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Retraction

Retracted: Optimization of Plane Image Color Enhancement Based on Computer Vision

Wireless Communications and Mobile Computing

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] M. Cao, "Optimization of Plane Image Color Enhancement Based on Computer Vision," *Wireless Communications and Mobile Computing*, vol. 2022, Article ID 3463222, 8 pages, 2022.

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Research Article

Optimization of Plane Image Color Enhancement Based on Computer Vision

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In order to enhance the color effect of plane image, this paper presents a method of optimization of color enhancement processing of plane image based on computer vision technology. This method combines Retinex algorithm with adaptive two-dimensional empirical decomposition and decomposes the image to achieve the effect of image color enhancement. The experimental results show that the average value of the image processed by this method is increased by about 0.3. The variance increased by about 0.13. Information entropy increased by about 0.3. The definition is improved by about 0.02. *Conclusion*. The optimization method of color enhancement processing of plane graphics based on computer vision technology can effectively improve the color of plane images, which is of great significance for image processing.

1. Introduction

Image color enhancement is the most basic and key image information processing technology [1]. Traffic monitoring, medical imaging, criminal investigation technology, and military fields have their applications. The unprocessed original plane image may have noise interference, including lighting conditions, weather reasons, the reflection properties of the object itself, and other factors, which will make the image not clear enough, the color saturation is not enough, and the details are missing, resulting in small gray value, high brightness, blurred image, and other problems.

Computer vision is an important part of the intellectual field. The aim of the study was to enable computers to recognize three-dimensional environmental data through two-dimensional imaging [2]. Computer vision is based on computer graphics, signal processing technology, and validation results, including geometry, neural networks, machine learning theory, computer data, and paper production technology. It analyzes and processes computer-generated data [3]. Try to create a device that receives information from various images and information based on scientific research, computer vision, scientific research, and technology. Computer vision is a broad field that involves scientists in many fields, including computer science, engineering, architecture, physics, mathematics, statistics, neurophysiology, and cognition [4–6]. Computer vision is also a very active field in the current computer science. The field of computer vision is closely related to image processing, pattern recognition, projection geometry, statistical inference, statistical learning, and other disciplines. In recent years, it also has a strong connection with computer graphics, three-dimensional representation, and other disciplines [7]. With the rapid development of information technology, the development of computer vision image technology is advancing by leaps and bounds. Under normal circumstances, these technologies will be applied in the process of image data acquisition and detection image processing of human internal vision system. Highly integrated with visual technology, it can be applied to the image processing of industrial testing instruments and equipment and parts. Some technologies will also be applied to the deep multilevel image processing of the part image data to be collected. In this environment, using computer vision technology to enhance and optimize the color of plane image can greatly improve the quality of plane image, so as to better use plane image for problem processing.

2. Literature Review

Image color enhancement is the most basic and key image information processing technology. Traffic monitoring, medical imaging, criminal investigation technology, and military fields have their applications. The unprocessed original plane image may have noise interference, including lighting conditions, weather reasons, and the reflection properties of the object itself, which will make the image not clear enough, the color saturation is not enough, and the details are missing, resulting in small gray value, high brightness, blurred image, and other problems. In order to solve these problems, relevant professionals have done a lot of exploration and research. For example, Tao proposed the fundus color image enhancement method. Although it can enhance the color and effectively improve the color and brightness, it needs to manually set parameters during calculation, resulting in cumbersome calculation and no adaptability [8]. Huang et al. explored the use of histogram to enhance the image. This method has strong adaptability. However, when the original image has a small gray dynamic range and uneven distribution, the image details will be lost, and even the noise will be amplified [9].

Computer vision technology refers to the visual process of simulating human visual observation and analysis of images through computers. It requires computers to have the ability to use images to perceive the surrounding environment in the process of artificial intelligence, simulate the specific process of human visual function, and then realize intelligent processing of relevant images. Computer vision technology is an artificial intelligence technology, which simulates the process of human perception of the environment. Therefore, this technology integrates multiple disciplines and technologies, including image processing, artificial intelligence, and digital technology [10, 11]. This technology plays a very important role in the development of computers. Especially in modern society, people need computers to complete more intelligent behaviors to replace human beings to solve some work in special environments. In addition to the application of computer vision technology in the development of computer, it also has certain applications in mechanized production. In the future mechanical automation production, this technology can be used to extract the image of objective things and then used for the detection and control in the production process. Compared with the traditional automation control, this technology can realize the control function of faster speed, greater amount of information, and more functions.

Computer vision began with the introduction of the 1950 model. At the time, the work focused only on two-dimensional analysis and identification, such as knowledge of optical behavior, analysis and interpretation of work surface, micrography, and aerial photography. In the mid-1970s, the laboratory opened a "car vision" class. Since the 1980s, blind computer research has shifted from advanced experiments to practical applications. The rapid development of computer manufacturing and the development of intelligent, functional, and neural network technologies have helped to improve the performance of computer vision systems and to participate in research into various techniques of visual processing. Currently, computer visual technology is widely used in geometry, computer graphics, graphic design, and robotics, as shown in Figure 1.

The concept of machine vision was introduced into China at the beginning of the 21st century. Up to now, the technology is still in the stage of popularization. As China's development ability in machine vision hardware and software is not very strong, there is a certain gap between domestic MVT and foreign MVT, resulting in high development cost and low efficiency of related products [12]. In recent years, domestic research institutes, universities, and related enterprises have increased their research on MVT and applied the technology to industrial sites, such as electronic manufacturing, semiconductor industry, and pharmaceutical industry. Some experts and scholars have developed product defect detection equipment based on MVT, which can sort unqualified products. With the gradual improvement of MVT, it has also been applied in the domestic automobile manufacturing industry and new energy industry. At present, MVT in China is extending to many fields and industries. The technological process of viewing information in a computer visual system depends only on the method of image processing. These include image enhancement, data encoding, transmission, smoothing, edge sharpening, segmentation, feature unpacking, image recognition, and understanding. After this process, the quality of the output image is improved to a certain extent, which not only improves the appearance of the image but also allows the computer to recognize, process, and recognize the photos. Based on the above research, this paper proposes an optimization method for color enhancement of planar images based on computer vision technology. This method uses Retinex algorithm, adaptive two-dimensional empirical decomposition, and computer vision technology to decompose it, so as to achieve the purpose of enhancing and optimizing the color of plane image [13, 14].

3. Research Methods

3.1. Principles of Computer Vision Technology. Computer vision is the use of computers to transform many organ systems and the brain into a complete, explanatory environment, according to the technique of comprehension. The ultimate goal of computer vision research is to enable computers to control, understand, and adapt to the world through human-like vision. Only with long-term efforts can we achieve our goals. Therefore, before achieving the ultimate goal, the main goal of human activity is to create a vision that can do certain tasks based on certain perceptual and feedback skills. For example, an important area of computer visual application is visual vehicle navigation. There is no system that recognizes and understands the environment and regulates itself like a human being. Therefore, the goal of human research is to identify visionary drivers who are able to control the highway and avoid collisions with oncoming vehicles. What is being said here is that the computer plays an important role in changing the human brain's computer vision, but this does not mean that the computer must be

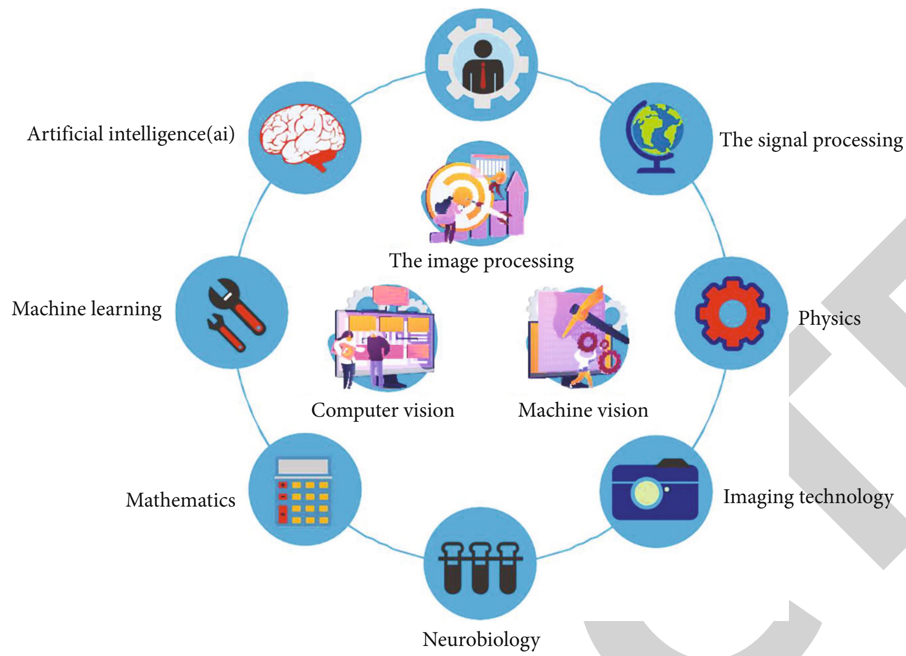

Figure 1: Domain relationship of computer vision.

able to complete the data it sees as a model of human vision. The computer's vision must be visible and in accordance with the characteristics of the computer. However, the human visual system is the most robust and perfect visual system.

As we will see in the following chapters, the study of human vision will provide inspiration and guidance for the study of computer vision. Therefore, computer information processing is used to study the mechanisms of human vision and to develop the sensory perception of human vision. This study is called vision counting and can be considered as a computer vision survey [15]. Figure 2 shows the scope of a computer vision system.

3.2. Retinex Algorithm. The Retinex algorithm is based on visual perception of brightness and color and automatically adjusts the perceived color and brightness to ensure color persistence. The reason for distinguishing the illumination change and surface change of a plane image is that the color change caused by the brightness of the incident light is slower than that caused by the reflection of the object surface. Thus, a plane image composed of the interaction between the incoming and outgoing light and the reflector can be obtained.

In the Retinex algorithm, the incident light and reflection attributes can be expressed by the following mathematical expressions, as shown in the following formula:

$$f(x, y) = l(x, y) \times r(x, y). \tag{1}$$

The original image is $f(x, y)$, and the incident light and reflected light images are $l(x, y)$ and $r(x, y)$, respectively.

The reflected light image can be calculated from the following formula:

$$R = F - L, \tag{2}$$

where $R = \log(r)$, $F = \log(f)$, and $L = \log(l)$, respectively, represent the reflected light image, and the result of logarithm between the original image and the incident light image is the R exponential function [16].

3.3. Adaptive Two-Dimensional Empirical Decomposition. Adaptive two-dimensional empirical decomposition (ABEMD) converts one-dimensional signals into two-dimensional signals through the optimization method of multiscale architecture and then combines the two-dimensional intrinsic mode function to collect the image extreme points, interpolate the surface of the extreme points, and calculate the average value on the envelope surface. Then, the two-dimensional intrinsic mode function is used to subtract the two-dimensional signal, and the obtained value is the trend function. Finally, the iteration is performed [17]. $f(x, y)(x = 1, \cdots, M, y = 1, \cdots, N)$ refers to the image signal of $M \times N$ size. To divide the original image into two-dimensional intrinsic mode functions of high frequency and low frequency, adaptive two-dimensional empirical mode decomposition can be used. The frequency corresponding to the decomposed image scale is sorted in ascending order, that is, the detail mode is built. When decomposing, it is necessary to ensure that the two-dimensional intrinsic mode function is commensurate with the initial two-dimensional signal whose mean value is 0, and that the maximum point and minimum point are positive and negative, respectively. The following formula represents the decomposition result:

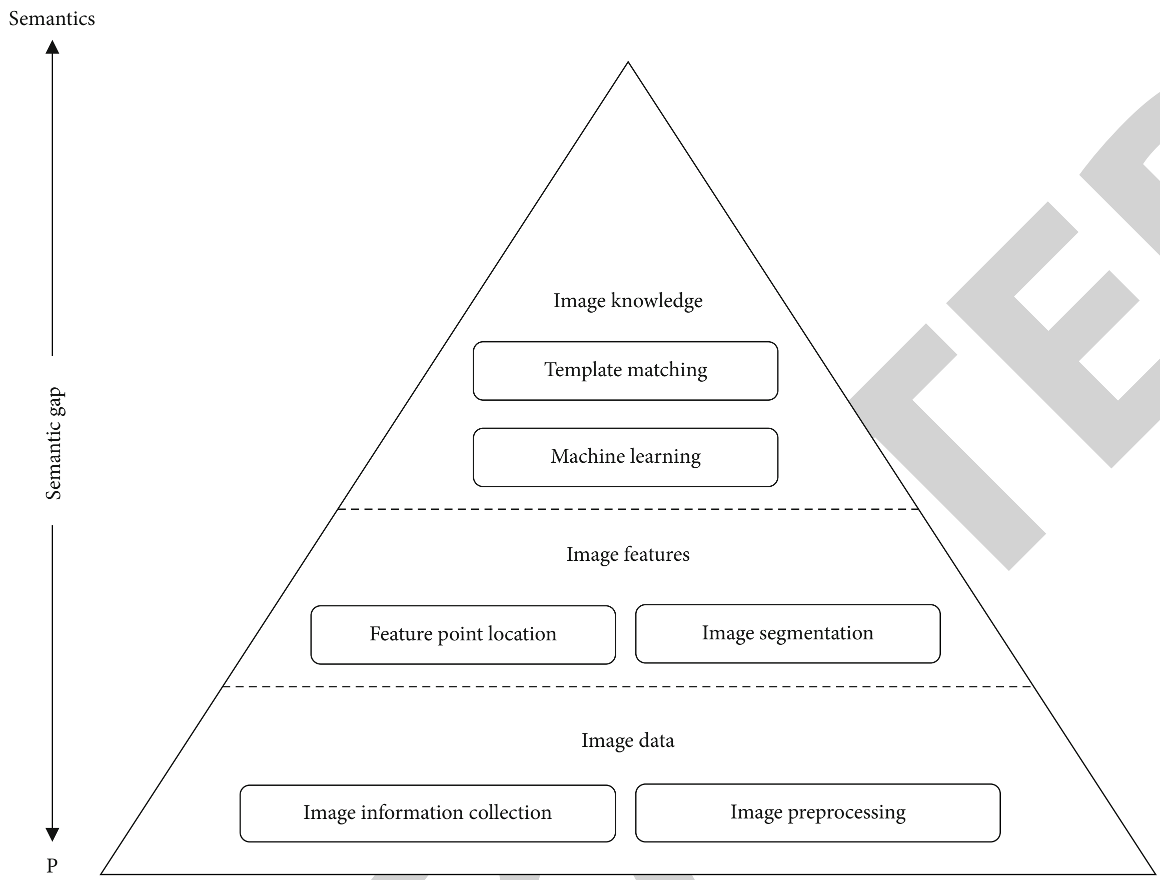

Figure 2: Computer vision recognition system framework.

$$f(x, y) = \sum_{k=1}^{N} \mathrm{bim}f_k(x, y) + r_N(x, y), \tag{3}$$

where $\mathrm{bim}f_k(x, y)$ is used to describe the two-dimensional intrinsic mode function image of layer K, and the trend image is obtained through n-layer division [18].

3.4. Combination of Retinex Algorithm and Adaptive Two-Dimensional Empirical Mode Decomposition. Gaussian convolution is used to calculate the incident light component of the original plane image, and the center surround Retinex algorithm is used [19]. The selection of scale should be considered in this process. If a single scale Retinex algorithm is adopted, it will focus on the local. If a multiscale Retinex algorithm is adopted, the efficiency will be reduced due to the increase of the amount of computation. In addition, when setting single scale and multiscale, the results will be different due to different environments. When the incident light component is collected by the adaptive two-dimensional empirical mode decomposition method in this paper, the scale will be matched independently according to the original characteristics of the image, and the operation method is very simple.

After adaptive two-dimensional empirical mode decomposition, several two-dimensional intrinsic mode function images and trend images with different scales are obtained, and different frequency characteristics are summarized, respectively [20]. When estimating the incident light component, the adaptive two-dimensional empirical mode decomposition can match the scale independently, which can maximize the acquisition area of details. Therefore, the detail information, such as image noise, is deleted, which is the high-frequency component. The reason why "halo" will not appear in the calculation process of Retinex algorithm is that the illumination component can directly reflect the illumination information in this process.

3.5. Algorithm Flow. The best way to realize planar image processing is to effectively ensure that the subsequent processing of planar images is less complicated and the image enhancement effect is good. The method proposed in this paper is a planar image color enhancement method based on computer vision technology, and its specific framework is shown in Figure 3.

The *RGB* space of the image is transformed into *HSV* space, and then, each component is decomposed by the Retinex algorithm. Finally, the Retinex algorithm is used to correct and adapt the incident light and reflected light components. Weighted acquisition of the brightness component after enhancement can simplify the three channels of R, G, and B into single channel calculation. The saturation component S is corrected based on the enhanced brightness component V', and the chrominance component should be

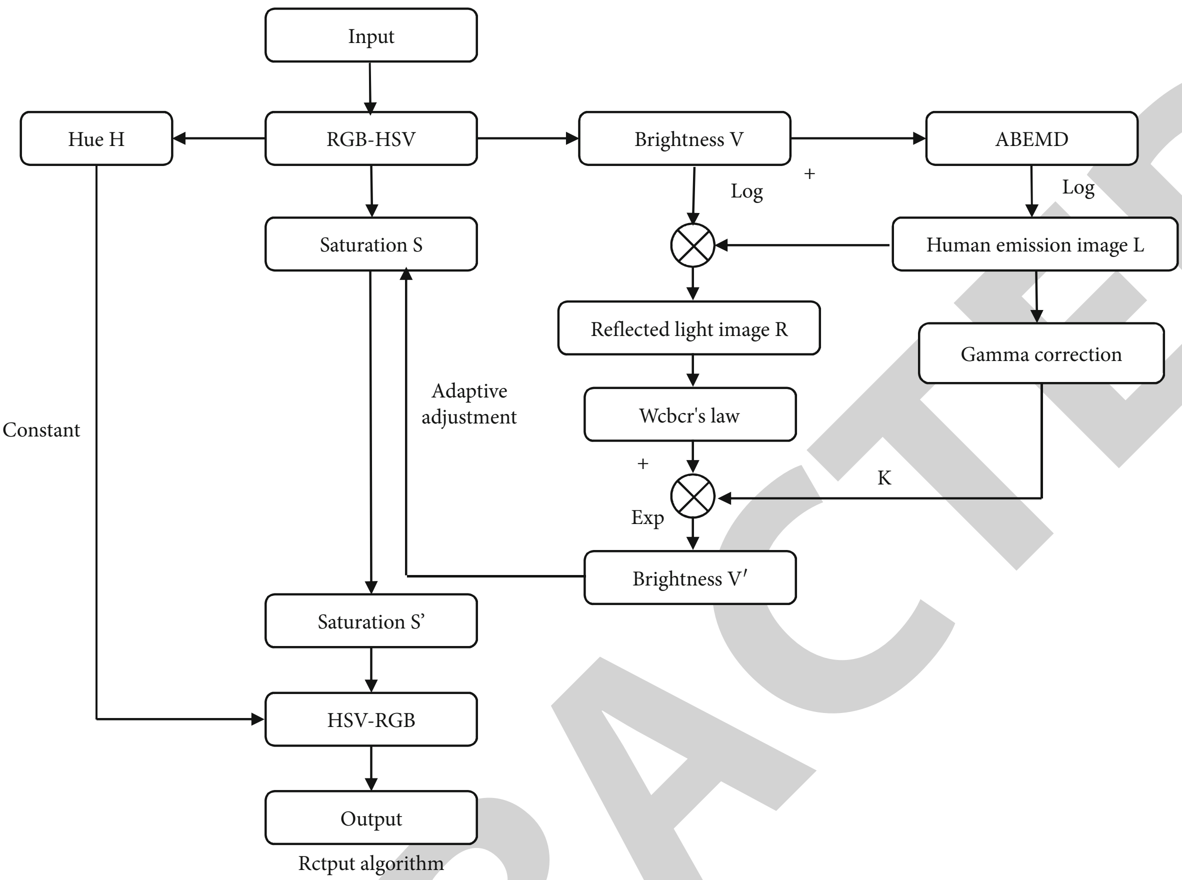

Figure 3: Specific framework of this method.

consistent with the previous one. In this way, the color of the color image can be kept undistorted, and finally it can be converted into RGB domain.

3.5.1. Area Retinex Incident Light Image Acquisition. Regional Retinex incident light image acquisition is the core of image color enhancement. Here, adaptive two-dimensional empirical mode decomposition is applied to decompose the image into k layers to obtain the regional Retinex incident light component. The specific steps are as follows.

(1) The histogram of the original image $f(x, y)$ is averaged, and the color space is converted to obtain three quantities: chromaticity H_{org}, saturation S_{org}, and brightness V_{org}

(2) Under different illumination conditions, the brightness component V_{org} is increased to obtain $n_1, n_2, \cdots, n_m$ illumination coefficient and M images $V_{\text{org1}}(x, y), V_{\text{org2}}(x, y), \cdots, V_{\text{org}m}(x, y)$

(3) The plane image V_{org} is decomposed by adaptive two-dimensional empirical mode, and the $V_{\text{org1}}(x, y), V_{\text{org2}}(x, y), \cdots, V_{\text{org}m}(x, y)$ is divided into k layers, where the high-frequency component is $\text{imf}f_{ij}$ and the low-frequency component is $p_{ih}(x, y)$, that is, the area Retinex incident light component obtained by decomposition

3.5.2. Calibration Based on Retinex Algorithm. For the incident light, reflected images, and output results obtained by Retinex algorithm, in order to obtain high-quality results adapted to visual features, the following steps can be used for correction.

(1) Correction of Incident Light Image. Gamma correction of incident light image is used to solve the problem of uneven brightness caused by uneven illumination. In order to enhance its self-adaptability, the following formula is used for transformation to obtain and correct the incident light image,

$$y(i) = i^{a \cdot i + a}, \tag{4}$$

where the pixel value is i, the pixel is a, and the range is {0-1}. After the transformation, the effect of low brightness area can be enhanced and the severe exposure of high brightness area can be controlled at the same time, so as to achieve the goal of global enhancement.

(2) Correcting Reflected Light Images. If the critical visible deviation is met, the reflected light image can be corrected by using Weber's law in order to improve the regional clarity of the contrast of the reflected light p image. The ratio between the difference of two brightness values and the background can be identified visually, that is, the light intensity I is 1-1000 cd, expressed by the following formula:

$$\frac{\Delta R}{R} = \text{constant}, \tag{5}$$

where R is the reflected light image and is the critical visible deviation of the reflected light image.

Optimize the calculation amount to better match the edge and surface of the object, which is expressed by the following formula:

$$\frac{\Delta R}{R} = 0.002216 \times R^{-1.09} + 0.05943 \times R^{-0.2645}. \tag{6}$$

The modified reflected light map can well coordinate the local details of the image and increase the brightness and contrast of the global image. At the same time, because it has adaptive characteristics, it is not necessary to consider setting data in advance.

(3) Retinex Algorithm Output Correction. In order to truly present the objective image, the center surround Retinex algorithm is improved. The enhanced image only has a narrow brightness range. The improved formula is as follows:

$$\begin{cases} \log\left(V'\right) = R + KL, \\ K = \dfrac{L}{246}. \end{cases} \tag{7}$$

The luminance component V' is used to describe the image after enhancement processing. The weighting coefficient is K, and the pixel mean value is L. After improvement, it can increase the real lighting and enhance the enhancement effect.

3.5.3. Global HSV Color Space Correction. The brightness component of the enhanced planar image will change the matching degree between saturation and brightness to a certain extent and affect the color sense of the image. To ensure the global color idealization, the saturation component should have the following adaptive adjustment. The adjustment method is shown in the following formula:

$$s'(x, y) = s(x, y) + t\left(v'(x, y) - v(x, y)\right) \times \lambda(x, y)$$

$$v_W(x, y) = \frac{1}{n \times n_{(i,j)\in W}} \sum_W u(i, j), s_W(x, y) = \frac{1}{n \times n_{(i,j)\in W}} \sum_{(i,j)},$$

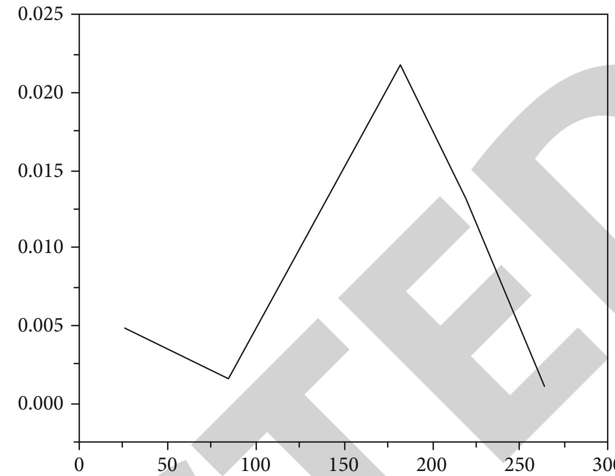

Figure 4: Before enhancement.

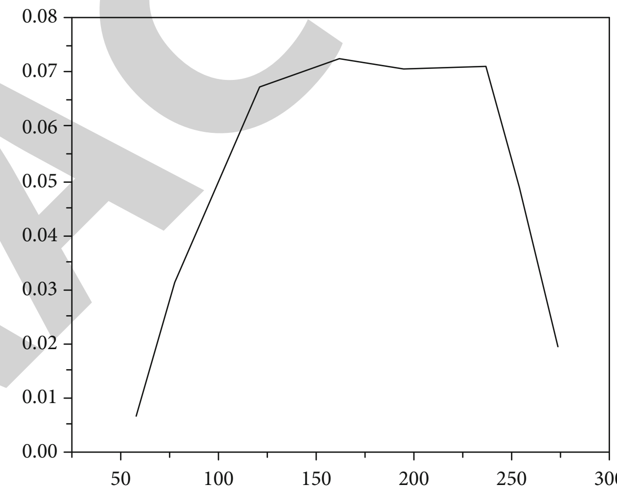

Figure 5: After enhancement.

$$\delta_V(x, y) = \sum_{(i,j)\in W} [v(i, j) - v_W(x, y)]^2, \delta_s(x, y) = \sum_{(i,j)\in W} [s(i, j) - s_W(x, y)]^2,$$

$$\lambda(x, y) = \sum_{(i,j)\in W} |v(i, j) - v_W(x, y)| \times |s(i, j) - s_W(x, y)| / \sqrt{\delta_V(x, y) \times \delta_s(x, y)}. \tag{8}$$

The brightness values before and after enhancement are $v(x, y)$ and $v'(x, y)$, respectively, and the saturation values before and after change are $s(x, y)$ and $s'(x, y)$, respectively. The constant ratio is t. In this paper, the luminance and saturation values of $t = 0.35$ and (x, y) in the domain window W are $v_W(x, y)$ and $s_W(x, y)$, respectively, and the variances of luminance and saturation are $\delta_V(x, y)$ and $\delta_s(x, y)$, respectively.

The change result of the λ, V component of the addition coefficient will affect the S component. The greater the value

Table 1: Image enhancement performance analysis of three methods.

Image	Contrast	Mean value	Variance	Information entropy	Definition
	Original drawing	0.2758	0.1215	0.4688	0.0141
	Method 1	0.386	0.2092	0.6602	0.0296
Street	Method 2	0.5783	0.1965	0.6411	0.0301
	Paper method	0.5816	0.2635	0.7091	0.0309
	Original drawing	0.1631	0.0691	0.3063	0.0131
	Method 1	0.1536	0.1563	0.5571	0.0141
Flower	Method 2	0.4514	0.1692	0.5322	0.0174
	Paper method	0.4612	0.1921	0.6638	0.0201

of λ, the greater the influence of the V component on the S component.

4. Results and Discussion

4.1. Image Enhancement Effect Analysis. Randomly select a plane image from the experimental database, and use this method to enhance the image. See Figures 4 and 5 for the histogram equalization effect before and after image enhancement.

The results of the image processed by the method proposed in this paper not only achieve the effect of plane image enhancement but also highlight the details of the image background and reduce the image noise. In the gray histogram, each pixel is distributed within a reasonable range without reducing the gray level, and the image equalization effect is good [21].

4.2. Image Color Enhancement Performance Analysis. The experiment measures the image enhancement effect of this method through four evaluation indexes: mean, variance, information entropy, and sharpness of plane image. The larger the evaluation index value, the better the image enhancement effect. The experimental images are the floor and street real scene plane images randomly selected from the image database [22, 23]. When using the formula to calculate the mean, variance, information entropy, and definition of image subblocks, divide the plane image into 10×10 pixel blocks, calculate the mean value of each subblock of each channel in the RGB color space, and then calculate the average value. Normalize the calculation results in the range of 0-1, and the results are shown in Table 1.

It can be judged from the objective evaluation criteria that the average value of the image processed by this method is increased by about 0.3. The variance increased by about 0.13. Information entropy increased by about 0.3. The definition is improved by about 0.02. Its lifting effect is good [24, 25].

5. Conclusion

This paper studies the method of color enhancement of plane image based on computer vision frequency decomposition. When using this method to enhance the color of plane image, it has achieved the effect of universal application and simplicity of calculation, from the estimation of illuminance to the optimization of incident light component and reflected light component and then to the correction of HSV color space. From the objective evaluation criteria, it can be judged that the average, variance, information entropy, and clarity of the image processed by this method are better than those of the other two methods, which accurately reflects that this method has more advantages in image enhancement processing through enhanced visual observation and objective index evaluation. It can be verified that the image enhanced by this method has moderate brightness, full color, and clear details and can be widely used in the color enhancement of planar images.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The author declares no conflicts of interest.

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