Enhancement Method of Video Image in Haze Weather

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ABSTRACT

In order to enhance the visual quality of video image collected by the internet monitoring equipment in the haze weather, the enhancement algorithm combine dark channel prior and Gamma correction was proposed. This method can improve the quality of the image and enhance the contrast of the image.

INTRODUCTION

Video image is the most basic and most important data in the safe city base video platform[1], and the video image becomes blurred due to the camera's own reason (such as dust on the camera lens) or outside haze weather, thus affecting the visual effects of video images, which is not conducive to the video image of the further analysis and operation[2].

At present, the traditional video image preprocessing algorithm includes histogram equalization, homomorphic filtering, wavelet transform, Retinex algorithm[3], etc. These enhanced algorithms in different environments have already obtained a good de-fog effect and achieved the goal of image enhancement, but the algorithm in the realization of de-fog still has its own limitations. Therefore, in order to improve the visual effect of video images under rain and fog weather conditions, enhance the contrast of image images and improve the quality of images, this paper will adopt the method of dark channel prior combining Gamma correction for image enhancement.

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IMAGE ENHANCEMENT METHOD

Dark Channel Priority

Dark channel priority’s having been widely concerned [4-5] is due to that Dr. He Kaiming's team put forward a new idea in 2009 and then got ideal treatment effect. Through a large number of outdoor clear color image observation, it can find outdoors clear image of the non-sky area of the image, and some pixels in the R, G, B three channels existing in a color channel value is very small. In addition to the sky area, the dark channel value is close to 0, and the auspicious rule of a dark channel can be described as a mathematical expression:

$$J_{dark} (x) = \min ( \min_{y \in \Omega(x)} J^c (y)) \approx 0$$

Among them, \(J^c\), \(c\) is any color channel of the original image \(J\), and \(\Omega(x)\) is a local small area centered on \(x\). The value of \(J_{dark} (x)\) is lower than that of the sky region, which approaches 0. If the image \(J\) is a foggy image, then \(J_{dark} (x)\) becomes the dark channel image of the image \(J\).

The dark channel priority algorithm described in this paper is based on the flow chart shown in Fig. 1, and the specific steps are:

Step 1: Use the dark channel theory to obtain the dark channel image of the atomized image.

Step 2: Assume that the overall light intensity \(A\) of the atmosphere is known and the transmittance is \(l(x)\) roughly calculated using the dark channels acquired in step 1.

Among them, the overall intensity of the atmosphere is obtained in accordance with the following steps:

Step 2-1: Obtain its dark channel image \(J_{dark}\) for the input original fogged image \(I\).

Step 2-2: Select one of the brightest pixels of the total number of pixels (\(NUM\)) in the dark channel image \(J_{dark}\) (\(N = NUM / 1000\)) and note the pixel coordinates (\(x, y\)).

Step 2-3: The coordinate points obtained based on step 2-2 get these pixel points in the three channels of R, G and B of the original fog image irrespectively, and add (\(sumR, sumG, sumB\)).

Step 2-4: The atmospheric light values are obtained \(A_c = [A_r, A_g, A_b]\), among them, \(A_r = sumR / N\), \(A_g = sumG / N\), \(A_b = sumB / N\).
For the calculation of the transmittance, assuming that the transmittance is known, and the atmospheric light intensity has been calculated by the steps 2-1 to 2-4, then the two values can be calculated twice on both sides of the equation (1):

\[
\min_e (\min_{y \in \Omega(x)} J^c(y)) = A^c - \frac{A^c}{I(x)} + \min_e (\min_{y \in \Omega(x)} \frac{I^c(y)}{t(x)})
\]  

(1)

And through the dark primary a priori rule it can be known:

\[
J_{dark}(x) = \min_e (\min_{y \in \Omega(x)} J^c(y)) = 0
\]  

(2)

According to (1) and (2), it can be obtained:

\[
t(x) = 1 - \min_e (\min_{y \in \Omega(x)} \frac{I^c(y)}{A^c})
\]  

(3)

In real life, even in clear weather, there will be some small particles in the air, which makes the distant scene still feel the presence of fog. In addition, the presence of fog can make things more real due to existence of the sense of depth. Therefore, in the process of de-fog, a certain degree of the existence of the fog should be retained, thus introducing a [0,1] between the coefficient factor, so (3) can be amended as:

\[
t(x) = 1 - \omega \min_e (\min_{y \in \Omega(x)} \frac{I^c(y)}{A^c})
\]  

(4)

Step 3: Using the morphological opening operation, the transmittance \( t(x) \) obtained in step 2 is optimized for the refined transmittance \( t'(x) \).

Among them, the morphological open operation is the first to carry out the operation of corrosion and expansion, mainly in order to remove the structural elements of small image details, and play the role of filtering salt and pepper noise, such as (5):

\[
f(x) \circ g = (f(x) \otimes g) \oplus g
\]  

(5)

Step 4: Use the dark channel to estimate the intensity of the atmosphere \( A \).

Step 5: The original brightness of the image is restored by the optical model and parameters of the fog image \( I(x) \), \( A \) and the estimated thinning transmittance \( t'(x) \), thus restoring the original brightness of the image \( J(x) \).

Step 6: The image \( J(x) \) is enhanced according to step 5 to obtain the pre-processed image.
Gamma Correction

Gamma is a corresponding curve derived from a display / television (CRT), that is, brightness and input voltage of a non-linear relationship[6]. Gamma correction[7] is mainly to compensate for the different output devices existing on the display of different colors on the display differences, making the image on different displays show the same image effects. In image processing, steps are generally conducted as follows:

Assuming that the pixel gray value \( \alpha \in [0, \alpha_{\text{max}}] \), \( \alpha_{\text{max}} \) is the maximum value of the pixel.

Step 1: Normalize the pixels to obtain the gray value \( \hat{\alpha} \in [0,1] \) of the normalized pixel.

Step 2: Calculate the Gamma function \( \hat{b} = \hat{\alpha}^\gamma \), \( \hat{b} \) is the corrected pixel gray value, and \( \gamma \) is the characteristic index.
Step 3: The gray value of the pixel gray value $b$ corrected by Gamma is transformed to obtain the transformed pixel gray value $b \in [0, \alpha_{\text{max}}]$, which can be expressed as the $b = (\frac{\alpha}{\alpha_{\text{max}}})^\gamma \alpha_{\text{max}}$.

As the video image will be the dark on the whole after dark channel priority processing, so it needs brightness enhancement.

**EXPERIMENTAL RESULTS AND ANALYSIS**

This paper chooses one of the day and night video images respectively, after the dark channel priority processing the first time, the Gamma correction begins, then the overall brightness of the image has improved. The result is shown in Fig. 2 and Fig. 3, where (a) represents the original image; (b) shows the image after dark channel processing; and (c) represents the image after Gamma correction.

![Figure 2. Result of video image of daytime.](image1)

![Figure 3. Result of video image of night.](image2)
CONCLUSIONS

In this paper, it can be concluded that, through using the combined way of dark channel priority and Gamma correction for the video image processing under the weather of haze, the brightness and contrast of image have been improved effectively, which lays a good application base for the subsequent image processing and analysis.

REFERENCES