Heliyon 9 (2023) e23241

Contents lists available at ScienceDirect

Heliyon

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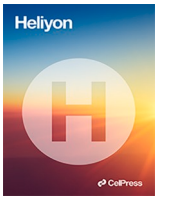

Multimedia image evaluation based on blockchain, visual communication design and color balance optimization

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A R T I C L E I N F O

Keywords:
Multimedia visual images
Image analysis
Image enhancement
Color balance
Blockchain technology

A B S T R A C T

The relationship between image processing and image analysis is inseparable. With the increasing demand for multimedia visual images, the quality of image analysis is also increasing. However, in image processing and computer vision tasks, protecting users' privacy and preventing data leakage and abuse are not handled well. Image enhancement and nonlinear image color balance algorithm are applied to improve the visual quality of multimedia visual images and make them clearer and fuller. The article utilized image enhancement and a non-linear image color balance algorithm to improve the processing effect before visual image analysis. It also utilized the encryption mechanism of blockchain technology to detect the similarity of multimedia visual images. By comparing the feature points of the images, similar images were matched to address the copyright issue of the images. After experimental testing, the effect of image enhancement is significant, and the histogram of image equalization is significantly better than the original image. In the experiment of image analysis, the computer accurately classified visual images with different attributes. Finally, in the similarity detection algorithm of blockchain, the test results showed that when the number of image transactions reaches 500, the difference hash algorithm takes 1.13 s and 0.78 s to calculate the similarity comparison between the original and secondary images. The differential hash algorithm of blockchain is significantly superior to the Message-Digest Algorithm (MD5) in terms of computational speed and resource consumption. It has better image similarity detection performance and can also provide better image copyright protection mechanisms.

1. Introduction

Multimedia vision belongs to the field of computer vision, which refers to the field of understanding the deeper connotations of computer-generated digital videos or images. Processing and analyzing multimedia visual images refers to converting videos or images from multimedia devices into digital representations, performing image preprocessing, feature extraction and classification, analysis and understanding, and other operations. With the increasing influence of computer vision in recent years, multimedia visual image analysis has played an important role in many fields. In the analysis of multimedia visual images, image processing technology is the core technology, and image color balance processing is a key technology of image processing technology. The color balance processing in multimedia visual images determines the quality of image processing. Therefore, to improve the quality of multimedia visual image processing and analysis, one should start from the aspect of image color balance processing and further improve the technology of

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https://doi.org/10.1016/j.heliyon.2023.e23241
Received 3 August 2023; Received in revised form 9 October 2023; Accepted 29 November 2023
Available online 4 December 2023

image analysis. In addition, the multimedia visual image analysis system is operated through full network automation, and the steps of image acquisition and analysis are relatively complex. Differences in image processing equipment and environment can also lead to differences in image data among different multimedia devices, and ensuring the security and privacy protection of image data is an inevitable requirement for multimedia visual image analysis. Blockchain mechanism is a new research direction in image processing security for multimedia image processing and analysis in the Internet era. The decentralization, non-tampering and encryption of blockchain can build a more reliable and efficient image copyright protection mechanism and provide better rights protection for creators and image users [1]. By using image enhancement, color balance optimization and blockchain technology, the quality, analysis effect and copyright protection mechanism of multimedia visual images are improved, which provides an innovative solution for the field of multimedia image processing and protection.

Multimedia visual images contain a lot of information, and how to extract useful information from visual images has become a research hotspot in the field of computer vision. Zhang Juan proposed an artificial intelligence recognition method for 3D multimedia visual images based on sparse representation algorithm. By analyzing the feature extraction of two-dimensional visual multimedia target image and the generation of three-dimensional visual multimedia target image change feature, the feature of three-dimensional visual multimedia target image is extracted [2]. Ma Ling corrected remote education images based on digital image processing technology, decomposed each color channel using a hierarchical processing model, and then processed the brightness channel of the image. This ensured the fusion effect while effectively reducing computational overhead. Research has shown that the algorithm has good performance in image correction, which can provide theoretical reference for subsequent related research [3]. Pashaei Elnaz used parametric mapping function and new objective function to achieve image enhancement. The proposed framework overcame the limitations of traditional enhancement technology based on histogram equalization. It was shown that the proposed frame provided better capabilities than all existing methods in terms of various metrics. The presented scheme also helped to enhance substantial feature enhancement and contrast enhancement in images while preserving the natural feel of the original image [4]. Liu Risheng has established a seafloor image capture system and constructed a large-scale real-world underwater image enhancement dataset, using object detection performance on enhanced images as a new task specific evaluation standard. The results of these assessments not only confirmed the commonly accepted view, but also improved the visibility of underwater images in the real world. The color correction and target detection methods proposed in the study provided promising solutions and new directions [5]. Wang Kun proposed a new color correction module based on triplet state to obtain color balance images with the same color channel distribution. With the inherent constraints of the triplet structure, the information of other channels can be recovered by using the information of less distorted channels. An iterative mechanism was also proposed to jointly optimize color correction and clutter removal. By learning transformation coefficients from the decolorization features, the color features and basic features of the original image were gradually refined, and color balance was maintained during the decolorization process to further improve the image clarity and provide better performance for underwater target detection [6]. Multimedia visual image is a rich information carrier, which contains rich visual and semantic information. Extract useful information from these images and convert it into a form that computers can understand and process. These studies have certain research value, but most of them are explored from a theoretical perspective.

The application of blockchain technology in the field of computer vision is not yet fully mature, but in recent years, blockchain technology has played a significant role in the security and privacy protection of image processing. More and more people are paying attention to the role of blockchain technology in computer vision image processing. Zhaofeng Ma proposed a robust and high security digital rights management scheme for network misuse detection of artwork images based on watermarks and blockchains. The blockchain conducted decentralized right confirmation of artwork and information in an unmodified ledger. A large number of experiments showed that the proposed trusted blockchain scheme based on watermarks is secure and robust, and is used for image data protection and misuse detection [7]. Ghimire Sarala proposed a new video integrity verification method using a blockchain framework. The proposed approach employed an efficient blockchain model in centralized video data to verify the integrity of videos by combining hash-based message authentication code and elliptic curve encryption. The proposed new video integrity verification method was validated on computer environments and embedded systems of accident data recorders. It has been shown to have better detection capability and better robustness to various tampering behaviors compared to other state-of-the-art methods [8]. These studies have certain reference significance for multimedia visual image analysis. Although there have been many studies on image copyright protection, there are still some challenges in the existing methods to protect the integrity and authenticity of image content. Traditional digital watermarking technology may affect the visual quality of images, while traditional copyright management methods may be limited by centralized institutions. In addition, although some studies have begun to explore the application of blockchain in copyright protection, there is still a lack of comprehensive discussion on how to combine it with other hidden technologies. This paper is based on this research, which combines the imperceptibility of blockchain and the concealment of zero watermark to provide a more reliable and secure image copyright protection solution.

With the increasing use of images, the problems of protecting users' privacy and preventing data abuse have become increasingly important. The purpose of this paper is to explore an innovative method, which combines blockchain technology, visual communication design and color balance optimization to realize the comprehensive evaluation of multimedia images. This paper applies blockchain technology, visual communication design and color balance optimization to multimedia images, and improves the image quality by applying image enhancement and color balance algorithm. The blockchain differential hash algorithm is compared with MD5 algorithm, and it has better performance in computing speed and resource consumption. At present, there is no complete research system for commonly used multimedia visual image analysis and color fusion algorithms. In order to improve the clarity of visual image analysis and processing and the accuracy of color classification, this paper uses a color balance algorithm to fuse and effectively process image colors in multimedia devices. By applying image enhancement and nonlinear image color balance algorithm, the visual quality of the image can be significantly improved. Such processing can make the image clearer and fuller, which is helpful to improve

the analyzability and readability of the image. Combining image processing, computer vision and blockchain technology, the quality and analysis accuracy of multimedia images are improved, and a more reliable mechanism for image copyright protection is established. After testing, the image processing effect is significant. In addition, in response to the copyright issue of images during processing, blockchain technology based on distributed architecture is used to provide a security protection mechanism for the process of image data processing, and its security has also been verified in experimental testing.

2. Multimedia visual image evaluation and security evaluation

2.1. Multimedia visual image evaluation

Multimedia visual image analysis refers to extracting various visual features from multimedia images, including facial detection, target object detection, image classification, and other operations. Image analysis is conducted according to specific requirements. Multimedia image analysis is not only the processing of static images, but also the processing of objects in dynamic video. However, regardless of the processing object, the core technology of image analysis is still image processing technology. Various visual processing technologies are constantly developing, such as segmentation of image size, calibration, pixel beautification, and high-resolution images [9]. Image processing refers to a technical means aimed at obtaining high-quality images. The combination of image processing technology and visual technology has been applied in multiple fields. Image processing and visual analysis can both belong to the same field, which can be divided into image processing, image analysis, and computer vision [10]. The steps of analyzing multimedia visual images can also be divided into image processing and image analysis.

2.1.1. Visual image processing

The preprocessing part of visual image processing is to transform the image by enhancing or weakening some features in the image, in order to proceed with the next step of processing. The essence of image transformation is to transform the pixels that make up the image. After image transformation, it would become a new image, including three transformation methods: spatial domain transformation, frequency domain transformation, and spatial and frequency domain transformation. Spatial transformation refers to the overall translation, rotation, scaling, and transposition of an image, which determines the mapping relationship between image pixels before and after the transformation. In the specific transformation process of pixels, matrix transformation is performed on the pixels. The second is a transformation in the frequency domain, which refers to operations such as image description, compression, computation, filtering, etc. There are different methods for transforming images in the frequency domain, including Fourier transform, cosine transform, etc [11]., all of which are used to ensure the effectiveness of image transformation. There are also methods of spatial domain and frequency domain transformation, which means that after the image pixel matrix is enlarged, the complexity of image processing increases. Therefore, spatial domain internal conversion is transformed into frequency domain internal processing. The processing methods include Fourier transform, cosine transform, K-L (Karhunen-Loeve) transform and other methods [12].

Image transformation is to transform the pixels of an image in order to change the characteristics or expression of the image and prepare for the subsequent processing [13]. Image enhancement is to improve the visual quality of the image through specific methods, such as enhancing the contrast, contour and edge of the image. Color balance is an important content of image enhancement, which is

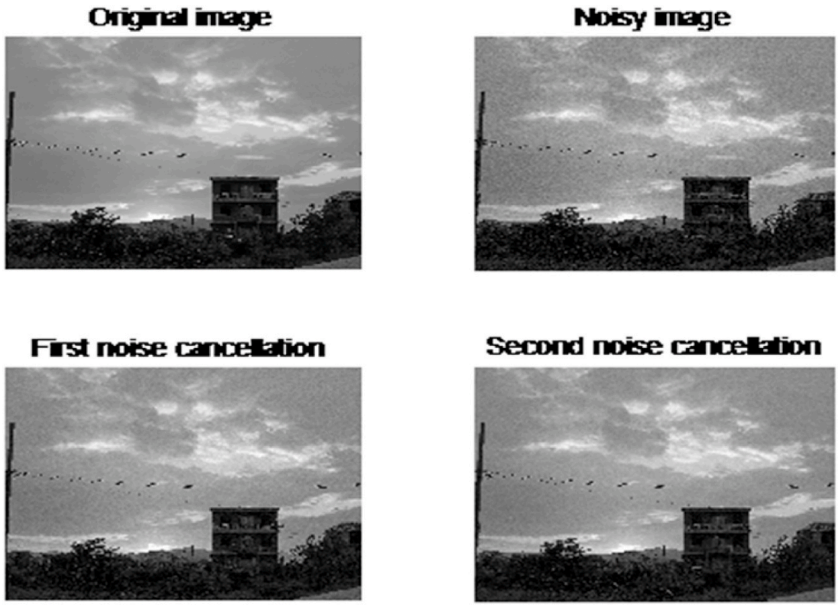

Fig. 1. Image transformation denoising.

realized by adjusting the color distribution of the image. The adjustment of color balance can make the color of the image more balanced and avoid color deviation. In image processing, the perception and quality of images can be improved by adjusting the color balance of images.

In environments with insufficient lighting, camera sensors typically cannot capture clear images or videos [14]. There is a need to increase and process the image. After image transformation, image enhancement is performed, which refers to the processing of features such as edges, contours, and contrast through specific image processing methods. Traditional image enhancement methods divide image enhancement into spatial domain methods and frequency domain processing methods, with spatial domain methods including gamma transform and frequency domain methods including wavelet transform. However, traditional image enhancement methods are simple, so the processing speed is fast. The effect is not very obvious. In recent years, deep learning convolutional neural network algorithms have played a significant role in image processing. Convolutional Neural Networks (CNN) can perform image deblurring, denoising, defogging, and other operations, greatly improving the quality of image enhancement. Color balance is an important enhancement effect of image enhancement. The adjustment of color balance can make the image achieve color balance. The color balance method would be introduced below. Fig. 1 shows the image denoised by wavelet transform.

2.1.2. Image evaluation

Multimedia image analysis includes operations such as feature description, image feature extraction, and image segmentation. There are different features in multimedia visual images, and image analysis needs to describe these features. The features in visual images include natural features and artificial features. Image description can analyze the shape, size, geometric properties, and interrelationships of images. The second step is to extract features from the visual image, which involves extracting useful information from the image and extracting iconic image information through specific image feature extraction methods. The commonly used methods for image feature extraction include SURF (Speed Up Robust Features) algorithm and SITF (Scale-Invariant Feature Transform) algorithm. However, in recent years, the feature extraction methods of deep learning have attracted many people's attention, and deep learning methods have shown significant results in terms of accuracy and accuracy in image feature extraction. Deep learning CNN extracts image features through convolutional and pooling layers. Through backpropagation, the convolutional kernel parameters are determined to obtain the final parameter features, which is the overall process of CNN extracting image features. The calculation process of convolutional layers can be expressed using the following logical formula:

$$H_{i,j} = g\left(\sum_{m=0}^{2}\sum_{n=0}^{2}\omega_{m,n}x_{i+m,j+n} + \omega_{\delta}\right) \tag{1}$$

In Formula (1), $H_{i,j}$ represents the element coordinates of the target image; g represents the activation function; ω represents the weight; δ represents bias. X represents the characteristics of convolutional neural networks. Formula (1) represents the convolutional kernel calculation method with a depth of 1. If the depth of the extracted target image is greater than 1, the following formula can be used for calculation:

$$H_{i,j} = g\left(\sum_{I=0}^{D-1}\sum_{m=0}^{K-1}\sum_{n=0}^{K-1}\omega_{I,m,n}x_{I,m+i,n+j} + \omega_{\delta}\right) \tag{2}$$

In Formula (2), D represents the depth; K represents the width or height of the image; I represents the number of layers of the image. Fig. 2 shows the effect of CNN image segmentation.

After feature extraction of multimedia visual images, similar regions in the images are divided. The main two parts of image segmentation are the segmentation of the brightness amplitude of monochromatic photo images and the color components of color

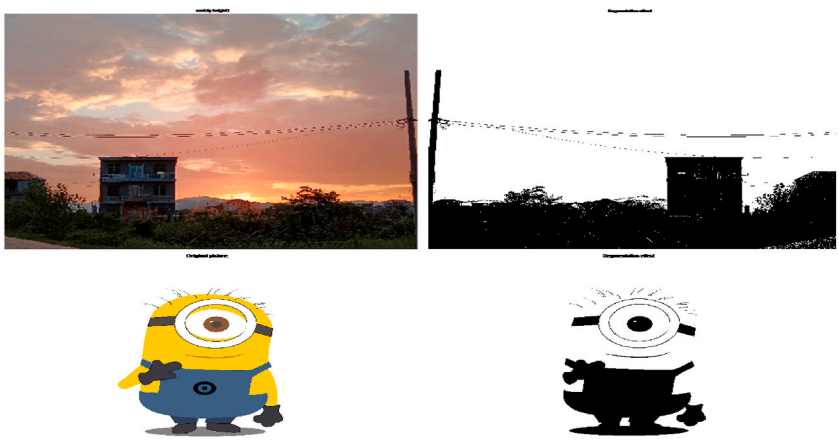

Fig. 2. Image segmentation effect display.

photos. Unlike image object detection, the role of image segmentation is to extract useful information at a deeper level for image analysis. Traditional image segmentation can perform static image segmentation, and CNN method has been successfully used for multimedia video object segmentation, which can complete image segmentation of multimedia visual images within a few seconds and maintain extremely high accuracy.

2.1.3. Application of multimedia visual images in visual communication and artistic design

Multimedia visual images play an important role in the field of visual communication and artistic design, providing rich and diverse ways for creative expression and information transmission. Multimedia visual images are widely used in advertising and publicity to attract the attention of the target audience. Through the color, composition and visual effects of images, advertisements can convey brand information and product characteristics more vividly and interestingly.

With its diverse and rich forms of expression, multimedia visual images have become an indispensable part of the field of visual communication and art design. The following are their applications in these two fields：

1) Visual communication: Visual communication refers to the use of various visual elements, such as text, images, colors, etc., to visually convey information. Multimedia visual images can be used to convey information, promote products and services, and show brand images to audiences. They can show the characteristics, advantages and quality of products, and can also strengthen the awareness of brand image. They can also be used in various media, including advertisements, magazines, posters and websites. Visual communicators can use various image processing techniques and software to create various types of visual images, including pictures, vector graphics, 3D models, animations, and videos.
2) Art and design: Multimedia visual images can also be used to create art and design works, including paintings, illustrations, cartoons and movies. Artists can use various technologies and tools to create various types of visual images, including digital art, animation, virtual reality and augmented reality. They can help designers attract people's attention, make advertising more attractive and contagious, and make it more vivid and interesting. Multimedia images are also widely used in illustration design. They can make illustrations more vivid and interesting, highlighting the artist's style and creativity. Multimedia images are also a very important element in video production. They can enhance the visual effects of the video and help the audience better understand the content in the video. Therefore, in art and design, the application of multimedia visual images is very extensive. They can help designers better express their creativity and ideas, and improve the quality and beauty of their works.

2.2. Color balance algorithm

In multimedia visual image analysis, high dynamic image processing requires high compression, display, and clarity within a certain range. In order to improve image quality, current efforts are limited to designing algorithms for binary image [15]. Color balance can control the color distribution in the multimedia visual image, so that the visual processing effect can be satisfied in terms of color and brightness continuity. The automatic color balance algorithm can automatically process the details of image colors, and can also comprehensively consider the spatial relationship between colors and brightness in the visual image, achieving local or overall adjustment of image colors and brightness. Here, based on the literature, an automatic color balancing algorithm is introduced. The algorithm used in this paper is an adaptive color balance algorithm. Adaptive color balance algorithm is a method for adjusting the color balance of an image, which dynamically balances the color of the image according to the local characteristics and statistical information in the image. It aims to solve the problem of illumination and color changes in different areas or scenes, so as to improve the visual quality of images. According to the local characteristics of the image, accurate color correction can better deal with the image under uneven illumination. This color balancing algorithm performs adaptive filtering operations on local characteristics in the image, achieving brightness and color adjustments for local and nonlinear features, as well as contrast adjustments. Firstly, color adjustments are made to the image and color difference correction is performed on the visual image, as shown in the following formula:

$$P(r) = \sum_{j \epsilon SUBSET} \frac{p(I(r) - I(j))}{d(r,j)} \tag{3}$$

Formula (3) represents the reconstructed image after correcting for color difference in the image, I stands for corrected image. $d(r,j)$ represents the distance measurement function, and p represents the brightness representation function. After correction, the visual image needs to be dynamically expanded, with linear expansion for single color images, which can be represented by the following formula:

$$F(x) = \frac{L(X) - MIN\ L}{MAX\ L - MIN\ L} \tag{4}$$

In Formula 4, MAXL and MINL represent the maximum contrast and the minimum contrast.

Formula (4) represents a linear extended model of a single color channel. Most previous single image contrast enhancement methods adjust the tone curve to correct the contrast of the input image, but due to the limited information in a single image, these methods are usually unable to reveal image details [16]. Multimedia visual images are generally colored, so linear expansion cannot be used for multimedia visual image processing. Therefore, nonlinear mapping calculation processing methods are introduced here. The larger the size of the visual image, the more time it takes to process. Therefore, the time-consuming problem of image processing should also be considered. Therefore, the image color balance processing method can be optimized, as shown in the following formula:

$$\arg\min \frac{1}{2}\sum_{x}\left(P(x)-\frac{1}{2}\right)^{2}-\frac{1}{4M}\sum_{x}\sum_{y!=x}\mu(x,y)D(P(x)-P(x)) \tag{5}$$

Formula (5) represents the solution of the optimal model to achieve the optimal image processing effect. The above is the use of nonlinear extension methods to adjust the brightness, color, and contrast of images.

In the current era of the Internet, as one of the most important means of multimedia dissemination of information, the vividness of image content is loved by the public, and the carriers of dissemination are gradually diversified. Some multimedia institutions have an increasing demand for images. Images have become an important component of the multimedia field in the new era. Driven by the dissemination of digital images, the problems of information leakage and copyright protection in image dissemination have become increasingly prominent. The growing popularity of social networks and cloud computing has greatly increased the exchange of some JPEG (Joint Photographic Experts Group) compressed images. The security of transmission channels and cloud storage is vulnerable to privacy leakage [17].

Color balance algorithm is a kind of image processing method, which aims to adjust the intensity of different color channels in the image to achieve a more natural, balanced and attractive visual effect. It can be used to correct the color deviation in the image and improve the overall color balance and visual experience of the image.

2.3. Blockchain image security mechanism

With the increasing demand for multimedia images on the Internet, traditional image copyright registration methods take a long time to process, and can no longer meet the decentralized and decentralized creative mode of the all media era. In order to protect the color image copyright protection of multimedia big data, it is necessary to design an algorithm to address the security of image copyright protection [18]. The emergence of blockchain provides new technical support for the protection of image copyright. Blockchain has become an effective tool for protecting sensitive information [19]. Blockchain technology is a database storage technology. Unlike other database technologies, blockchain is a security mechanism platform with a distributed storage structure and key technologies such as consensus mechanisms, digital signatures, and smart contracts.

Blockchain technology provides a new security mechanism in the field of image security, which can be used to ensure the integrity, authenticity and copyright protection of images. As a distributed account book, blockchain can be used to store hash values, copyright information and owner information of images. The hash value of the image is stored in the blockchain to ensure that the image will not be tampered with during transmission and storage.

2.3.1. Image similarity detection

The encryption technology inherent in blockchain can provide similarity detection for images. Similarity detection is generally achieved using hash algorithms, while blockchain's built-in hash algorithms can perform image similarity detection. Improving the hash algorithm of blockchain, combined with deep learning image detection algorithm, can extract image feature points, calculate the similarity of image feature points, and match the feature points of two images. The more feature points matched, the higher the similarity between the two images. Multimedia information is shared online in the form of images, text, and other forms. By detecting image similarity, the copyright information of digital images can be detected. There are significant differences in image similarity detection for media information transmitted by different media carriers. Therefore, image similarity detection can be used to protect the copyright of multimedia image information. Based on the detected image similarity, blockchain would feedback the copyright source information of relevant images in the system to users, which can avoid image infringement issues, not only improving the security of multimedia image sharing, but also improving the efficiency of image dissemination. Mean hash is an image hashing algorithm, which is used to generate a simplified representation of an image. It reduces the image to a fixed size, calculates the average pixel value of the image, and then compares each pixel with the average value, setting the pixel larger than the average value as 1 and the pixel smaller than the average value as 0, finally forming a hash code. Difference hashing is an image hashing algorithm, which generates a hash code by calculating the difference between adjacent pixels. MD5 is a commonly used hash function, which is used to map data of any length into a hash value of fixed length (128 bits). Scale invariant feature transformation is a feature extraction algorithm for image processing and computer vision. Perceptual hashing is a hashing algorithm for comparing the similarity of images, which pays more attention to the visual perception characteristics of images. Table 1 shows the algorithm performance tested based on different image detection algorithms.

Table 1 tests several algorithms for image similarity detection. From the data in the table, it can be seen that the average hash and difference value hash algorithms performed better than other algorithms in terms of graph, algorithm execution time, and algorithm

Table 1
Performance of different image similarity detection algorithms.

Detection algorithm	Execution time (0.1 %)	Robustness (%)	Misjudgment rate (%)
Average hash	0.06	92.3 %	13.0 %
Hash of difference value	0.04	94.6 %	0
Message-Digest Algorithm 5	0.15	–	–
Scale Invariant Feature Transform	0.40	54.0 %	9.0 %
Perceptual hash	0.09	87.0 %	0

robustness. The difference hash algorithm had significant effects in three dimensions: algorithm execution time, algorithm robustness, and similarity detection misjudgment rate.

2.3.2. Multimedia image copyright protection

Private blockchain can be applied to handle large amounts of data and solve security issues [20]. Image copyright trading is an important link in multimedia networks, and traditional image trading network systems can no longer meet the transaction requirements of security and reliability. Blockchain technology exists in the form of smart contracts or chain codes [21]. It can provide an independent and private trading environment for image copyright trading platforms, and blockchain can use built-in storage methods to store media image information. Another database can also be built to store both plaintext and ciphertext information for image encryption. This ensures the security of selecting transactions. Blockchain also has the characteristics of sharing transparency and tamper resistance. Media institutions and individual users can upload image information through the blockchain system. The system compares image feature values for similarity, and if no similar images are found, transactions would be made. After being linked, the blockchain system would also track and record all transaction information of the image, and would only stop when the image returns to the copyright owner information [22]. The image copyright protection method based on blockchain and zero watermark combines the imperceptibility of blockchain and the concealment of zero watermark, providing a more reliable and secure image copyright protection mechanism [23,24].

2.3.3. Art safety measures

Blockchain has great potential for the security and protection of works of art. The following is a description of several aspects：

1) Confirming the authenticity of works of art: Blockchain technology can be used to verify the authenticity of works of art to ensure that they would not be deceived when buying or selling works of art. By recording the ownership and historical information of works of art, including the maker, production date, owner of the works of art, transaction records, etc., an immutable digital identity can be established on the blockchain, so that buyers can better understand the history and value of works of art. This can eliminate many false goods and fraud, and protect the transparency and impartiality of the market.
2) Controlling the circulation of works of art: Blockchain technology can also be used to control the circulation of works of art. Since the information on the blockchain is immutable, it is possible to track the history and circulation records of works of art. In addition, blockchain can also be used for smart contracts, which can automatically enforce specific terms and conditions, such as automatically deducting a certain percentage of the sales value as copyright fees when works of art are sold. This can prevent unauthorized copying and sale of works of art and protect the rights and interests of artists and copyright holders.

In general, blockchain has great potential for the security and protection of works of art. In the future, with the continuous development and popularization of blockchain technology, it is believed that more art fields would adopt this technology to ensure the safety and value of art.

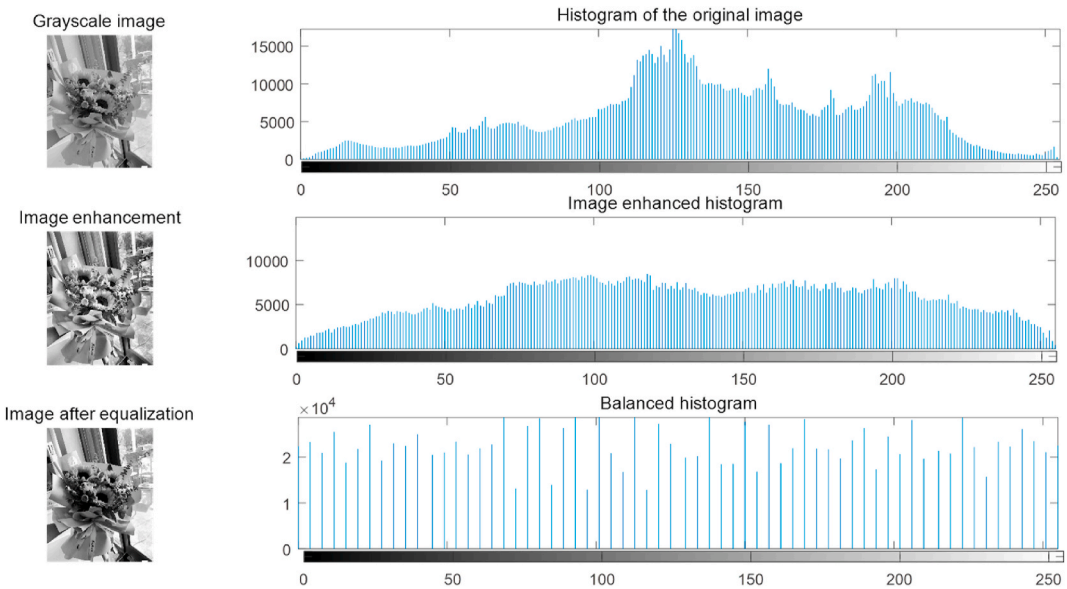

Fig. 3. Multimedia image enhancement effect.

3. Multimedia image evaluation test

Based on the introduction to the processing and analysis of multimedia visual images in the previous section, any image was selected as the test dataset. Image enhancement was performed on the multimedia images of the dataset. Then, color correction was performed on the dataset image using the color equalization algorithm introduced in this paper. Finally, images from the dataset were selected for secondary operations to test the performance of image similarity detection algorithms under blockchain. Below are the test results.

Fig. 3 shows the effect of multimedia visual image enhancement. After graying out the image, the image was enhanced. Fig. 3 can be viewed based on the balanced histogram. The histogram showed that the enhanced histogram was significantly better than the original image. The image used two different enhancement methods, so the displayed enhancement effects were also different, but the enhancement effects were both significant. Three visual images were selected, and the attributes of the images were analyzed using a computer to provide analysis results. The difference of pixels in the enhanced histogram is not much different, and there are no abnormal outstanding pixel values, which will make the image clearer.

Collect a set of color images, covering different themes and color distribution. Make sure that the image has different hue, saturation and brightness. For each color image, the histogram distribution of R, G and B channels is calculated respectively. Analyze the histogram to understand the color distribution characteristics of the image. The color equalization algorithm is implemented to equalize the histogram of each channel. Ensure that the overall color characteristics of the image are preserved in the equalization process. Compare the color images before and after processing. Visual contrast can be used to evaluate the changes in color distribution of images. Quantitative evaluation indexes, such as standard deviation of color distribution and histogram uniformity, are used to quantify the effect of image color equalization.

Fig. 5 shows the analysis of three different multimedia visual images. The three pie charts corresponded to the three dataset images in Fig. 4, and the information in the images was summarized. The first visual image computer analysis resulted in a visual image that was mainly entertainment; the second image computer analysis resulted in a visual image that was mainly office study; the third image computer analysis resulted in a visual image that was mainly food. The multimedia visual image data set contains visual image analysis data, and the accuracy of image attribute analysis is judged by analyzing the results of multimedia visual images. From the results of image analysis, it can be seen that the analysis of multimedia visual images is accurate. By combining image enhancement and color balance techniques, computers can accurately analyze image attributes. Below is a test of image copyright protection technology under blockchain technology. Firstly, a dataset image was selected and subjected to secondary operations. Then, image similarity detection algorithms were used to match the difference hash algorithm and MD5 algorithm for image similarity.

The leftmost image in Fig. 6 is the original image. In the middle of Fig. 6, a horizontal rotation operation was performed on the original image, while the rightmost image was the image with text annotations on the original image. After the second operation, the blockchain similarity detection algorithm was tested, using the original image as the query object. The results of image matching after the second operation are shown in the table.

The test results in Table 2 showed that the difference value hashing algorithm successfully queried the images of the second operation, while the MD5 algorithm failed to query the results. The difference value hashing algorithm was more effective in detecting image similarity. The similarity detection performance of the two algorithms was tested below, as shown in Fig. 7.

Fig. 7 tests the performance of the difference value hash algorithm and the MD5 algorithm, operating on the original and secondary images, respectively. Fig. 7a shows the calculation time for comparing the similarity between the original image and the secondary image. The test results showed that as the number of image transactions increased, the computation time of similarity comparison between the original and secondary images by the difference value hashing algorithm was gradually lower than that of the MD5 algorithm. When the number of transactions reached 500, the similarity comparison calculation time of the differential hash algorithm for the original and secondary images was 1.13 s and 0.78 s, and the calculation time of the MD5 algorithm was 1.31 s and 0.88 s. From Fig. 7b, it can be seen that as the number of image transactions increased, the network bandwidth consumed by the two algorithms for image operations also gradually increased. Test data showed that before the number of transactions reached 300, the bandwidth consumed by the difference hash algorithm for image operation was higher than that of the MD5 algorithm. However, when the number of transactions reached 300 or more, the bandwidth consumption of the differential hash algorithm for original and secondary

Fig. 4. Multimedia visual image dataset.

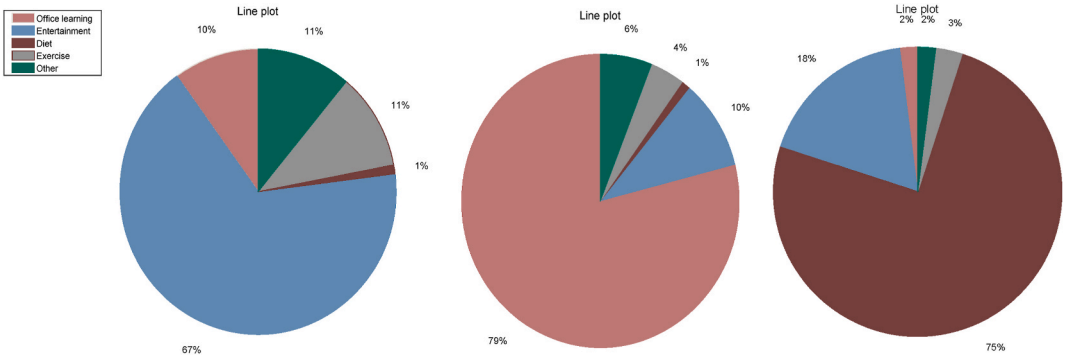

Fig. 5. Multimedia visual image analysis results.

Fig. 6. Image dataset.

Table 2
Image similarity matching query results.

Algorithm	Original picture	Horizontal rotation chart	Text annotation diagram
MD5	Query successfully	Query failed	Query failed
Hash of difference value	Query successfully	Query successfully	Query successfully
Scale Invariant Feature Transform	Query successfully	Query failed	Query failed
Perceptual hash	Query successfully	Query successfully	Query successfully

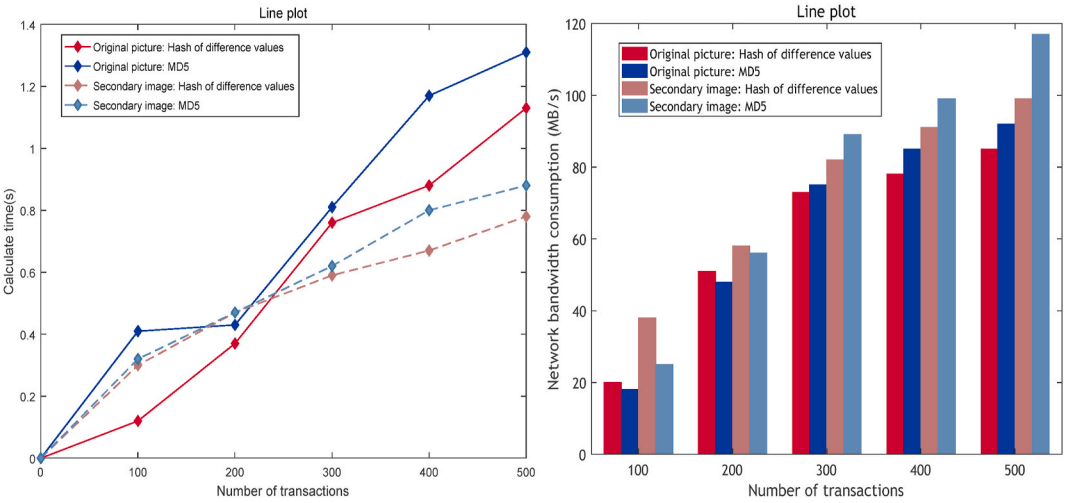

Fig. 7. Performance comparison of blockchain image similarity detection algorithms
Fig. 7a. Calculation time for comparing the similarity between original and secondary images using two algorithms
Fig. 7b. Network bandwidth consumption of two algorithms for original and secondary image operations.

graph operations gradually decreased compared to the MD5 algorithm. Similarly, when the number of transactions was 500, the network bandwidth consumption of the differential hash algorithm for image operations was 85 MB/s and 99 MB/s, respectively. The network bandwidth consumption of the MD5 algorithm for image operations was 92 MB/s and 117 MB/s, respectively. It can be concluded that the differential hash algorithm of blockchain is significantly superior to the MD5 algorithm in terms of computational speed and resource consumption, and has better image similarity detection performance.

4. Discussion

In this study, image enhancement and nonlinear image color balance algorithm are applied to improve the visual quality of multimedia visual images. The experimental results show that the clarity and fullness of the processed image have been significantly improved. Compared with the original image, the histogram of image balance is obviously better. This shows that the algorithm is effective in improving the visual effect of the image, thus providing better input data for multimedia image analysis. By combining image processing, nonlinear image color balance optimization and blockchain technology, a comprehensive method of multimedia image evaluation is proposed. This method can not only improve the image quality, but also improve the accuracy of image analysis and the efficiency of blockchain similarity detection. However, in the future research, there are still some aspects that need to be further explored, such as how to further optimize the performance of blockchain and how to adapt to different types of multimedia images.

5. Conclusions

With the increasingly widespread application of multimedia visual images, the demand for image processing and analysis is also increasing. This article focused on multimedia visual image analysis technology and demonstrated the importance of image enhancement technology in image analysis. By combining color balance algorithms, further enhancement processing was carried out on visual images, and non-linear image color expansion algorithms were used to balance the colors of the images to meet the requirements of clarity and brightness in image analysis. In the new era, the copyright issue of visual images is becoming increasingly prominent. This article combined blockchain technology, and utilized image similarity detection algorithms and image copyright protection mechanisms to address the security of image dissemination in the multimedia era. Experimental analysis was conducted from the effects of image enhancement and the results of image analysis. The experimental results showed that multimedia images obtained significant image equalization effects after image enhancement, and different styles of multimedia images were analyzed through computers. The analysis results were also relatively accurate. Finally, combining the similarity detection algorithm of blockchain, image similarity matching was tested. The test results showed that the difference hash algorithm based on blockchain has better image similarity detection performance than the MD5 algorithm. The method proposed in this paper is excellent in image analysis and copyright protection. This has practical application value for multimedia industry, digital marketing field and copyright institutions. Practitioners can consider applying the method in this study to practical projects to improve image quality and protect copyright. Although blockchain technology can ensure that image copyright information can not be tampered with, it is still necessary to consider how to prevent forged copyright information from entering the blockchain. Future research can explore more secure and credible ways to ensure the integrity of image copyright information.

Data availability statement

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

CRediT authorship contribution statement

Zitong Yang: Writing – original draft. **Shuo Yang:** Writing – review & editing.

Declaration of competing interest

The authors declare that there are no conflicts of interest regarding the publication of this article.

Acknowledgments

This work was supported by. The Heilongjiang Province Art Science Planning Project: Application and Discussion of the Promotion Platform Mechanism of Minority Cultural Handicrafts in Heilongjiang River Basin Based on Blockchain Technology (Item number: 2022D045).

References

[1] E. Glebova, P. Mihal'ová, New currencies and new values in professional sports: blockchain, NFT, and fintech through the stakeholder approach, J. Physical Educat. Sport 23 (5) (2023) 1244–1252.
[2] Juan Zhang, Simulation of artificial intelligence identification method for 3D multimedia visual images, Comput. Simulat. 35 (9) (2018) 435–438.

[3] Ling Ma, Research on distance education image correction based on digital image processing technology, EURASIP J. Image and Video Proces. 1 (2019) (2019) 1–9.
[4] Elnaz Pashaei, Elham Pashaei, A fusion approach based on black hole algorithm and particle swarm optimization for image enhancement, Multimed. Tool. Appl. 82 (1) (2023) 297–325.
[5] Risheng Liu, X. Fan, M. Zhu, Real-world underwater enhancement: challenges, benchmarks, and solutions under natural light, IEEE Trans. Circ. Syst. Video Technol. 30 (12) (2020) 4861–4875.
[6] Kun Wang, L. Shen, Y. Lin, Joint iterative color correction and dehazing for underwater image enhancement, IEEE Rob. Autom. Lett. 6 (3) (2021) 5121–5128.
[7] Ma Zhaofeng, Weihua Huang, Hongmin Gao, A new blockchain-based trusted DRM scheme for built-in content protection, EURASIP J. Image and Video Proces. 1 (2018) (2018) 1–12.
[8] S. Pandey, M. Singh, V. Pandey, Image transformation and compression using fourier transformation, Int. J. Current Engin. Technol. 55 (2015) 1178–1182.
[9] Sarala Ghimire, Jae Young Choi, Bumshik Lee, Using blockchain for improved video integrity verification, IEEE Trans. Multimed. 22 (1) (2019) 108–121.
[10] Bhih Amhmed, Distributed system design based on image processing technology and resource state synchronization method, Distributed Processing System 2 (Issue 4) (2021) 28–35, https://doi.org/10.38007/DPS.2021.020404.
[11] J. Logeshwaran, M. Ramkumar, T. Kiruthiga, SVPA-the segmentation based visual processing algorithm (SVPA) for illustration enhancements in digital video processing (DVP), ICTACT J. Image and Video Proces. 12 (3) (2022) 2669–2673.
[12] S. Bhairannawar, S. Sarkar, K. Raja, FPGA implementation of optimized karhunen-loeve transform for image processing applications, J. Real-Time Image Proces. 17 (2020).
[13] Imran A. Khan, Video monitoring system for natural environment protection area supporting image recognition, Nature Environ. Protect. 2 (Issue 3) (2021) 31–39, https://doi.org/10.38007/NEP.2021.020304.
[14] Wenqi Ren, S. Liu, L. Ma, Low-light image enhancement via a deep hybrid network, IEEE Trans. Image Process. 28 (9) (2019) 4364–4375.
[15] Bin Yan, Yong Xiang, Guang Hua, Improving the visual quality of size-invariant visual cryptography for grayscale images: an analysis-by-synthesis (AbS) approach, IEEE Trans. Image Process. 28 (2) (2018) 896–911.
[16] Vincent Itier, Pauline Puteaux, William Puech, Recompression of JPEG crypto-compressed images without a key, IEEE Trans. Circ. Syst. Video Technol. 30 (3) (2019) 646–660.
[17] Jianrui Cai, Shuhang Gu, Lei Zhang, Learning a deep single image contrast enhancer from multi-exposure images, IEEE Trans. Image Process. 27 (4) (2018) 2049–2062.
[18] Qingtang Su, Xiaofeng Zhang, Gang Wang, An improved watermarking algorithm for color image using Schur decomposition, Soft Comput. 24 (1) (2020) 445–460.
[19] Maliha Sultana, A. Hossain, F. Laila, K.A. Taher, M.N. Islam, Towards developing a secure medical image sharing system based on zero trust principles and blockchain technology, BMC Med. Inf. Decis. Making 20 (1) (2020) 1–10.
[20] Bin Cao, X. Wang, W. Zhang, A many-objective optimization model of industrial internet of things based on private blockchain, IEEE Network 34 (5) (2020) 78–83.
[21] Muhammad Rifqi, Muhammad Isradi, Fajarianto Otto, Smart blockchain technology in image processing between challenges, transformation and digital-based learning solutions, J. Sci. Techol. Engin. 2 (1) (2022) 1–9.
[22] Wen-Wei Li, Weizhi Meng, Kuo-Hui Yeh, Shi-Cho Cha, Trusting Computing as a Service for Blockchain Applications, IEEE Internet of Things Journal, 2023.
[23] Xiaosheng Huang, Yi Wu, An Image Copyright Authentication Model Based on Blockchain and Digital Watermarking, PREPRINT (Version 1) available at: Research Square, 22 June 2023, 10.21203/rs.3.rs-3078286/vol. 1.
[24] B. Wang, S. Jiawei, W. Wang, P. Zhao, Image copyright protection based on blockchain and zero-watermark, in IEEE Transact. Network Sci. Engin. 9 (4) (2022) 2188–2199, https://doi.org/10.1109/TNSE.2022.3157867, 1 July-Aug.

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