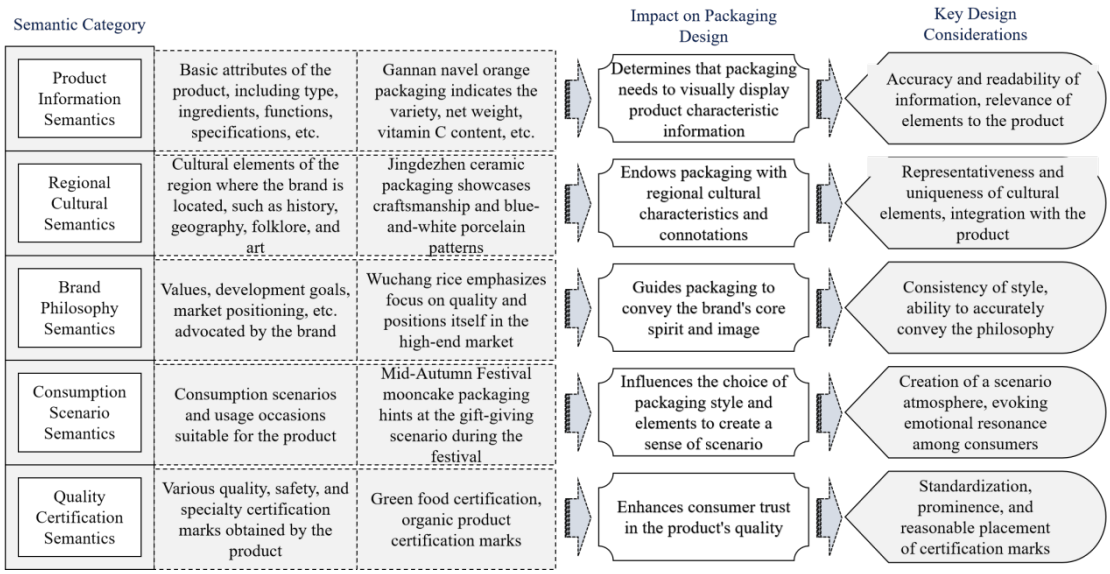

Figure 1 Semantic classification diagram of regional public brand packaging design

3.2. The technical path of AIGC to realize semantic recognition

AIGC makes an in-depth analysis of the relevant texts of regional public brands with NLP technology. Firstly, through lexical analysis, the text is divided into words or phrases to identify key information. For example, for the description of "Yantai apple, with bright color, crisp and sweet taste and rich in vitamins", lexical analysis can extract key information such as "Yantai apple", "bright color", "crisp and sweet taste" and "vitamins". Then, syntactic analysis is used to understand the sentence structure and clarify the relationship between the components, so as to accurately grasp the semantics. For example, it is analyzed that "bright color" and "crisp and sweet taste" are descriptions of the characteristics of "Yantai Apple". Finally, in the semantic understanding stage, lexical and syntactic information is integrated, and the pre-training model and domain knowledge are combined to understand the real intention behind the text and extract the product information semantics accurately.

In packaging design, a lot of information is presented in visual form. AIGC uses image recognition technology to extract the features of packaging images through convolutional neural network (CNN). CNN's multi-layer convolution layer and pool layer can automatically learn the texture, shape, color and other features in the image. For packaging images with regional cultural features, CNN can identify the features such as pattern shape and TINT, and compare them with the features of regional cultural patterns in the database, so as to judge the regional cultural semantics contained in them. At the same time, combined with target detection technology, we can locate the position of specific elements in the image, such as brand logo, product name, etc., to further assist semantic recognition.

3.3. Key influencing factors of semantic recognition

High-quality data is the basis for AIGC to accurately identify semantics. Training data should be comprehensive, accurate and representative. If the information about the public brands in a certain region is missing or wrong in the training data, AIGC may not be able to accurately identify the relevant semantics. When training the image recognition model, if the provided regional cultural pattern samples are incomplete or mislabeled, the model may misjudge the cultural elements in the packaging image, resulting in semantic recognition deviation. Different AIGC model algorithms have different abilities in dealing with complex semantics. Some simple models may be difficult to understand the deep-seated brand concept semantics or the relationship between complex regional cultural semantics. Advanced model algorithms, such as the model based on Transformer architecture, can better capture the semantic dependencies in long sequence texts and deal with complex semantics. Therefore, it is very important to choose the appropriate model algorithm to improve the accuracy and depth of AIGC in the semantic recognition of regional public brand

packaging design.

Through the above semantic recognition mechanism, AIGC can accurately understand all kinds of semantics in the packaging design of regional public brands, and lay a solid foundation for subsequent visual generation.

4. AIGC empowers the visual generation mechanism of regional public brand packaging design

4.1. Semantic-based visual element generation

After accurately identifying the semantics of regional public brand packaging design, AIGC needs to transform these semantics into specific visual elements and overall design layout, which depends on its unique visual generation mechanism. The visual elements of regional public brand packaging design are rich and varied, which are closely related to the semantic categories mentioned above. AIGC generates corresponding visual elements according to the recognized semantics. AIGC generates visual elements mainly by generating models, such as GAN and VAE. Taking GAN as an example, the generator receives semantic information as input to generate initial visual elements, and the discriminator judges the similarity between the generated elements and the real elements. The two are constantly playing games, prompting the generator to generate more semantic and realistic visual elements.

4.2. Combination and layout of visual elements

Table 1: Common Visual Element Layout Methods and Characteristics of Regional Public Brand Packaging

Layout Method	Characteristics	Applicable Scenarios	Visual Effect Examples	Role in Shaping Brand Image
Central Focus	Placing the main visual elements at the center of the packaging to highlight core information	Emphasizing products or concepts, such as high-end tea packaging	The tea bud at the center is eye-catching, surrounded by blank space	Strengthening the brand's core values, shaping an image of high quality and uniqueness for the product, and attracting consumers who pursue quality
Symmetrical	Visual elements are symmetrically distributed along the central axis, giving a sense of stability and solemnity	Traditional specialty products, such as packaging for time-honored pastry brands	Traditional patterns symmetrically surround the product name, presenting a neat and balanced layout	Conveying the brand's historical heritage and reliability, making consumers feel the brand's tradition and authenticity, and enhancing trust
Scattered	Arranging multiple visual elements in a scattered manner to create a lively and rich visual effect	Targeting young consumer groups or products with multiple features, such as mixed fruit gift boxes	Colorful fruit patterns are distributed in a staggered manner, appearing lively and vibrant	Showcasing the brand's vitality and diversity, aligning with young consumers' pursuit of individuality and richness, and enhancing the brand's affinity among young groups
Surrounding	Arranging other visual elements in a circular pattern around a central subject element to form a unique visual focus	Highlighting specific elements or creating an atmosphere, such as packaging for commemorative products	Relevant patterns and text are arranged around the commemorative logo	Highlighting the brand's specific elements, reinforcing commemorative significance or special themes, and adding unique cultural connotations and commemorative value to the brand
Layered	Arranging visual elements in layers according to a certain logic to make the information well-structured	Products with abundant information, such as health supplement packaging with information presented in layers	The boundaries between each layer of information are clear, facilitating quick reading	Shaping a professional and rigorous brand image, helping consumers efficiently understand complex product information, and enhancing the brand's credibility

After the visual elements are generated, they need to be reasonably combined and laid out to form a complete and attractive packaging design. AIGC follows certain design rules and principles

for combined layout. The common layout methods and characteristics are shown in Table 1.

In the process of layout, AIGC will consider factors such as the proportion between elements, the density relationship and color matching. Designers need to adjust the size and proportion of visual elements based on brand positioning and product characteristics to highlight key elements; At the same time, the distribution density of visual elements should be reasonably controlled to avoid overcrowding or excessive white space; In addition, it is necessary to select a color matching scheme that conforms to the brand tone and product characteristics to enhance visual performance and improve brand recognition. At the same time, AIGC will combine elements according to semantic relevance, so that visual presentation is highly compatible with brand semantics. For example, patterns reflecting regional culture are skillfully combined with product information elements, making it easier for consumers to understand brand connotation.

Through the above visual element generation and combination layout mechanism, AIGC can transform the semantics of regional public brand packaging design into creative visual design that conforms to the brand image, and effectively enhance the attractiveness of packaging and the effect of information transmission.

5. Conclusions

This article focuses on the semantic recognition and visual generation mechanism of public brand packaging design in AIGC empowerment area. By systematically combing the relevant theoretical basis, the respective characteristics and relations of regional public brands, packaging design and AIGC are clarified. In the aspect of semantic recognition mechanism, the semantic composition categories are analyzed in detail, and it is clarified that AIGC realizes semantic analysis through NLP and image recognition technology, and the key influence of data quality and model algorithm on its accuracy is pointed out. In the visual generation mechanism, the process and way of generating visual elements and rational layout based on semantics are explained. The research results show that AIGC can bring innovative changes to the packaging design of regional public brands, and accurately realize the transformation from semantic understanding to visual presentation.

AIGC still faces challenges such as data optimization and model improvement in practical application. In the future, we should further explore the integration path of AIGC and packaging design, improve the application efficiency of AIGC in this field, and help regional public brand packaging design achieve higher quality development.

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