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Exploring visual design for image-enhanced communication in digital technology

Peijuan Li[1], Dan Wang[1,]✉

[1.] *School of Arts Sciences, Nanning College of Technology, Nanning, Guangxi, 530000, China*

ABSTRACT

In response to the problems of traditional visual design that overly relies on designer experience, poor design effectiveness, and low efficiency, this article studied visual design based on digital technology. In this paper, linear stretch visual design image enhancement method and histogram equalization visual design image enhancement method are used to enhance the image of advertising visual design image, packaging visual design image, beauty visual design image, cultural visual design image. Peak signal to noise ratio (PSNR) was used to analyze the effect of digital technology in visual design. The conclusion was drawn that the linear stretching enhanced visual design image method has better results. This article utilized the linear stretching visual design image enhancement method to enhance 20 visual design images, and analyzed the effectiveness of the linear stretching visual design image enhancement method using a questionnaire survey. The survey results indicated that after processing with the linear stretching visual design image enhancement method, the evaluation scores of the enhanced images by the respondents in School S, School T, and School A were 8.28, 8.76, and 8.47, respectively, which were higher than the original image evaluation scores. The visual design method based on digital technology is beneficial for improving the visual effect of images, and is of great significance for the dissemination of visual images.

Keywords: Visual Design, Linear Stretching, Image Enhancement, Digital Technology

1. Introduction

With the continuous development of modern communication technology, a variety of communication and technology continues to improve, video communication has also become part of people's lives. Image processing technology is the fundamental technology to realize video transmission, with the continuous development of computer technology, image processing technology has also been greatly developed, the use of computers can better realize the processing and editing of image data [1-4]. Different from analog image processing, digital image processing can achieve complex nonlinear processing, and has a strong analytical judgment ability, which improves the degree of automation of

✉ Corresponding author.
E-mail address: liuli5319@163.com (D. Wang).
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image processing, and can reduce human intervention [5-8]. However, digital image processing also exists problems such as slow processing speed, large consumption of computational resources and easy to cause information loss [9-10]. In the future, with the progress of computer technology, digital image processing technology will be further improved and developed.

For the image processing technology in the image enhancement technology, this technology can improve the visual effect of the image, is a combination of contrast, noise and other processing techniques, has been widely used in many video processing software [11-13]. Loop filtering technique is one of the commonly used image enhancement methods in the field of video communication, which can effectively eliminate the image block effect caused by compression coding and improve the image quality by adopting a symmetrical loop filter structure at the encoding end and decoding end [14-17]. And the subsequent filtering technique is another commonly used image enhancement method in the field of video communication. Unlike loop filtering which needs to be configured correspondingly at the encoding end, subsequent filtering is carried out entirely at the decoding end, and the filter is designed only based on the decoded image signal characteristics, and its main purpose is to eliminate the block effect introduced by video compression coding [18-21]. At present, image enhancement techniques have been widely used in systems such as video conferencing and video calls, which have significant effects on image enhancement [22-23].

In order to improve the visual effect and communication effect of the visual design image, this paper first used the linear stretch image enhancement method and the image enhancement method based on histogram equalization to process the visual design image. After comparing the effects of the two visual design image enhancement methods, the linear stretch image enhancement method was selected to process the visual design image. Afterwards, this article analyzed the effectiveness of linear stretching image enhancement methods using a questionnaire survey method, and concluded that digital technology is beneficial for improving image visual effects. Compared with other studies, this article used practical analysis methods to study the image enhancement effect of visual design based on digital technology, and comprehensively utilized objective image enhancement effect evaluation methods based on peak signal-to-noise ratio and subjective image enhancement effect evaluation methods based on survey questionnaires.

2. Visual Design Application Based on Digital Technology

2.1. Application Effects of Digital Technology

Compared with traditional manual visual design methods, digital technology based visual design methods can provide a new carrier for visual design. Traditional artificial visual design relies on the experience of designers and uses paper and pens as design tools, which is detrimental to expressing the creative thinking of visual designers. The application of digital technology in visual design can enable visual designers to better utilize resources such as text, images, and videos on the internet, thereby enriching the content of visual design. In the context of digital technology, with the abundant resources on the Internet, creators can easily find the image and video resources they need, and integrate digital technology, visual design methods, and artistic elements. Through digital technology, they can showcase their creative designs, thus breaking through the traditional two-dimensional spatial planarization of content design.

From the application of digital technology in visual design, it can be seen that in the past, visual design was presented in a flat form, which is prone to visual fatigue. Visual design based on digital technology can enrich the expression forms of visual design works. Viewers can intuitively see the design ideas of designers through digital technology, thereby understanding their design concepts and creative intentions. Therefore, the application of digital technology has promoted innovative forms of expression in visual works, providing new forms and methods for visual works, which plays an important role in enhancing the aesthetic value of visual works.

It can enhance the dissemination of visual design image works. From the perspective of the transformation and upgrading of the visual design industry, digital technology based visual design can promote the transformation and upgrading of the design industry. The application of digital technology has brought new vitality to visual design and has a certain driving effect on the transformation and upgrading of traditional design industries. The traditional design industry mainly uses two-dimensional planes for information dissemination, which is inefficient and unable to meet the visual needs of the audience. After the application of digital technology, new display methods and information dissemination channels have emerged. From the perspective of direct dissemination of visual design image works, the application of digital technology can strengthen the interactive forms of communication characteristics, which can allow the audience to have more effective communication with them and enable them to have a deeper understanding and mastery of the connotation of visual design works. It allows them to experience the meaning, ideas, and emotions expressed in the work, and brings good visual senses and emotional communication to the audience, thereby improving the effectiveness of visual design image communication.

2.2. Application Scenarios of Digital Technology

Font design: Font design is widely used in visual design. Font patterns are not only graphical symbols, but also have unique styles and functions. A good font design should have a reasonable and beautiful typesetting that can express the content that a visual design work wants to express. It can present a complete picture and provide a good visual feedback to the receiver of visual transmission, thereby giving people a good visual effect. Good font design can be applied to various scenarios such as product packaging, advertising communication, cultural and artistic works dissemination, and plays an important role in them. For text design, visual designers can easily adjust the font size, color, font, and other aspects of image text through the use of digital technology, and quickly judge the coordination of text in the image through real-time feedback from the human eye senses and design experience, thereby preventing problems such as excessive expansion, unevenness, and asymmetry of text. For example, visual designers can use simplified methods to design text symbols.

Packaging design: The rapid development of the economy has made shopping a common behavior. For product sellers, packaging design with good visual communication effects can increase the success rate of customer purchases and attract more customers to make purchases. Therefore, in order to effectively enhance the visual effect of the product and optimize the design of product packaging images, it is necessary to use digital technology to revitalize the product images and display the product in a more specific and detailed manner, thereby making the product images more vivid and lively, highlighting the natural beauty of the product. On online shopping platforms, high-quality and detailed product images are more likely to attract visitors, which also makes product images more attractive, attracting people's attention and increasing their purchasing desire. For example, for tea products, the aesthetics of product packaging images have a significant impact on people's purchasing desire.

Advertising design: good advertising design can stimulate and encourage consumption. The visual and sensory images and signals evoked by advertisements often trigger consumers' genuine desire to purchase. Good advertising design can convey product knowledge and better guide consumption. Through advertising, product sellers can comprehensively introduce the characteristics, quality, and use of the product, and solve their doubts about maintenance, installation, and other issues, thereby arousing customers' desire to purchase. In advertising design, visual designers should recognize the important role of advertising design in promoting products, and can use digital technology to showcase their unique design concepts and styles, ensuring that the final image design is more beautiful. At the same time, visual designers should use digital technology in conjunction with the form of advertising design to ensure that the form and content of advertising design are consistent with the actual situation of the product, in order to ensure the authenticity of the content. In addition,

color, as a visual element, has a significant impact on advertising effectiveness, for example, it can affect restaurant advertising information with a focus on taste. Color also has an impact on website visitors' preferences, and excellent visual design methods can effectively improve the quality of a website.

Art work design: The artistic principles contained in art design works are conducive to cultivating people's sentiment and improving their aesthetic ability; it is also beneficial for developing people's perception and visual thinking abilities, and for cultivating people's innovative thinking. Digital technology is beneficial for the creation of art works. It enriches the carrier of art design and promotes innovative creation. Designers can use digital technology to express what they want through audio, video, or images, thereby creating more diverse and colorful art works for people, and giving them a stronger visual impact. For example, compared to traditional art creation, using digital technology based aesthetic education resource platforms for art design can not only complete the creative content that traditional art creation cannot complete, but also improve the quality of art creation by utilizing the rich resources brought by digital technology, and improve the efficiency of art creation. At the same time, digital technology is conducive to the dissemination of art works. The digital form of art works greatly improves the dissemination efficiency of art works, and in the digital context, this dissemination process also has interactive characteristics. Digital technology enhances the dissemination characteristics of art works and can greatly leverage the functions of art, such as guiding people to discover beauty, improving aesthetic standards, and cultivating sentiment.

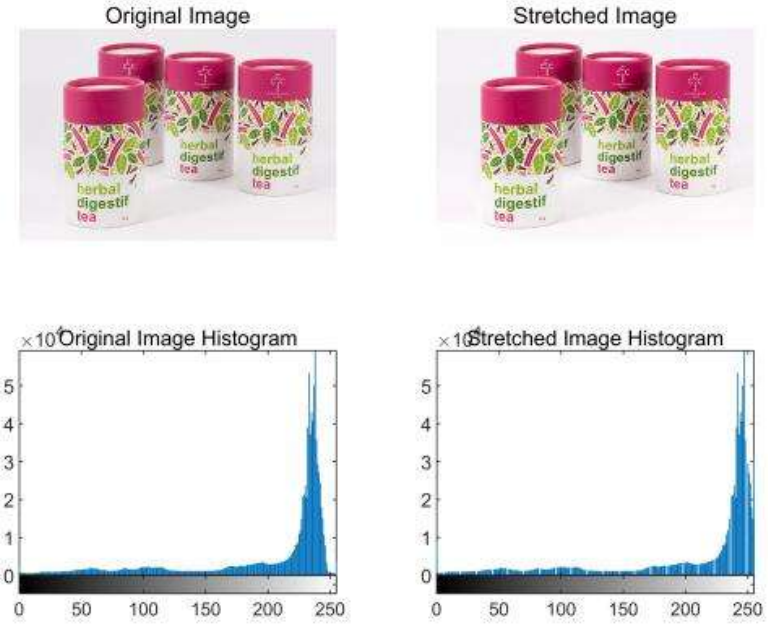
Cultural image work design: Excellent cultural works can inherit traditional culture and promote excellent culture, thereby exerting the "educational" role of culture. Cultural works have the function of conveying civilization, and the dissemination of cultural image works enables people to understand the experience, technology, and social background accumulated by humans during a certain period. For example, the 24 solar terms calendar atlas, as an intangible cultural heritage image, carries the wisdom summary of ancient Chinese working people about climate and seasonal knowledge, and has an important guiding role for agricultural production and daily life at that time. For example, "Shadow of the Lotus Light", "Red Leaf Birds", and "Golden Homeland", these intangible cultural embroidery images reflect the advanced embroidery techniques mastered by the working people. The dissemination of cultural works is conducive to regulating human behavior and exerting the leading role of rationality in human behavior. The dissemination of cultural works is also conducive to consolidating social forces. The dissemination of cultural works can stimulate people's national and national emotions, and deepen their identification with culture, nation, and country, which plays an important role in consolidating social strength. In terms of cultural image creation and dissemination, digital technologies such as artificial intelligence and virtual technology have greatly enriched the creative techniques and connotations of cultural image works. The three-dimensional design method and augmented reality interaction method have greatly increased the experience of cultural image recipients, promoting the dissemination and development of cultural image works. For the dissemination of intangible cultural heritage images, digital technology has a great promoting effect on their dissemination, which is conducive to the preservation and dissemination of intangible cultural heritage.

3. Application Practice of Digital Technology in Visual Design

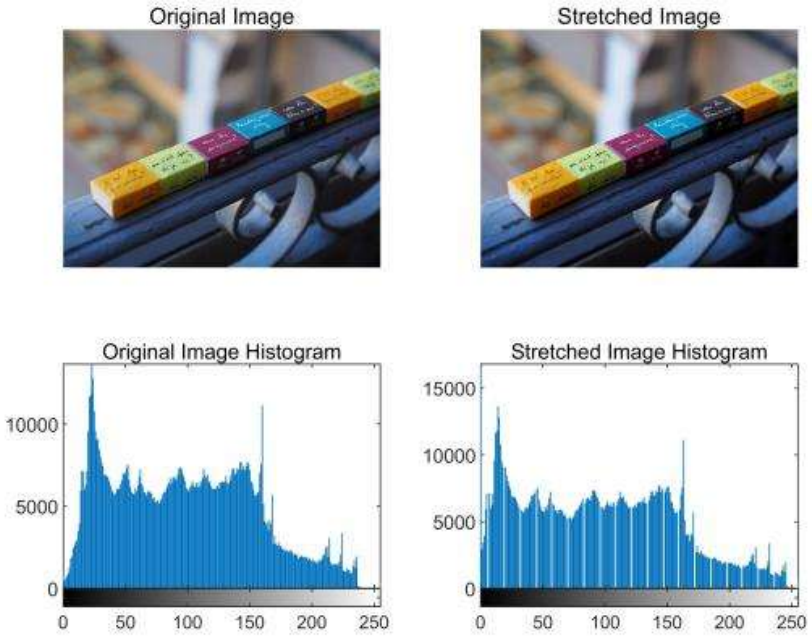
Image enhancement refers to the processing of degraded image features, such as edges, contours, contrast, etc., through a certain image processing method to improve the visual effect and clarity of the image, or to highlight certain "useful" parts of the image, compress other "useless" information, and convert the image into a form more suitable for human or computer analysis and processing. Starting from the visual arts of art and design, this article explored the enhancement and dissemination of visual effects in visual design images under digital technology. This article is based on digital technology and utilizes various methods to enhance visual design images.

3.1. Using Linear Stretching to Enhance Visual Design Images

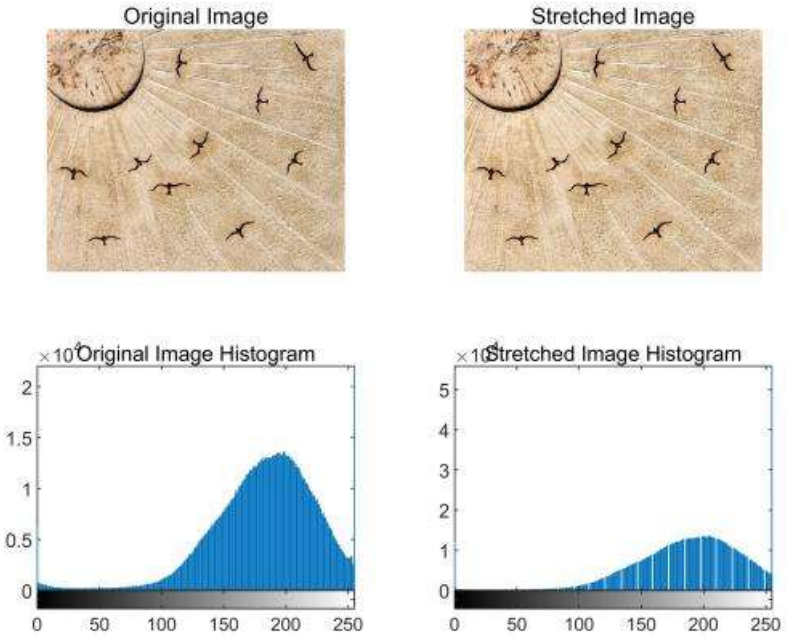
One advertising visual design image, one packaging visual design image, one art visual design image, and one cultural visual design image were selected, and four visual design images were enhanced using linear stretching. The results are shown in Figure 1.



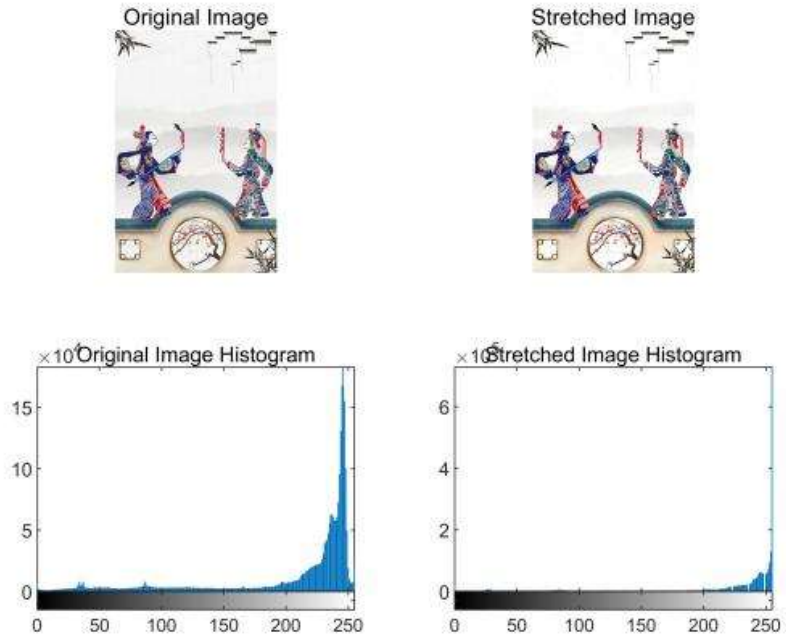
(a) Advertising visual design images



(b) Packaging visual design images



(c) Art visual design images



(d) Cultural visual design images

Fig. 1. Enhanced visual design image after linear stretching

Figures 1(a), 1(b), 1(c), and 1(d) show advertising visual design images, packaging visual design images, art visual design images, and cultural visual design images before and after image enhancement. From the perspective of human visual senses, compared to the original image, the four visual design images processed using linear stretching have improved image contrast and image clarity, and the four visual design images present better visual effects.

3.2. Image Enhancement of Visual Design Based on Histogram Equalization

Histogram reflects the distribution of image gray value, and the principle of histogram enhancement is to enhance the image by affecting the distribution of gray value. This paper analyzes the image enhancement of visual design based on histogram equalization. The grayscale histogram of visual design images is treated as a one-dimensional discrete function:

$$l(c) = m_c \tag{1}$$

m_c is the number of pixels in the visual design image with a gray level of c.

The normalized histogram is defined as the relative frequency of the occurrence of grayscale level $I_r(c)$, and its expression is:

$$I_r(c) = m_c / M \tag{2}$$

r is the gray value of the original visual design image, and t is the gray value of the visual design image after histogram equalization. The relationship between the two is:

$$t = S(r) \tag{3}$$

Among them, S is the transformation function.

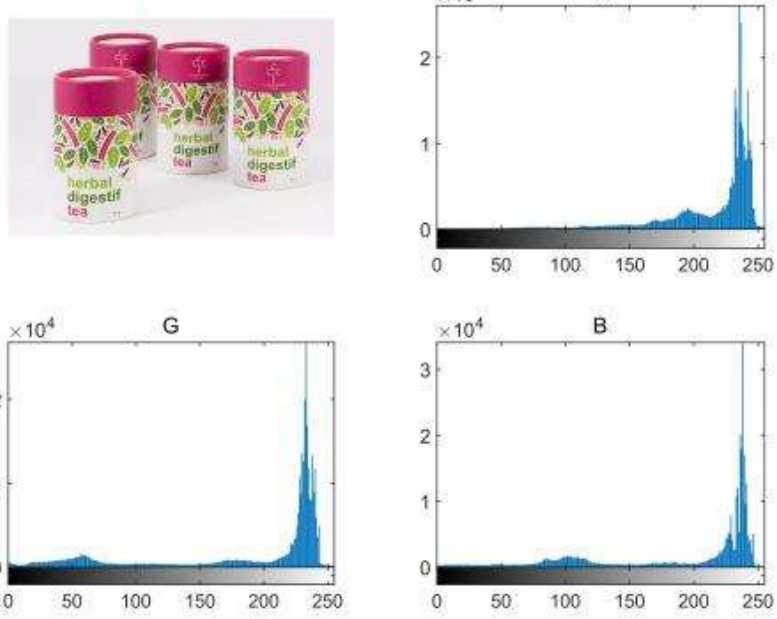
If the probability density of r is set to $I_r(r)$, then the distribution function of t is:

$$F_t(t) = \int_{-\infty}^{t} I_{t(t)} dt = \int_{-\infty}^{t} I_{t(t)} dr \tag{4}$$

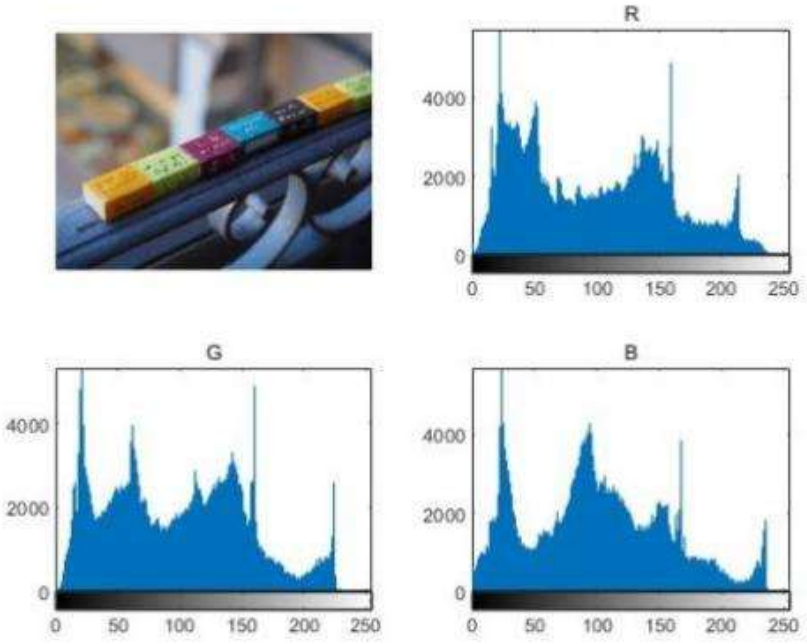
After taking the derivative of t on both sides of Formula (4), it can be concluded that:

$$I_t(t) = \frac{dF_{t(t)}}{dt} = \frac{d\left[\int_{-\infty}^{r} I_{r(r)} dr\right]}{dt} = I_{r(r)} = \frac{dr}{dt} = I_{r(r)} \frac{dr}{d\left[S(r)\right]} \tag{5}$$

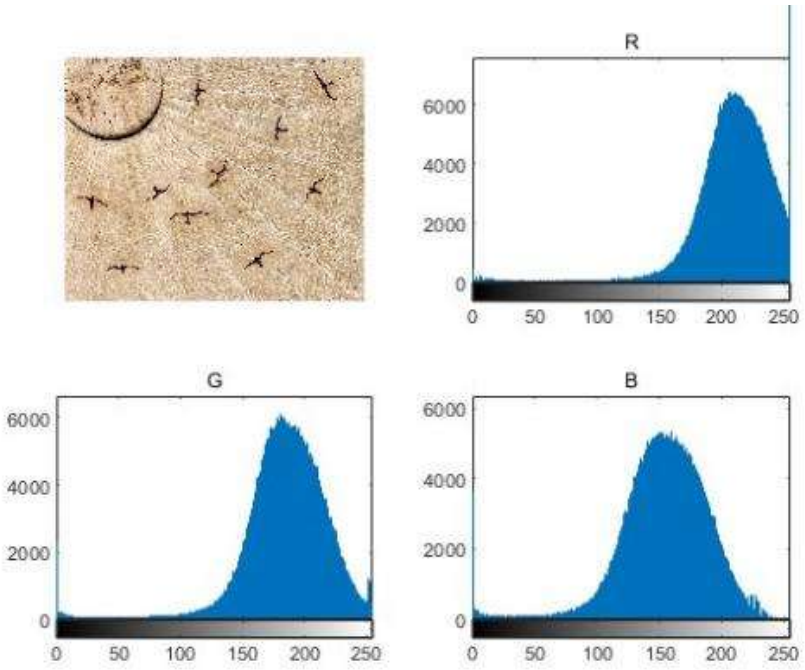
Histogram equalization is used to analyze visual design images. The display results of color RGB (red, green, blue) image histograms are shown in Figure 2. Figures 2(a), 2(b), 2(c), 2(d) are advertising visual design image histograms, packaging visual design image histograms, art visual design image histograms, and cultural visual design image histograms.



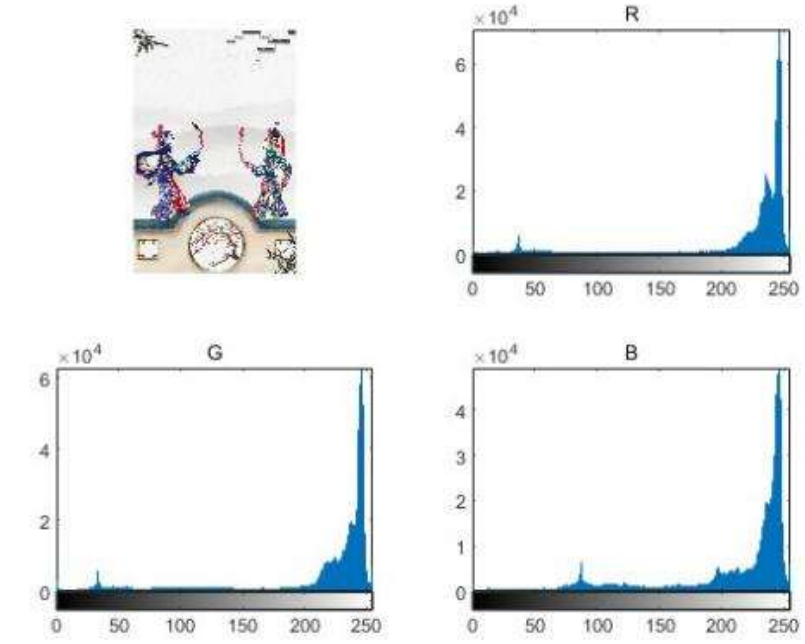
(a) Advertising visual design image histogram



(b) Packaging visual design image histogram



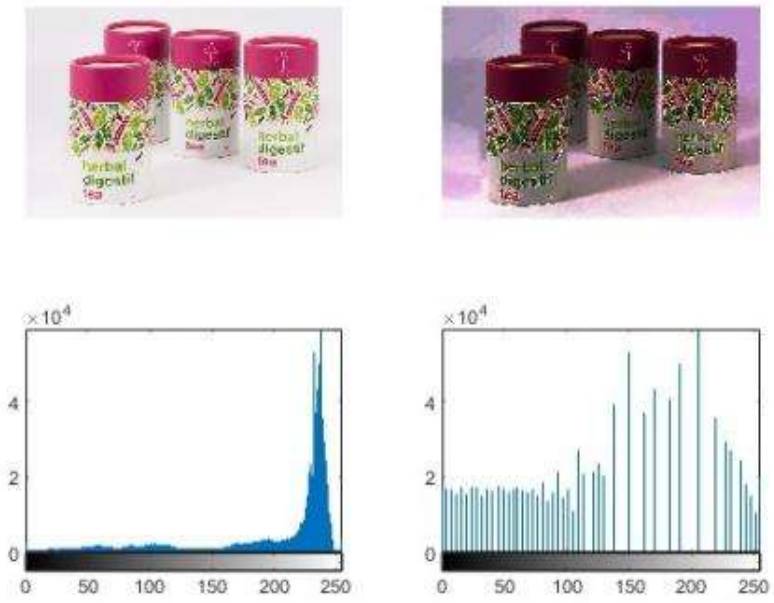
(c) Art visual design image histogram



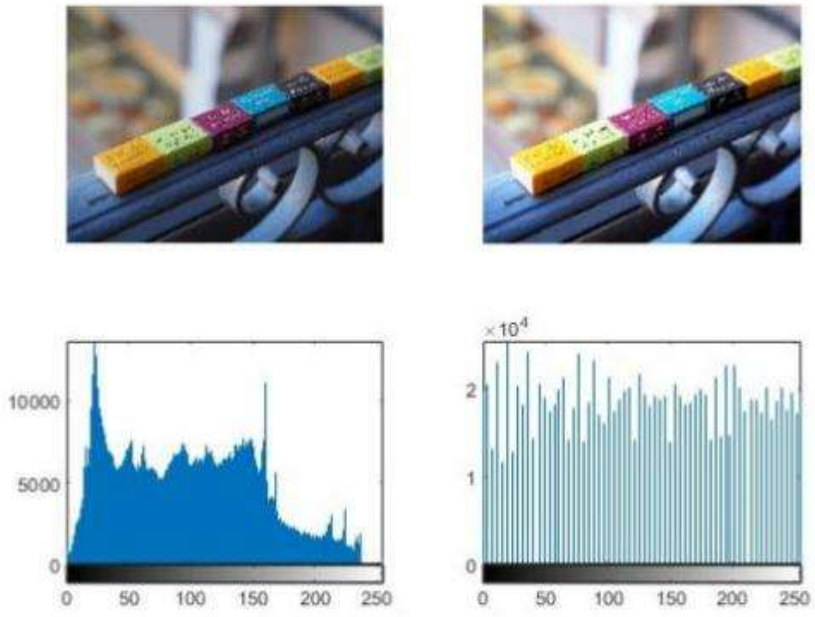
(d) Cultural visual design image histogram

Fig. 2. Display results of color RGB image histogram

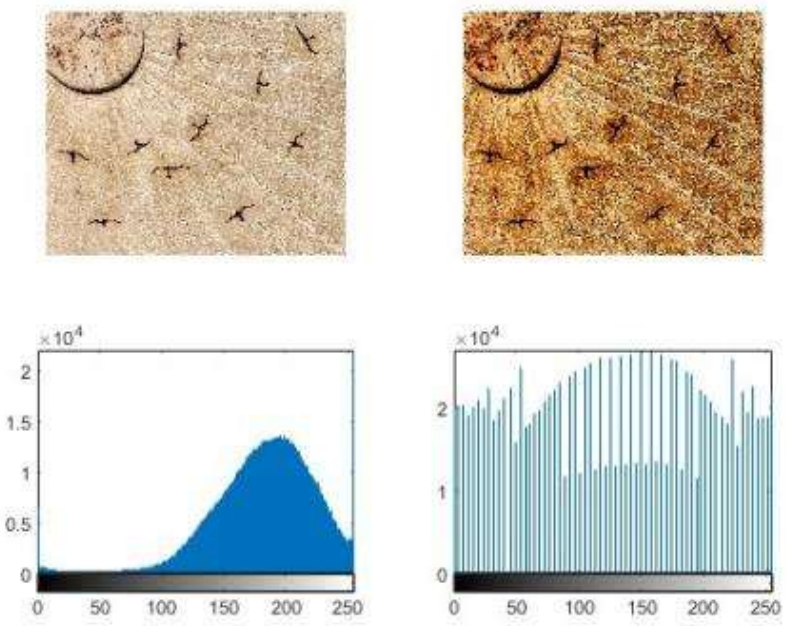
Histogram equalization is performed on four visual design images, as shown in Figure 3.



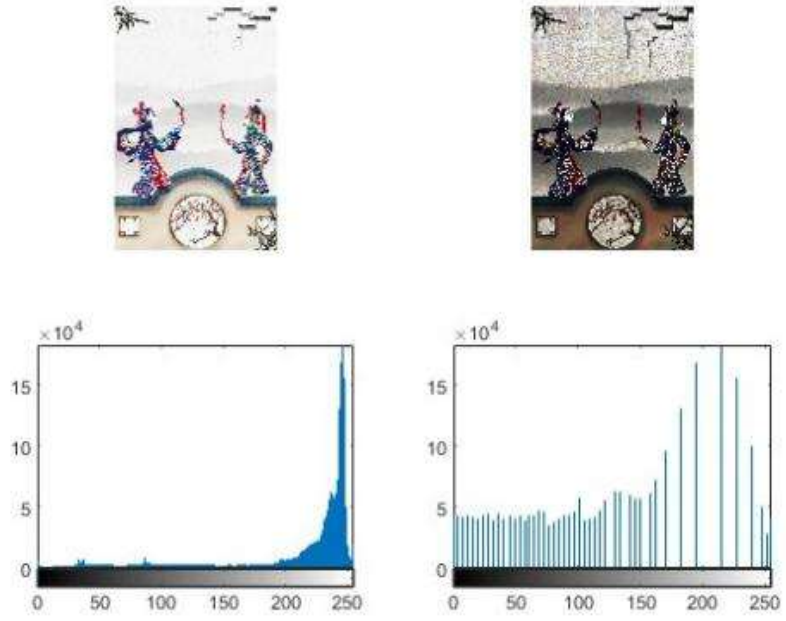
(a) Histogram equalization equalization result of advertising visual design image



(b) histogram equalization equalization result of packaging visual design image



(c) Histogram equalization equalization results of art visual design image



(d) Cultural visual design image histogram equalization equalization results

Fig. 3. Display result of histogram equalization

Figures 3(a), 3(b), 3(c) and 3(d) respectively show the advertising visual design images, packaging visual design images, art visual design images and cultural visual design images before and after image enhancement using histogram equalization. Compared with the original image, the contrast of the image processed by histogram equalization is improved, but the display effect of advertising visual design image and cultural visual design image is not ideal. Among the four visual design

images, the image processed by histogram equalization has a worse visual effect than the image processed by linear stretching.

3.3. Effect of Digital Technology in Visual Design

This paper compared the effect of the image enhancement method of visual design based on linear stretching and histogram equalization, as shown in Table 1.

Table 1. Evaluation of image enhancement effect based on peak signal-to-noise ratio

	Linear stretching	Histogram equalization
1	30.24dB	9.92dB
2	33.51dB	17.23dB
3	33.33dB	11.71dB
4	30.10dB	8.97dB

In Table 1, "1, 2, 3, and 4" respectively represent the enhanced advertising visual design images, packaging visual design images, art visual design images, and cultural visual design images in this article. Compared with the original image, the peak signal-to-noise ratio of the four images after histogram equalization was 9.92dB, 17.23dB, 11.71dB and 8.97dB, respectively. Generally speaking, the peak signal-to-noise ratio below 20dB is considered to be very poor image quality. Peak signal-to-noise ratio between 20 dB and 30 dB is considered average image quality, and PSNR values between 30 dB and 40 dB are generally considered good image quality; PSNR values above 40 dB are considered very good image quality Compared with the original image, the peak signal-to-noise ratios of the four images using linear stretching image enhancement method were 30.24dB, 33.51dB, 33.33dB, and 30.10dB, respectively.

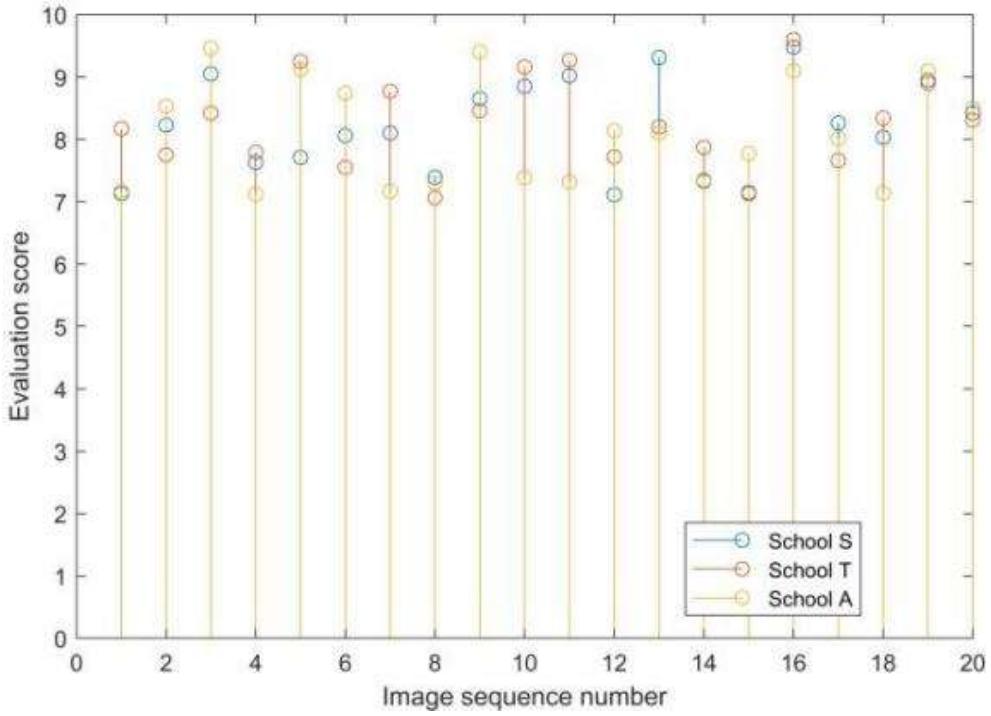
This article used the linear stretching visual design image enhancement method to enhance 20 visual design images. These 20 images can be divided into advertising visual design images (image numbers 1-5), packaging visual design images (image numbers 6-10), art visual design images (image numbers 11-15), and cultural visual design images (image numbers 16-20), each containing 5 images. At the same time, this article conducted a questionnaire survey in three universities (School S, School T, and School A) in N city, and invited a total of 1000 students to evaluate the application effect of digital technology in visual design Among them, 300 questionnaires were distributed in schools S and T, and 400 questionnaires were distributed in School A. A total of 996 questionnaires were collected, of which 989 were valid, with an effective recovery rate of 98.9%. The basic characteristics of the surveyed subjects are shown in Table 2.

Table 2. Basic characteristics of the respondents

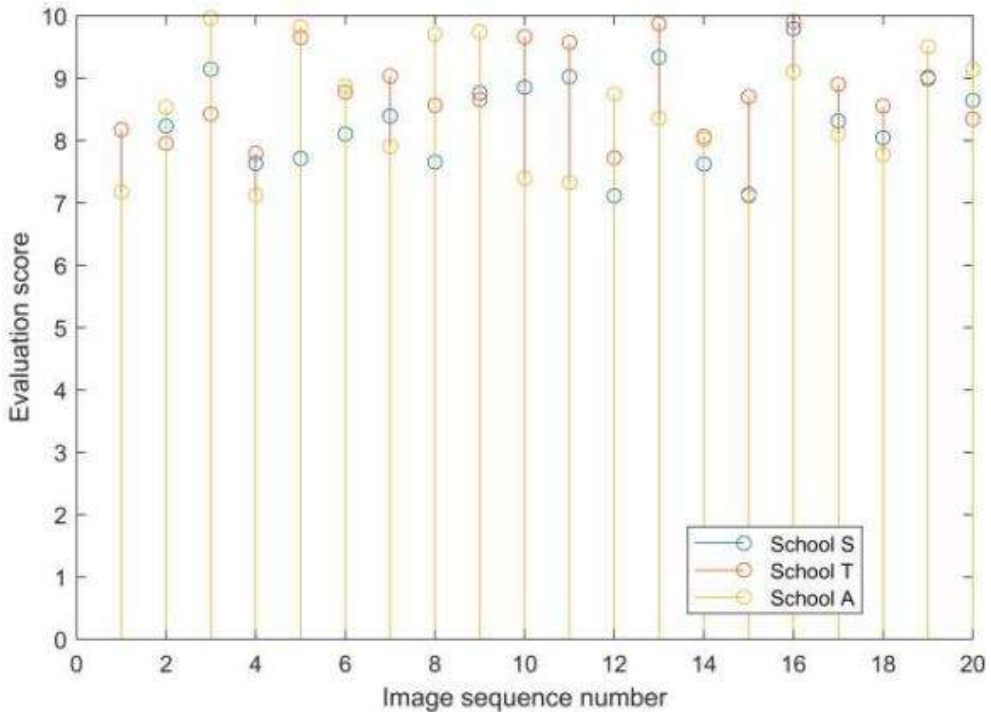
		School S	School T	School A
Age range	Below 18	0	3	2
	18-22	284	275	379
	Over 22 years old	11	21	14
Male classmates		136	164	298
Female classmates		159	135	97
Professional category	Philosophy	37	13	24
	Economics	23	5	8
	Law	29	25	21
	Education	9	22	12
	Literature	45	3	77
	History	18	32	41
	Neo Confucianism	13	37	38

	Engineering	6	10	8
	Agronomy	10	42	67
	Medical Science	24	8	18
	Management	37	22	22
	Art Studies	44	80	59

The respondents were invited to evaluate their visual design works, with a maximum score of 10 points. A score of 8 or above indicates excellent performance, 6 or above indicates average performance, and a score of 6 or below indicates poor design performance. The evaluation scores are shown in Figure 4.



(a) Evaluation score of the original image



(b) Evaluation score of the enhanced image

Figure 4 Evaluation scores of visual design works by respondents

Figure 4(a) shows the evaluation scores of the respondents on the original image, while Figure 4(b) shows the evaluation scores of the respondents on the enhanced image. The respondents' evaluation scores for both the original and enhanced images were above 7 points. The evaluation scores of the respondents in School S, School T, and School A on the original image were 8.19, 8.27, and 8.1, respectively. The evaluation scores of the respondents in School S, School T, and School A on the enhanced image were 8.28, 8.76, and 8.47, respectively. Compared with the original image, the evaluation scores of the respondents in School S, School T, and School A on the enhanced image were higher. The visual design method based on digital technology is beneficial for improving the visual effect of images, and is of great significance for the dissemination of visual images.

4. Development Strategy of Digital Technology in Visual Design

Emphasizing the integration of creative design: Visual designers should not overly rely on digital technology. When using digital technology, they should consider people's aesthetic needs and different requirements, and should reasonably integrate creative elements into visual design. Creativity and imitation should be thoroughly combined, and the display and dissemination effects of visual design should be strengthened. In addition, designers should integrate innovative elements into all aspects of modular design to ensure that the design work is rich in content. It needs to have distinct connotations and high visibility, in order to better meet the personalized needs of audiences of different age groups in countries in the digital age. While emphasizing the integration of creative design, visual designers should also invest more emotions in the design. They should not only focus on modular visual design based on digital technology, but should combine it with specific real-life environments to give visual design products more emotional connotations, causing empathy and communication among people.

Continuously innovating in multidimensional visual design: In the digital age, diverse visual thinking is crucial for visual designers. Designers need to improve their design skills through practical visual design. They need to continuously master advanced knowledge of visual design while

cultivating diverse visual thinking, and cultivate multi-dimensional design abilities. It is necessary to deeply explore the problems of visual design at this stage, and change the traditional design thinking mode, so as to achieve multi-dimensional visual design in the process of visual design practice. In the process of visual design practice, technologies such as augmented reality and virtual reality should be efficiently utilized to integrate visual design creation into virtual and three-dimensional spaces. In addition, the expression methods of visual design works should be diverse. Designers should combine the background and theme of their work at different levels, and carefully and flexibly choose and use colors. By effectively visualizing design works and enhancing their sustainability and visibility, diverse sensory experiences can be provided to audiences of different ages through different expressions. For example, using contrasting colors to express the theme of a work can enhance its visual effect and attract the attention of the audience, thereby creating a deeper impression on the work.

Emphasizing the localization of ethnic visual design: Designers need to have a comprehensive and multi-level understanding of traditional folk culture. In the process of implementing localization design using digital technology, they should reasonably extract and improve the visual elements of traditional culture and art, such as ceramic decoration, New Year paintings, calligraphy, carving, and other local cultures. Designers should grasp the essence of local culture and integrate it into various aspects of visual communication design. By flexibly utilizing digital technology in local design and organically combining traditional and modern elements, the content of the work can be enriched. They need to fully embrace the characteristics of the digital age and continuously improve visual design through the process of optimizing and innovating visual design works.

Cultivating high-quality visual design talents: the development of digital technology has changed the visual design from pursuing visual design effect to pursuing visual design thinking innovation. Therefore, in order to better promote the development of digital technology in visual design, relevant personnel should pay attention to the cultivation of visual design talent teams. Talent training should first focus on stimulating, guiding and cultivating the creativity and innovative consciousness of visual design talents in the transformation of design concepts and design thinking, and mobilize their subjective initiative as much as possible through education and training in various ways and means. Secondly, digital technology should be integrated into the daily training of designers, which enables them to optimize their cognitive abilities during the design process and better understand the requirements of the visual design field for design work. To achieve the goal of effectively integrating daily design with digital technology, visual designers need to continuously strengthen the practical application of digital technology and cultivate advanced design concepts. By continuously improving the ability to think and judge the value of visual design, one can master the use and innovation of digital technology.

5. Conclusions

The development of digital technology and the continuous emergence of new communication tools have made a qualitative leap in the development of visual language and design effects. In this context, this article investigated the visual design of image enhancement propagation under digital technology. This article first analyzed the application effects of digital technology in visual design, including providing new carriers for visual design and enhancing visual design. It also analyzed the application scenarios of digital technology in text design, packaging design, advertising design, art design, and cultural image design. After that, this article analyzed the effectiveness of linear stretching visual design image enhancement methods using a questionnaire survey method. The conclusion drawn was that applying digital technology to visual design is beneficial for improving the visual effect and quality of visual images. Although the research in this article can provide some reference for related research in visual design, the image enhancement methods used in this article are not sufficient. The image quality evaluation indicators used in this article are not comprehensive

enough, and the number of samples selected in the questionnaire survey is not large enough. In future research, more image enhancement methods would be used to study visual design images and increase the evaluation indicators of image visual effects.

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