A Modified Gamma Correction Algorithm Applied to the Medium and Bright Light Problems in AI Image Recognition

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Abstract: In this paper, an improved block gamma correction algorithm is proposed for the problem of bright light repair in outdoor scenes in the field of artificial intelligence image recognition, and simulation verification is carried out. Firstly, the strong light area is quickly extracted to meet the high-speed and low-calculation requirements of the artificial intelligence image recognition algorithm. Secondly, the strong light area is divided into sub-blocks, and different gamma values are used according to the standard deviation of each sub-block, which effectively reduces the strong light area. Finally, high image detail information and color confidence are preserved, and at the same time, it meets the requirements of the subsequent image recognition network for the input image.

1. Introduction
With the continuous development of artificial intelligence image recognition technology, this technology has been widely used in various fields such as industry, security, finance, and medical care. In order to improve the accuracy of image recognition, network structures such as VGG, Inception, ResNet, and DenseNet are proposed. On this basis, one-stage and two-stage target detection algorithms are also widely used. It can be said that image recognition and target detection technology based on artificial intelligence has achieved unprecedented development and has been widely used at this stage. However, it must also realize that the basis of artificial intelligence image recognition technology is images. The quality of the image directly affects the effect and accuracy of subsequent intelligent recognition. If the collected original image loses the detailed information, no matter how precise the algorithm or the network is, the image recognition function cannot be completed [1][2]. Therefore, various enhancement algorithms for original images are still a key research area.

In the fields of industry and security, outdoor scenes are an important application field. However, compared with indoor scenes, images collected in outdoor scenes are more affected by light. This kind of illumination will change the intensity and position with the movement of the sun, which will cause uncertain areas of strong light, resulting in the loss of image detail information. The loss will affect the accuracy of subsequent image recognition algorithms [3] [4]. At the same time, since the recognition network needs color images as input, the color information of the images still needs to be saved in the processing [5].

Based on the above reasons, this paper proposes an algorithm to solve the problem of glare in the field of artificial intelligence image recognition. While meeting the high speed, low computational complexity, and color information required by artificial intelligence image recognition scenes, the gamma correction algorithm is improved to restore image details and obtain better glare correction.
2. Basic approach to solving the strong light problem

Some basic methods to solve the strong light problem are analyzed and compared below.

2.1. Histogram equalization

Histogram equalization is to redistribute the image gray scale according to the transformation function, and try to make the image gray scale evenly distributed in each gray scale. The histogram equalization will make the low gray value in the image become larger, and the high and low gray value will become smaller. Histogram equalization can extend the low gray value part of the image and compress the high gray value part. It can play a certain role in the restoration of strong light pictures.

2.2. Logarithmic transformation

The logarithmic curve has a large slope in an area with a lower pixel value, and a smaller slope in an area with a higher pixel value. Therefore, after the image is logarithmically transformed, the contrast of the darker area will be improved, so the dark details of the image can be enhanced. It can also play a role in the restoration of strong light pictures.

Logarithmic transformation can expand the low gray value part of the image to show more details in the low gray value part. The transformation compresses its high gray value part, reduces the details of the high gray value part. It can emphasize the low gray value of the image part of the purpose. The transformation function is as follows.

\[ S = C \log(1 + r) \]  

(1)

\( r \) indicates the original pixel gray. \( S \) is the pixel gray after transformation and \( C \) is constant.

Gamma correction

The gamma transformation is a simple and highly applicable method to images. The overall brightness of the image was controlled by using two parameters, \( \gamma \) and \( c \). Its function expression is given as follows.

\[ I_{out} = c I_{in}^{\gamma} \]  

(2)

\( I_{in} \) indicates input image intensity after normalizing. \( I_{out} \) indicates the normalized output image intensity. \( \gamma \) and \( c \) both are used to shape the gamma function. When \( c = 1 \), both input and output images range between \([0,1]\). Different \( \gamma \) can produce different stretching effects. When \( \gamma < 1 \), \( I_{out} \) is brighter than \( I_{in} \), and image grayscale range is stretched. When \( \gamma > 1 \), \( I_{out} \) is darker than \( I_{in} \), and image grayscale range is compressed.

3. Improved gamma correction algorithm for strong light corrections

3.1. Characteristics of bright light images

Considering the image characteristics, artificial intelligence recognition in outdoor scenes is required. The bright light part is mainly local strong light due to the influence of sunlight with little effect on other parts. Artificial intelligence image recognition requires high timeliness and low computational complexity. Therefore, the size of the image that needs to be repaired can be reduced from the source by obtaining a bright light ROI (region of interest). It can correct this part of the bright light concentration area. The bright light is concentrated in this part of the area, and the gray value is mainly concentrated in the range of \([200,255]\). Using the methods of histogram equalization, logarithmic transformation, and gamma correction, their transformation domain is \([0,255]\), which will cause complete loss of middle and high grayscale details and color distortion. Therefore, this paper proposes an improved gamma correction algorithm to solve this problem.

3.2. The rapid extraction of the bright light regions

As mentioned above, artificial intelligence image recognition requires high timeliness and low computational complexity. The size of the image that needs to be repaired can be reduced from the source by obtaining the region of interest (ROI). Specific steps are as follows.

The first step is to consider that the target object must be complete in the image, so the image is
cropped and the upper, lower, left, and right borders are removed to reduce the amount of calculation.

The second step is to find all the bright light areas in the image, and filter out the small strong light areas according to the area area, and only keep the larger bright light areas. The third step is to appropriately expand the area to be processed for subsequent correction processing.

3.3. Improved gamma correction algorithm

The traditional gamma algorithm transforms the global image, and the transform domain is [0,255]. The gray value of the bright light image is mainly concentrated in the range of [200,255], which will cause the complete loss of middle and high gray details. At the same time, the traditional gamma algorithm uses the same gamma parameters for the global image. While compressing the bright light area, it also compresses the medium bright light area with image details, which will also cause the complete loss of medium and high grayscale details. In addition, the traditional gamma correction algorithm is only for grayscale images, and cannot process color images and retain color information. In summary, this article proposes an improved gamma correction algorithm. The specific steps are as follows.

The first step is to convert the BGR image to HSV type, and the subsequent operation only corrects the brightness information (V component).

In the second step, the brightness information image is divided into several sub-blocks, each sub-block has a size of N*N, and the standard deviation of each sub-block is calculated.

The third step is to select corresponding different gamma values according to the standard deviation of each sub-block, and perform gamma correction. Sub-blocks with large standard deviations have mid-to-high gray level details and need to be extended, at this time gamma<1. Sub-blocks with small standard deviations are mainly sub-blocks with almost all light intensity of 255. There is no detailed information and needs to be suppressed. At this time, gamma>1.

In the fourth step, the transformed brightness information (V component) is re-imported into the HSV image matrix, and then restored back to the BGR image.

4. Simulation results and analysis

This paper verifies the above algorithm by Opencv-python, and the simulation platform uses Baidu aistudio, simulation results and analysis as follows.

Figure 1 is a color image that requires artificial intelligence image recognition in a natural scene. It can be seen that there is a bright light area on the target container due to illumination. The uneven texture on the surface of the container in this area disappears, and the image size is 590*360. Figure 2 is a partial image of bright light obtained according to the rapid extraction algorithm of bright light described in 3.2. Among them, the bright light detection threshold is [250,255], and the detection area threshold is 500. The region boundary expansion coefficient is 1.1 and the image size is 39*31. The image size that needs subsequent processing is significantly reduced.
Figure 3 is the result of bright light correction obtained by using color histogram equalization. It can be seen that the area of the bright light area is significantly reduced, but its color information is largely lost, which will affect the subsequent image recognition. Figure 4 is the result of the strong light correction obtained by using the logarithmic transformation method. It can be seen that the strong light area is forced to uniformly turn into gray, and the medium and high brightness details and color information are all lost. Figure 5 shows the glare correction result obtained by the traditional gamma correction method. It can be seen that the area of the glare area has been reduced. However, due to the global use of uniform gamma parameters, the middle and high brightness details are lost, and the original low brightness grayscale is suppressed. This part of the details is also lost. Figure 6 shows the glare correction result obtained by using the improved gamma correction method proposed in this paper. It can be seen that the area of the strong light area is reduced, and because different sub-blocks adopt different gamma parameters according to their standard deviations. Mid-high brightness details and original low-brightness details have been preserved. The color information is also retained, which meets the requirements of the subsequent image recognition network for the input image.

5. Conclusion
This paper focuses on the problem of bright light repair in outdoor scenes in the field of artificial intelligence image recognition. An improved block gamma correction algorithm is proposed and verified by simulation. The algorithm first reduces the amount of subsequent calculations and increases the speed of calculations by quickly extracting the strong light area. The bright light area is divided into sub-blocks, and different gamma values are used according to the standard deviation of each sub-block, which effectively reduces the strong light area. High image detail information and color confidence are preserved, while meeting the requirements of subsequent image recognition networks for input images.

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