

# Research on image processing algorithm of product packaging design based on human eye attention mechanism

Xiaonan Qin

Shanghai Publishing and Printing College, Shanghai, China  
250197414@qq.com

*Abstract—With the rapid development of information technology, computer technology has been widely used in many industries; industry upgrading speed is getting faster and faster, market competition is becoming more and more fierce, product requirements are increasing, and packaging design as a basic part of the product, because the image information has a certain complexity and relevance, there may be incomplete and inaccurate problems during processing. Therefore, some scholars have proposed using graphic processing algorithms for product packaging design. After understanding the development status of product packaging design, this paper deeply discusses whether integrating a human visual attention mechanism into constructing an image grey histogram can effectively achieve an image enhancement effect and finally obtain high-quality product packaging design results.*

*Keywords—human eye attention mechanism; Product packaging; Packaging design; Image processing; Image enhancement*

## I. INTRODUCTION

Nowadays, the world we live in is full of a lot of visual information. The human world system needs to process various external information daily, and the information integrated into the retina is effectively processed, which can facilitate people to recognize and guide actions. To extract effective content from large amounts of data information, the data system will effectively filter the input information and use limited resources to encode and process external information quickly. Therefore, the existing computing model will be gradually optimized and improved with the growth of data information. When a computer vision system is processing image information, it is difficult to achieve the real-time task, and it will compute pixels in the image successively, which will not only occupy a lot of computing resources but also delay the computing processing speed. Although scholars in various countries have strengthened the application research of computer vision systems, and the corresponding technical theories have achieved excellent results, there is still a big gap compared with the excellent human vision mechanism. Selective visual attention, as an important information processing mechanism of the human eye, enables the brain to focus limited resources on an object in a one-time gaze, which is caused by image information or tasks. When the visual system receives external information, it will quickly analyze the visual information according to a certain calculation strategy and choose the most important content from it, ignoring the other content. The human visual system uses computational strategies to process the

information entering the eyes. After extracting features to obtain areas of interest in the scene, the eye movement can process this area in detail according to the high-resolution fovea on the retina. In this process, the human eye can eliminate secondary information and quickly react to complex information. There are two reasons for the formation of the selective attention mechanism: On the one hand, the brain has limited resources available, and the storage capacity is much lower than the amount of information provided by the visual system. On the other hand, when humans use their eyes to observe external things, not all external information is very important, and the brain will only respond to important content.[1.2.3]

Researchers have established high-quality visual models combined with existing computational models and processing algorithms for in-depth exploration to understand the selective attention mechanism better. From the perspective of image processing, product packaging, as a basic product of the continuous development of researchers, has developed so far, and its structure, use, material, and so on have undergone different changes. Especially after entering the information age, product packaging design has become more diverse; people pay attention to convenience at the same time, will pay attention to the simplicity and beauty of the overall design, the application of computer image processing technology to product packaging design, to improve the level of social and economic development of our country is of great significance. In this paper, according to the physiological structure of humans and the principle of the visual imaging system, the visual attention mechanism of human eyes is used to construct an image grey-level histogram to present the important information content in the image. Meanwhile, the perception characteristics of human eyes are used to enhance the image algorithm, reduce the amount of main grey level information in the histogram, and determine the image feature evaluation method.[4.5.6]

## II. METHODS

### A. Visual imaging perceptual characteristics of human eyes

Human visual perception image is divided into three parts: first refers to the capture of image signals, second refers to the retinal imaging and finally refers to the transmission and recognition of visual signals. Because the visual system of the human eye is a relatively complex visual perception and imaging system, it is closely related to sensitivity and spatial frequency. Combined with the existing research findings, the visual characteristics of human eyes are

reflected in the following aspects: first, spatial frequency. The image seen by the human eye is formed by the light reflected from the object in the retina; using the nursing solution transformation, this light can be broken down into sine brightness components and will change with the change of spatial frequency—second, multiple channels. The visual mechanism of the human eye has multiple channel structures, which can effectively transmit image signals and facilitate visual decomposition according to direction and frequency. At the same time, the number of channels is correlated with visual information. The multi-channel theory can better extract image features, and the channels interact. Third, the masking effect. If the target detection threshold is much higher than the contrast of the masked stimulus, the interference visual stimulus has little effect on the target vision detection. When the two are equivalent, the masking effect will offset part of the target detection threshold and improve the resolution of the target detection. When the target detection threshold is lower than the contrast of the masking stimulus, the target vision will be masked by the interference visual stimulus. Fourth is visual significance. This feature refers to the ability of the human visual system to distinguish image details. After extracting and processing image information effectively, relatively simple images will be roughly collected. Not all the information will be processed immediately after the image information is transmitted to the brain and other relevant locations through the retina and other structures. Still, the image information in key areas will be processed first. This situation is the attention mechanism of human vision. Combined with function analysis of this mechanism, it can be found that its structure is shown in Figure 1.7.8.9]

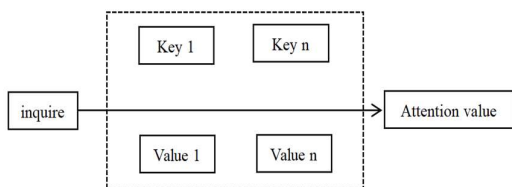


Figure 1. Structure of function-based image processing mechanism

### B. Computer image processing technology

In image processing algorithms, a histogram is a common tool; although it cannot directly represent the image information, it can reflect the image features. From a practical point of view, the histogram does not consider the intermediate position in the image and its information weight relationship. The human eye can effectively distinguish the information in the image and prioritize the content that the brain considers important, so it can also enhance the information processing of important parts during image processing. This paper constructs the image information histogram based on the human visual attention mechanism. The specific operation is divided into the following steps: First, the saliency detection model based on the visual attention mechanism is built, and the image's global saliency map is obtained using the model. Secondly, the data information of the global significance graph is normalized to obtain the weight coefficient of image pixels. Finally, the weight coefficient calculates the image greyscale and pixel

value that must be enhanced. The flow chart of image processing is shown in Figure 2 below [10.11.12]

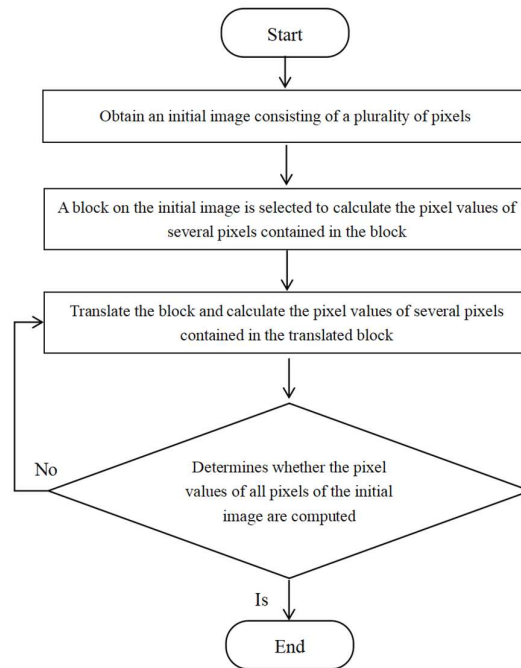


FIG. 2 Flow chart of image processing

### C Product packaging design

In the process of product packaging design, the patterns and materials used have the role of products online, that is, the use of pattern content to understand the relevant characteristics of the product and attract more consumer groups to buy. Image processing is critical to the product packaging design process in this process. The traditional image processing process is shown in Figure 3 below, which mainly integrates materials such as patterns and photos to carry out effective design based on abstract or figurative approaches. It should be noted that this design process needs to consider how to present relevant information from an aesthetic perspective and whether the final presentation effect is consistent with the characteristics of human eye image recognition. [13.14.15,16]

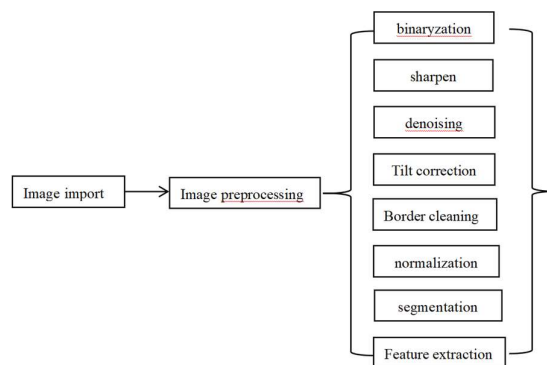


Figure 3. Flow chart of traditional image processing

### III. ANALYSIS

#### A. Case Analysis

Combined with the personnel attention mechanism and the corresponding processing algorithm of the above research, the grey scale histogram is combined with the visual characteristics of the human eye, and then the evaluation results of image feature quality are explored based on human eye visual perception. In the process of evaluation, you can see according to the brightness of the image and the edge contour is clear; these indicators are seen as the level of the image contrast characteristics, contrast characteristics and grey difference between the pixels, the two-pixel grey difference can use the gradient calculation, in the greater the gradient value, the grey difference will increase, the corresponding contrast will be bigger. Combined with, as shown in figure 4 below, image enhancement algorithm flow chart analysis, image classification as the basis of product packaging design image processing, according to the uniqueness and sensitivity of the human eye attention mechanism, built with visual attention mechanism and edge features of combining extraction, can effectively complete different category image classification processing, compared with the traditional model classification way more accurate and effective. Therefore, according to the image processing algorithm process of the product packaging design studied above, taking the image classification of the tea packaging design of an enterprise as an example, according to the current common mapping software, execute the command quickly with the support of the existing hardware system, and reserve sufficient design technology and language ability to build the tea packaging map. During the study, images of different categories of product design were collected, and a total of 2400 images were obtained. Each category of images had large intra-class differences, and the background was more complex. To verify the effectiveness of the research algorithm in this paper, the image enhancement algorithm is used for the comparison experiment: in experiment 1, 1,50% of all images were randomly selected as the training samples and the prediction experiment is shown in the following table; in experiment 2 adjusts the training ratio based on the former, 25% of the images were randomly selected as the training samples, and the prediction results are shown in Table 2 below:

TABLE 1. EXPERIMENTAL RESEARCH RESULTS

| group | Number of training samples | Number of classified test samples | The number of samples as classified accurately | Classification accuracy% |
|-------|----------------------------|-----------------------------------|--|--------------------------|
| 1     | 410                        | 410                               | 406  | 98.742.5%                |
| 2     | 92                         | 92                                | 89   | 96.778.2%                |
| 3     | 225                        | 225                               | 222  | 98.666.7%                |
| 4     | 494                        | 494                               | 493  | 99.391.5%                |

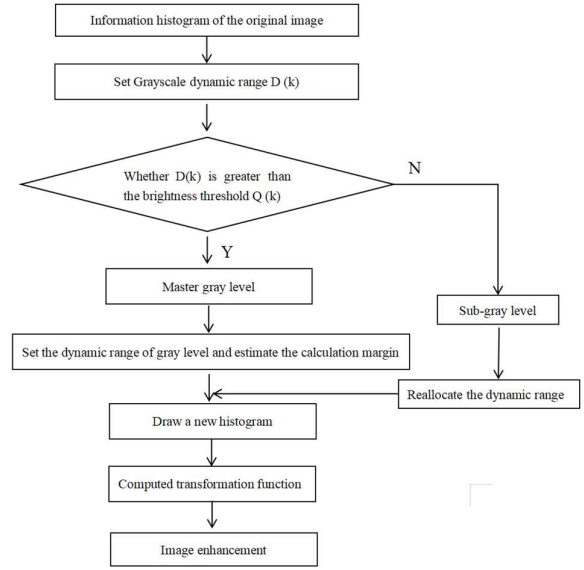


Fig. 4. Flowchart of image enhancement algorithm

TABLE 2. ANALYSIS OF THE RESULTS FROM EXPERIMENT 2

| group | Number of training samples | Number of classified test samples | The number of samples as classified accurately | Classification accuracy% |
|-------|----------------------------|-----------------------------------|--|--------------------------|
| 1     | 205                        | 612                               | 587  | 96.079.4%                |
| 2     | 46                         | 145                               | 125  | 90.0000%                 |
| 3     | 112                        | 337                               | 330  | 97.3333%                 |
| 4     | 246                        | 740                               | 731  | 98.978.9%                |

Combined with the above results, it is found that the classification accuracy of pictures exceeded 90%, and the overall classification accuracy reached 97%. The image processing algorithm of product packaging design based on the human eye attention mechanism can further enhance the accuracy of image classification, especially in the case of fewer training samples, which can highlight the application advantages of this algorithm. The comparison results of the accuracy of the four categories of image classification showed that because the two groups had specific profiles and significant edge features, the results of identifying the classification using the human eye attention mechanism were significantly improved.

According to the experimental results, compared with the original image, the salient image can better display the important information content in the image, and the smooth area of the histogram is effectively suppressed, improving the image's contrast. At the same time, the image enhancement algorithm based on human visual characteristics proposed in this study is more significant than the existing literature results. This proves that the image processing algorithm of product packaging design based on human visual

characteristics is worthy of promotion and application in the market.

#### B. Development of product packaging design

With the continuous development of the modern social economy, people's aesthetic requirements for spiritual and cultural consciousness are getting higher and higher, and the content and form of product packaging design have changed. The application of computer technology algorithms is generated on this basis, which can accelerate the effective integration of technical product information and emerge many new theories and technologies. Considering the various problems of image processing of product packaging design in recent years, on one side, Product design staff should deepen the understanding of the product and deeply explore the cultural connotation of the product; on this basis, it explicitly involves the various elements required for the packaging pattern, Determine the overall design requirements and working ideas; on the other hand, Scholars from all countries should strengthen the research on human eye attention mechanism and image processing algorithm, Pay attention to consider the research direction and research objectives from the perspective of enterprise development in the new period, Ensure that the digital technology means can be used in the enterprise product packaging design work, Be widely used, Improve the efficiency and quality of enterprise work, Enhance their market competitiveness. The rational application of advanced technology algorithms to product design to fully show the innovation and novelty of the human eye attention mechanism can not only improve the efficiency of product packaging design, better meet the individual needs of consumer groups, but also innovate the design of product packaging and obtain more inspiration elements. Product packaging design as aesthetics, color, and modelling elements of integrated rendering, under the guidance of the existing technology algorithm, can be more inspiration and creativity into real products, based on computer technology software directly, let consumer groups have a more intuitive understanding at the same time, exquisite product packaging form will attract consumer groups to buy, gradually improve product sales and sales channels, let buyers in visual and psychological satisfaction.

#### IV. CONCLUSION

In summary, this paper studies the development status of product packaging design and computer processing technology in the new era, determines the human vision characteristics, binocular vision characteristics and visual attention mechanism, and proposes a product packaging involving an image processing algorithm with human vision characteristics as the core, whose purpose is to display more important information in images. The final experimental results show that the proposed algorithm is more effective than the traditional image processing algorithm and further improves the technical development level of the industry.

#### REFERENCES

- [1] Y. Ou, H. Zhang, Z. Tang, "Journal of Northwestern Polytechnical University, 2022(002):040.)
- [2] M. Zheng, Y. Tian, S. Yang, "Remote sensing target detection based on improved FCOS network," *Aerospace Return and Remote Sensing*, 2022, 43(5):133-141. (in Chinese)
- [3] L. Sun, B. Chen, Z. Tan, "Web layout optimization method based on visual attention mechanism," *Journal of Taiyuan University: Natural Science Edition*, 2023, 41(3):48-53. (in Chinese)
- [4] Y. Wang, Z. Yu, J. Lu, "Regional style transfer of image salience based on visual attention mechanism," *Computer Engineering and Science*, 2022, 44(01):118-123. (in Chinese)
- [5] A. Duan, L. Li, X. Yang, "Image recognition and classification algorithm based on AlexNet," *Journal of Tianjin Vocational and Technical Normal University*, 2022(001):032.
- [6] Y. Li, D. Zhou, M. Li, "Low light image enhancement with smooth extended Convolutional network and attention mechanism," *Journal of Yunnan University (Natural Science Edition)*, 2022(005):044.
- [7] D. Long, "Application of computer image processing technology in packaging design," *Packaging World*, 2022(6):70-72.
- [8] A. Li, Y. Liang, "Research on color characteristics of Miao bird embroidery pattern in southeast Guizhou based on clustering algorithm", *Packaging Engineering*, 2023, 44(24):357-366.
- [9] Z. Li, "Visual image processing method of customized product packaging based on linear structured light imaging technology," *Laser Journal*, 2024(002):045.
- [10] Y. Song, X. Qian, L. Peng, "Research on Chinese Aesthetic Creative Design of AIGC", *Packaging Engineering*, 2023, 44(24):1-8.
- [11] T. Liang, Y. Long, W. Tang, "Plate counting algorithm based on peak-valley characteristics and combination voting method, *Journal of Packaging*, 2023, 15(3):85-90. (in Chinese)
- [12] W. Liu, "Research on fusion application of "Maogusi" painting image and local specialty packaging design," *Green Packaging*, 2023(8):132-135.
- [13] W. Li, "Application of Han Dynasty stone image in Huizhou ink packaging design," *Shanghai Packaging*, 2023(3):144-146.
- [14] Y. Gao, "Image Interpretation of "Shanghai Brand" packaging design (1960s to 1980s)", *Design*, 2022, 35(23):90-92.
- [15] D. Zhu, "Design of Product packaging Virtual Design System based on Machine Vision," *Automation & Instrumentation*, 2022(10):180-186.
- [16] A. Esrawi, and B. Alkhatib, "A Brief Review of the Automation of Dependency Satisfaction Within Microservices Architectures", *Journal of Digital Information Management*, 2024, 22 (3). pp 99-107