Intelligent Detection Method for Maximum Color Difference of Image Based on Machine Learning

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Abstract. There is color difference in the image collected under the background of night light. Machine learning and fusion tracking compensation method are used to detect and process the maximum color difference of the image, so as to improve the imaging quality of the image. A maximum color difference detection algorithm for nightlight background color difference image based on machine learning and fusion tracking compensation is proposed. Firstly, image feature acquisition and color difference feature blending preprocessing are carried out, image machine learning and fusion tracking compensation are carried out, and image color difference detection algorithm is used for image color difference smoothing and adaptive blending. The background color difference image of night light is automatically divided into target space by feature clustering, and the maximum color difference detection of the detail features of the image is carried out to the greatest extent. The simulation results show that the algorithm has high accuracy and good color difference resolution.

Keywords: Machine learning · Night light background · Image · Maximum color difference · Intelligent detection

1 Introduction

The image collected at night is affected by all kinds of color light, which leads to the imbalance of image color difference, and the collection and beautification of color difference image under the background of night light is the key technology of digital image processing. It is widely used in machine vision, video surveillance and other engineering fields. Due to the influence of complex natural lighting environment and shooting scene angle, the color difference image under the background of night light is produced, and the color difference image under the background of night light is affected by color and texture features [1]. To a certain extent, it is inevitable to be interfered by the external environment, resulting in the offset of color and texture features, so it is necessary to smooth and adapt the color difference of the color difference image under the background of night light at night, because of the color difference of the image. The detail features of the image target cannot be effectively distinguished and located, but the machine learning and fusion tracking compensation and smoothing methods are used to make up for the white balance of the similarity feature of the color difference

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image under the background of night light at night [2]. It can optimize the imaging performance of the image and show the details of the night scene image. By studying the machine learning and fusion tracking compensation method of the image, the maximum color difference detection and processing of the image under the background of night light can be realized, and the imaging quality of the image can be improved. The related algorithm research has attracted people's attention [3].

In the environment of external interference, it is difficult to display and beautify the details of the color difference image under the background of night light at night, and the image beautification method based on visual features is sensitive to the color difference between the external environment and the surrounding environment. Because the visual features change with the motion direction and angle of the imaging equipment, the target feature model is not fixed, so it is necessary to update the target mathematical model in real time to adapt to the changes of the environment [4]. In the traditional method, the maximum color difference detection algorithm of the color difference image under the night light background adopts the cyclic tracking pixel feature extraction algorithm, the time-frequency feature analysis method and the wavelet multi-layer decomposition method. The color difference compensation effect of the image is not good when the white balance deviation appears. In order to solve the above problems, a maximum color difference detection algorithm for night light image based on machine learning and fusion tracking compensation is proposed in this paper. Firstly, image feature acquisition and color difference feature reconciliation preprocessing are carried out, machine learning and fusion tracking compensation are carried out for color difference image in the background of night light, and image color difference detection algorithm is used to smooth and adapt the color difference of the image. The algorithm is improved and the performance of the algorithm is verified by simulation experiments, which shows the superior performance of the algorithm in beautifying and smoothing the color difference image under the background of night light.

2 Image Feature Acquisition and Color Difference Feature Harmonization Preprocessing

2.1 Problem Description and Image Acquisition

In the process of image acquisition and information processing with digital imaging equipment, due to defocus, jitter, optical system error and white balance deviation, the visual difference between the imaging equipment and the object is caused, and the multiple color difference is produced [5]. The color difference image under the background of night light is defined as g', and the high frequency part $\nabla_x = [1, -1]$, $\nabla_y = [1, -1]^T$ of the image is generated by discrete filter $y = [\nabla_x g', \nabla_y g']$. The energy function of the space invariant multiple chromatic difference kernel is as follows:

$$\min_{x,k} \lambda \|x \otimes k - y\|_2^2 + \frac{\|x\|_1}{\|x\|_2} + \beta \|k\|_1 \tag{1}$$

Satisfy constraints: $k > 0, \sum_i k_i = 1$. Where x is the high frequency part of the unknown clear image and k is the unknown multiple color difference kernel (k_i is an independent element).

According to the distribution structure of the edge profile information of the image in the two-dimensional neighborhood, the local structure points of the image can be expanded according to the first order Taylor series, and the group of the estimation model can be obtained. Update the multiple color difference nucleus using groups below two points, as shown in the following formula:

$$c_1 = \{i | i \in S\}, \quad c_2 = \{\{i, i'\} | i' \in N_i, i \in S\}, \quad C = c_1 \cup c_2 \tag{2}$$

As if there are objects in the image area, there are some interference factors such as dragging in the color difference image under the background of night light at night, which affects the beautification performance of the image, and in the dynamic motion area of the object in the imaging area of the image, The image is processed synchronously with the front curtain and the rear curtain, respectively. The image is set as the image of the time and the R_t is the image of the initial time. The color difference image observed in the night light background contains noise and fine texture. The information is marked by a multiple color difference kernel matrix, and its set is described by a formula:

$$\begin{aligned} L &= \{m_i \,|\, i \in S\} \\ m_i &= (a_{i1}, a_{i2}, a_{i3}, b_{i1}, b_{i2}, b_{i3}, c_{i1}, c_{i2}, c_{i3})^T \end{aligned} \tag{3}$$

Using the spatial proximity of pixel points in the neighborhood, the filter formula is expressed as follows:

$$R_i = \frac{1}{\gamma_i} \sum_{j \in \Omega} g_j d(\|i - j\|_2) l(\left\|g_i - g_j\right\|_1) \tag{4}$$

According to the above analysis, it can be seen that the key to using the above modeling algorithm to analyze the gradient amplitude information of the color difference image under the background of night light is to determine the energy function of the random field of the information, so as to realize the image acquisition and preprocessing.

2.2 Color Difference Feature Harmonic Preprocessing of Image Color Difference

In this paper, the smoothing problem of color difference image in the background of night light is discussed, and the image beautification is realized by smoothing the color difference under the background of night light. The multi-color difference of the image can be reduced by using the color difference feature blending method to reduce the noise in the image [6]. The color difference feature blending process is through the convolution of the clear image and the multiple color difference kernel, plus the noise, and carries on the interpolation operation, that is:

$$g = k \otimes f + n \tag{5}$$

According to the single-scale characteristics of the multiple chromatic difference kernel in the window region, the color difference equilibrium energy function of the image includes likelihood energy and prior energy, which are expressed as follows:

$$\begin{aligned} H_1 &: U(t) = V(t) + \alpha(t)W(t) \\ H_0 &: U(t) = V(t) \end{aligned} \tag{6}$$

In order to improve the accuracy of multiple color difference kernel estimation, the image preprocessing is introduced, the minimum maximum detection method is used to filter the image, and the bilateral filter and impulse filter are used to preprocess the color difference image under the background of night light [7]. The maximum likelihood ratio detection is used to obtain the harmonic discriminant function of the color difference characteristics of the image as follows:

$$\Lambda(U) = \frac{p(U(t) \mid H_1)}{p(U(t) \mid H_0)} \geq \eta \tag{7}$$

A fast iterative shrinkage threshold algorithm is used to estimate the multiple color difference kernels. The balanced locking results are obtained by logarithmic likelihood ratio detection:

$$LRT(U) = \ln \Lambda(U) \leq \ln \eta \tag{8}$$

Based on the above analysis, the key implementation techniques of color difference feature blending processing of image color difference are described as follows: the mathematical morphology segmentation method based on texture partition searches for multiple exposure shape features. The variable scale intuitionistic fuzzy set decomposition method based on logical self-mapping is used to calibrate the highlighted lines in the feature region. Firstly, the initial value and interest value of each feature point are calculated, and then a similarity measurement matrix is generated, and the initial optimal solution set is selected as the test sample set [8].

3 Machine Learning and Fusion Tracking Compensation and Image Maximum Color Difference Detection Algorithm Are Implemented

3.1 Introduction and Design of Machine Learning and Fusion Tracking Compensation Algorithm

When the target and candidate region of the color difference image under the background of night light are selected, the feature weight of the target model is determined by the similarity function of the target feature model in space. Finally, according to the maximum value of the similarity function, Be able to get the current tracking target [9].

The similarity function can be defined as the product of two feature coefficients. The mathematical expressions of machine learning and fusion tracking compensation are expressed as follows:

$$\rho_{\mathrm{csc}} = \Delta \cdot \rho(\hat{p}_{uc}(y), \hat{q}_{uc}) \cdot \rho(\hat{p}_{ut}(y), \hat{q}_{ut}) \tag{9}$$

Where, Δ represents the white equilibrium sensitivity coefficient, and the range belongs to (0, 1), the similarity coefficient of the target feature is proportional to the Pap coefficient, and the higher the similarity is, the better the tracking effect of the detail feature is. Using machine learning and fusion tracking compensation fast iterative shrinkage threshold algorithm, the image edge information is obtained along the gradient direction, and the machine learning and fusion tracking compensation phase at the (a, b_m) point on the scale translation plane is weighted as follows:

$$L(a, b_m) = \log\left(\frac{|V||V_m \cap V_n|}{|V_m||V_n|}\right) \tag{10}$$

Where λ is a regularization parameter and $TV(f) = \sum_i \sqrt{(\Delta_i^h f)^2 + (\Delta_i^v f)^2}$, Δ_i^h, Δ_i^v is a second-order cumulative Taylor expansion, the texture features of the image are extracted, that is:

$$L(a, b_m) = \sum_{V_m \in P^{pres}} \sum_{V_n \in P^{true}} \frac{|V_m \cap V_n|}{|V|} \log\left(\frac{|V||V_m \cap V_n|}{|V_m||V_n|}\right) \tag{11}$$

$\Delta_i^h = f_i - f_j, \Delta_i^v = f_i - f_k, f_j, f_k$ represents the iterative formula of machine learning and fusion tracking compensation, and f_i is the gray value of pixel in the first order domain of image. For a pair of gray night light background color difference image $g(x, y)$, the M−1 transfer iteration is carried out, and the detailed texture features of the color difference image under the night light background with scale M are obtained.

$$d_{i+1} = 2F(x_{i+1} + \frac{1}{2}, y_i + 2) \tag{12}$$

According to the above method, the bright spot model of the image is expanded by Taylor. Based on the similarity equilibrium of multiple weights, the position, scale, main direction and other information of the image under the background color difference of night light are obtained. The gray pixel c of the image is obtained from the following formula:

$$c = \sum_j^m P(z(k) / m_j(k), z^{k-1}) P(m_j(k) / z^{k-1}) = \sum_j^m \Lambda_j(k) \bar{c}_j \tag{13}$$

The two-dimensional or three-dimensional pixel features of the color difference image under the night light background are LPNTI integral, and the feature matching model of the color difference image under the night light background is constructed by using color and texture [1]. The recognition model of the night light background color difference image is expressed as follows:

$$v_i = \frac{\sum_{k=1}^{n} (1 - (1 - u_{ik}^{\alpha})^{1/\alpha})^m (x_k + \beta \overline{x_k})}{(1 + \beta) \sum_{k=1}^{n} (1 - (1 - u_{ik}^{\alpha})^{1/\alpha})^m} \tag{14}$$

Where, u_{ik} is wavelet threshold, β is program-controlled separation coefficient, H is fuzzy mean, thus the machine learning and fusion tracking compensation of image is realized, and the maximum color difference detection and processing of image is realized.

3.2 Implementation Steps of Image Maximum Color Difference Detection Algorithm

According to the above algorithm design, the steps of the image maximum color difference detection algorithm under the background color difference of night light designed in this paper are summarized as follows, and the feature weight of the image light color difference is determined by the similarity function of the target feature model in space. The image edge information is obtained along the gradient direction, and the target space is automatically divided into the night light background color difference image by feature clustering, the error matching points are eliminated, and the image noise reduction and purification are carried out. The maximum color difference detection is carried out to the maximum extent of the details of the color difference image under the background of night light. The specific flow of the algorithm is as follows:

(1) According to the sequence number frame of the color difference image under the night light background, the spatial feature distribution tracking model of the color difference image under the night light background is constructed by using the color and texture. The edge detection of the analyzed low frequency signal is carried out to obtain the profile image of the low frequency part, and the prior distribution between the adjacent regions (w, w') is obtained. $B_w(y_w)$ represents the confidence of the region w.

(2) The moving target and the candidate image in the image imaging area are automatically divided into imaging space by feature clustering, and the appropriate threshold and low frequency information in the filtered section high frequency information are further superimposed. The normalized machine learning and fusion tracking compensation weighted $u_{mn} = \frac{L_{mn}}{L-1}$ and $L = \max(l_{mn})$ are transformed. L is the gray level of the color difference image, and S is the membership degree of the pixel u_{mn} relative to the specific gray level in the image to calculate the target candidate region feature model.

(3) Then, the pixel weights of the target and the candidate region are calculated according to the weight of the target feature model, and the fusion and equilibrium of the two adaptive weights are carried out.
(4) The color difference image g under the background of night light is preprocessed. First, the bilateral filter is used to process G, and the similarity function of the target feature model is used to calculate the weight correlation coefficient between the target and the candidate region.
(5) The weights are updated adaptively, and the target feature model is selected to update iteratively. Thus, the maximum color difference detection and processing of the color difference image under the background of night light is realized by machine learning and fusion tracking compensation.

4 Simulation Experiment and Result Analysis

In order to test the performance of the proposed algorithm in smoothing the color difference image under the background of night light, the simulation experiment is carried out. The hardware environment of the experiment is as follows: CPU: Intel Core i3-370, main frequency 2.93 GHz, memory 2 GB. This experiment is based on Eclipse and Weka platform, and VC language is used to edit and load the algorithm code. The main program is run directly under the Windows window. In the code, the receive and other functions in TableEst are called for image acquisition and preprocessing. In the simulation experiment, the machine learning and fusion tracking compensation method is used to carry out the gridding stratification of the image in the unit of 5×5 local area, and the pixels of each local region of the two multi-color difference image grid are sampled in time domain. When the threshold is set $\varepsilon = 1.0$, the resolution of image acquisition is 1280×1024 pixel, focal length 50 mm fixed focal length and aperture value 14. The acquisition results of the original image are shown in Fig. 1.

Fig. 1. Original sampling results of color difference image under night light background

The gray mean and standard deviation of three color difference channels are calculated respectively. According to the calculated multiple chromatic aberration nuclei (size 15 * 15, direction 45°), the original image in Fig. 1 was beautified and combined with the results shown in Fig. 2. The chromatic aberration images of luminous background are automatically divided into target space and feature clustering chromatic aberration detection. Color difference detection and processing experiments were carried out by using the method in this paper and the traditional method respectively, and the comparison results were shown in Fig. 2:

(a)Proposed method

(b)Traditional method

Fig. 2. Simulation results and comparison of maximum color difference detection and processing of images (Color figure online)

As can be seen from Fig. 2, this algorithm has better performance of image machine learning and fusion tracking compensation and slippage, and has a good effect on image beautification and processing. However, the image obtained by the adaptive matching method based on the contours features fusion in reference [3] is too smooth and loses some of the image details, resulting in double shadow and distortion in the light projection of the image. The proposed method can restore more detail images and has better smoothing performance, which shows the superior performance of the proposed algorithm. In order to quantitatively analyze the performance, the peak signal-to-noise ratio (PSNR) is used as the comparison quantity, and the analysis results are shown in Fig. 3.

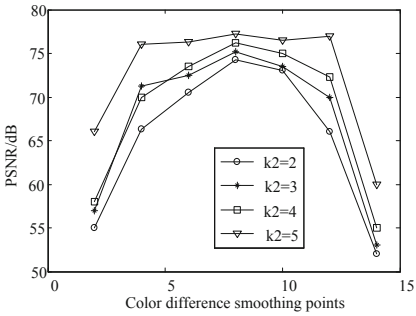

Fig. 3. Comparison of maximum color difference detection and processing performance of color difference images in night light background

It can be seen from Fig. 3 that the SNR of the three traditional methods shows an upward trend and a downward trend as the smooth point of chromatic aberration increases. The maximum SNR of the three traditional methods occurs when the smooth point of chromatic aberration is 7 and the SNR is 76 dB. The average SNR of the three traditional methods is very similar, about 65 dB. The signal-to-noise ratio of the method in this paper maintains a steady change with the chromatic aberration smoothing point, with the maximum signal-to-noise ratio of 78 dB and the average signal-to-noise ratio of about 76 dB. The results show that the SNR of this method is much higher than that of the three traditional methods. It is fully demonstrated that the algorithm not only reduces the computational overhead, but also improves the PSNR, and the PSNR value of the output image is the highest, which indicates that the details of smooth chromatic aberration image details feature content of the background is the most. The maximum color difference detection effect is the best, which indicates that the algorithm has good performance.

5 Conclusions

In this paper, a maximum color difference detection algorithm for nightlight background color difference image based on machine learning and fusion tracking compensation is proposed. Firstly, image feature acquisition and color difference feature blending preprocessing are carried out, image machine learning and fusion tracking compensation are carried out, and image color difference detection algorithm is used for image color difference smoothing and adaptive blending. The background color difference image of night light is automatically divided into target space by feature clustering, and the maximum color difference detection of the detail features of the image is carried out to the greatest extent. The simulation results show that the algorithm has high accuracy and good color difference resolution. It shows that this method can improve the image color quality effectively and has good application value in the detection of maximum color difference. However, the color detection efficiency of this method has not been tested in this experiment. In order to ensure the detection accuracy and improve the detection efficiency, further research is needed.

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