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Sand Dust Image Enhancement using Histogram and L-CLAHE Technique

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Abstract : Low contrast, color variation, and blur are common characteristics of images taken in sand-dust conditions, all of which have a negative impact on the image's clarity. In this paper explains a pixel-adaptive color correction technique that makes use of chromatic histograms. The statistical properties of the green component are used to alter the pixels of each color component. Then, a color normalizing method that maintains the green mean is provided.Further, the hue, saturation, and intensity components are identified from the same samples to enhance the detail information of the image. This is done using the luminance chrominance (YCbCr) color space approach. The luminance component is improved using CLAHE to produce the result, which is known as L-CLAHE. The proposed method may greatly improve the images taken during sand-dust weather conditions, and the results are better than those of previous methods, according to experimental data from quantitative evaluations.

IndexTerms – Sand-dust image enhancement, color normalization, green-mean preserving, color pixels shifting,L-CLAHE.

I.INTRODUCTION

Inclement weather causes outdoor images and videos to have poor contrast, color casts, poor vision, fuzz, and darkness.This phenomenon's primary cause is the way sand-dust particles scatter and absorb light. As a result, the processing power of monitoring systems, automated driving, and remote sensing systems has been directly decreased by the sand-dust-damaged images. Researchers have suggested various visibility restoration methods to enhance the processing capacity of computer vision systems in sand-dust conditions. The primary issues with sand-dust image enhancement are significant color casts or shifts [1]. A common method of improving images for greater contrast and clarity is histogram equalization[2]. Adaptive Histogram Equalization is a technique for enhancing image contrast. It varies from histogram equalization in that it uses an adaptive approach to construct multiple histograms, each of which corresponds to a different area of an image [3]. Sand-dust image dataset are available in internet[4].

II . LITERATURE REVIEW

The author **Z. Shi et al. [5]** discuss about a halo-based DCP-based image enhancing technique. The color shift was eliminated using the color elements in the Lab color space. In addition, haze in the RGB space was eliminated using the enhanced DCP.

The author **G. Gao et al. [6]** discuss about a label visibility restoration technique based on a blue channel and fusion to restore deteriorated images taken in sandstorm weather. First, we employ white balancing technology to correct the color distortion and blue channel technology to improve image contrast.

The author **X. Fu et al. [7]** discuss about a fusion-based method for improving a single sandstorm image is suggested. The suggested method is the first to tackle this difficult issue with just one degraded image. First, from the color-corrected sandstorm image, two inputs of differing brightness are produced.

The author **Joung-Youn Kim et al. [8]** discuss about the advanced histogram equalization algorithm for contrast enhancement. Due to its efficiency and simplicity, histogram equalization is the most widely used algorithm for contrast enhancement. Global histogram equalization is easy and quick, but has a limited ability to increase contrast.

III.EXISTING METHOD

Existing method [9]explains a novel image enhancing technique that makes use of the sand-dust image's color distribution properties. The present restoration process consists of four steps.The color histogram characteristics of sand-dust images, such as means and standard deviations, are used in the first stage. On the basis of the previously corrected color channels, a green mean-preserving image normalization technique is suggested in the second phase. A histogram shifting technique that maximizes the overlap between the red, blue, and green histograms .The brightness of the sand-dust image was then improved using image correction. The primary issues with sand-dust image enhancement are significant color casts or shifts.

To remove color veils due to sand dust, and to improve the brightness and contrast of the sand-dust image So in this paper proposed CLAHE for luminance to improve the visual quality of image. The parametric metrics evaluated shows that the proposed work achieves good results compared to existing work.

IV. PROPOSED METHOD

In this paper proposed method eliminate color veils produced on by sand dust as well as to enhance the brightness and contrast of the sand-dust image. CLAHE for luminance to improve the visual quality of image. Block diagram of Proposed methodology is shown in below figure 1

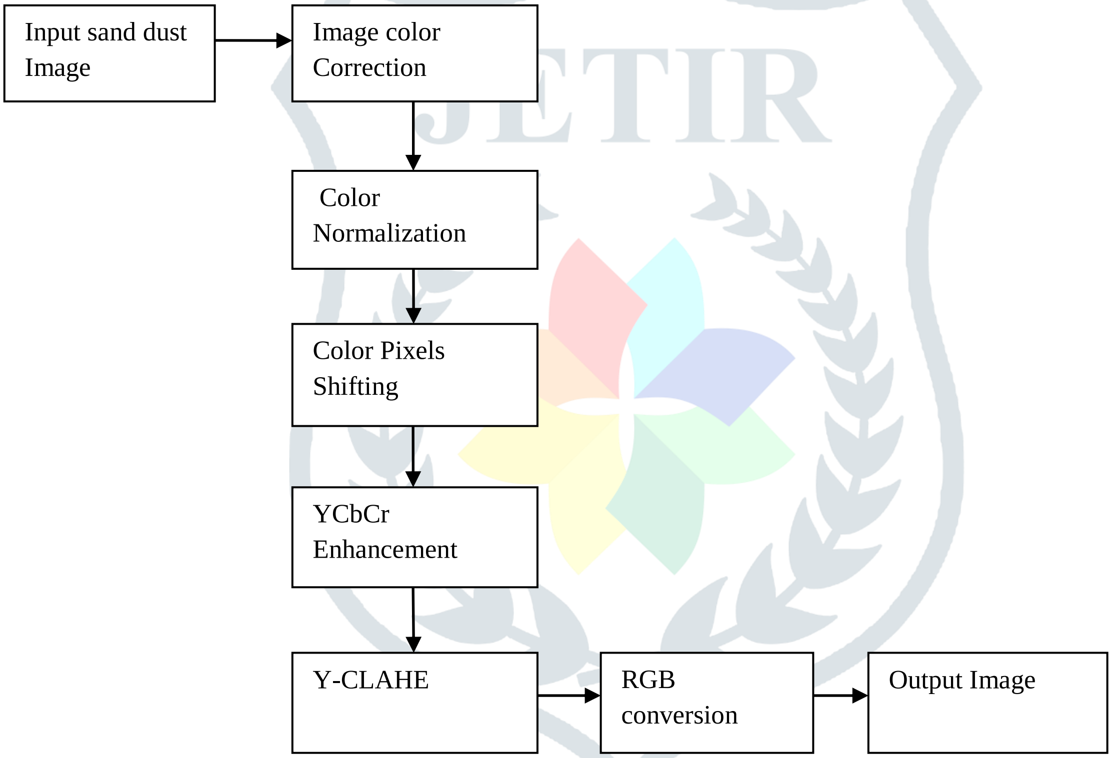


Figure1 : Block Diagram of Proposed Methodology.

The proposed method consists of following steps.
Step 1: Adaptive initial color correction.
Step2: Green mean-preserving color normalization technique.
Step3: Color pixel shifting based on maximum histogram overlapping.
Step4: Luminance-chrominance colour space analysis.
Step5: Luminance information fed to CLAHE.
Step6: RGB conversion.

4.1.Initial Color Correction

In this work by correcting the color using a weighted green component compensation technique.Let I^c $(c \in \{r,g,b\})$ be the color channel of the given sand-dust image, and $I^c(x)$ be the pixel value of I^c at the position $x=(x,y)$ within the image.The following steps are taken to correct the color.

$$I^c_1(x) = I^c(x) + \Delta^c I^g(x) \qquad (1)$$

Where $I^c_1(x)$ is a color corrected pixel and Δ^c is the weight of the green pixel. We propose three factors to construct Δ^c. That is,

$$\Delta^c = \delta^c_{md} \times \delta^c_{sr} \times \delta^c_{wm}(x) \qquad (2)$$

δ^c_{sr} is a channel-dependent term that adequately calculates the color channel's strength or weakness.

δ^c_{wm}, a generalized form of the weight employed in the conventional method, is a pixel-wise weight. which is defined as

$$\delta^c_{wm} = 1-kI^c(x) \qquad (3)$$

In this k is created by averaging the means of the red channel and the blue channel that has been inverted. where κ is a control parameter. If κ is set to 1

The below Fig 2 shows the initial color correction result

(a) (b)

Figure2: (a) sand dust image. (b) Initial color correction result.

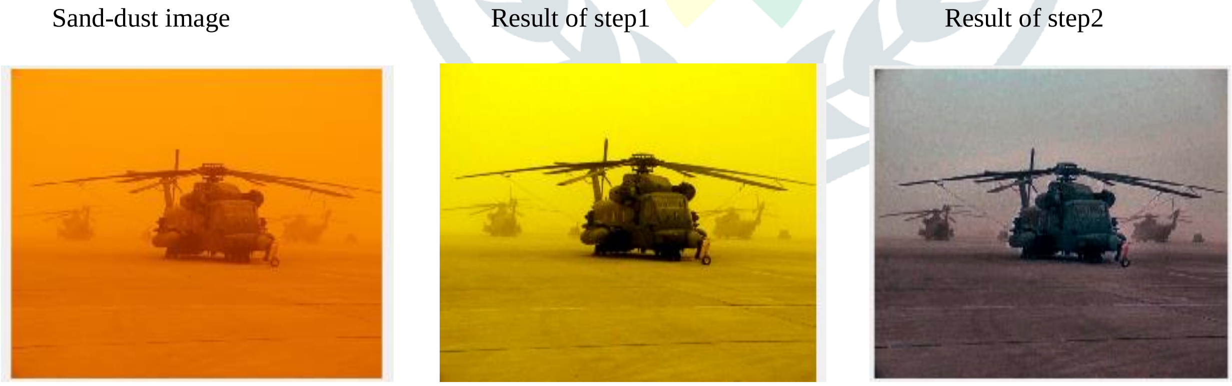
The color histograms are slightly changed by the suggested pixel-based initial correction step. However, the subsequent green-mean-preserving phase benefits greatly from this initial correction step.

4.2.Green Mean Preserving Image Normalization

Each color value is almost equal, and the average color for each channel across the entire image is grey. Therefore, we provide a green-mean-preserving visual normalization technique that stretches color components in accordance with the mean of the green component. This procedure is simple but quite useful. which is defined as

$$I^c_2(x) = (I^c_1(x) - m(I^c_1(x))/ \max_x I^c_1(x) - \min_x I^c_1(x)) + m(I^g(x)) \qquad (4)$$

Using the image normalization process, the color veil of many sand-dust images can be removed. Intermediate color correction result based on Step 2 after Step 1 is shown in below figure 3



Sand-dust image Result of step1 Result of step2

Figure 3: Intermediate color correction result based on Step 2 after Step 1.

4.3 Color Pixel Shifting

This technique is done to improve the brightness of the color-corrected image and remove the slight color cast. The gray-world algorithm, which has the same color mean as sand-dust images, can result in color casts since sand-dust images contain a dominant color, like red. The histogram of the red channel is narrow and has a strong peak after first color correction and green-mean-preserving normalization. The processed image displays a reddish artifact because to the histogram's limited width and high peak value. This is caused by equating the red or blue mean to the green mean. A color pixel shifting algorithm using the maximum histogram overlapping method .To avoid the effect of background luminance, we use normalized color values.

4.4 Luminance Chrominance Color Analysis

color variance; this step is carried out to improve the image's quality. There are three components in luminance chrominance color spaces. The overall brightness of the image is contained in luminance. It resembles a greyscale image somewhat; if you only considered the luminance component, it would resemble a black-and-white image. Two chrominance components. These Color pixel shift based on maximum histogram overlapping produces output with little indicate the color once the lightness component has been removed. Similar information is contained in the two chrominance components as it is in the hue and saturation parts of the HSL.There are multiple standards that have been established for conversion in various contexts[10].

$$Y = 0.299\,R + 0.587G + 0.114B \qquad (a)$$

$$C_b = 128 - 0.1687R - 0.3312G - 0.3312G + 0.5B \qquad (b)$$

$$C_r = 128 + 0.5R - 0.4186G - 0.0812B \qquad (c)$$

Where Y is luminance and C_b , C_r two chrominance components.To raise the intensity level, adaptive histogram equalization is provided the luminance information. To get the original image, it was ultimately converted to RGB.

4.5.CLAHE

In order to reduce the problem of noise amplification, Contrast Limited adaptive histogram equalization (CLAHE), a form of adaptive histogram equalization, limits the contrast amplification. CLAHE performs high precision contrast limiting histogram equalization in small patches or small tiles. By changing each pixel with a transformation function generated from a nearby region, adaptive histogram equalization (AHE) enhances this. Before calculating the Cumulative Distribution Function, the CLAHE restricts the amplification by clipping the histogram at a predetermined value (CDF). A source image is separated into non-overlapping contextual regions known as sub-images, tiles, or blocks in the CLAHE technique[11].

Block Size (BS) and Clip Limit are the two primary CLAHE parameters (CL). These two variables mainly control enhanced image quality. Because the input image has a very low intensity and a larger CL makes its histogram flatter, the image becomes brighter when CL is increased. As the BS increases, the dynamic range expands and the visual contrast also rises. CLAHE enhancement method for real-time system video quality improvement.

4.6 RGB conversion

The R, G, and B values are stored separately in each of the three different planes that compensate an RGB color model digital image. The following steps could be included in the CLAHE algorithm in RGB color space: The original image is initially separated into three separate images, R, G, and B images; Then, to produce better R, G, and B images, the three separate images are each enhanced using Rayleigh CLAHE; The enhanced CLAHE RGB color image is created by combining the improved R, G, and B images.

V.EXPERIMENTAL RESULTS

The experimental results are obtained using MATLAB. The experimental results shown in below figure 4

Sand Dust input image

Final Enhanced image

Figure 4: Sand-dust image enhancement results

Evaluation Metric is explained in below

5.1 Underwater Image Quality Measure (UIQM)

The evaluation of UIQM is a synthesis of several methodologies, including UICM and UISM. In order to calculate UIQM, the colorfulness, sharpness, and contrast of the pixels are used[12].

5.2 Natural Image Quality Evaluator (NIQE)

Natural Image Quality Evaluator (NIQE) is a completely blind image quality analyzer (IQA) that only uses observable deviations from statistical regularities detected in natural images, without any exposure to or training on distorted images that have been judged by humans[13].

5.3 Perception-based Image Quality Evaluator (PIQUE)

A non-reference perception-based image quality evaluation method for real-world images is a perception-based quality evaluator (PIQE). The image quality score is computed using the mean subtraction contrast normalizing coincident[14].

5.4 Blind/referenceless Image Spatial Quality Evaluator (BRISQUE)

The locally normalized brightness coefficients, which were used to determine the image features, are used by the BRISQUE model to assess image quality[15].

5.5 No-Reference Image quality metric for contrast distortion (NIQMC)

we first approximately eliminate anticipated parts from an image to obtain local details. Then, using visual saliency, we calculate the entropy of specific unpredicted locations of maximal information.

For NIQE,PIQUE and BRISQUE, smaller values represent better image qualities, and for NIQMC, larger values indicate better qualities of the enhanced image[16].

Table 1:Quantitative metrics Comparison with Previous Existing Method

Method	UIMQ↑	NIQE↓	PIQUE↓	BRISQUE↓	NIQMC↑
HSA[9] (Existing method)	0.941	2.733	34.195	28.198	6.399
L-CLAHE (Proposed method)	1.100	2.502	34.014	14.824	7.228

In the above table 1 represents the NIQE, PIQUE and BRISQUE are smaller values represent better image qualities, and UIQM, NIQMC are larger values indicate better qualities of the enhanced image.

IV.CONCLUSION

In this paper an effective sand-dust image enhancing system that generates achromatic histogram by successive color balancing is done.The initial color correcting technique presented was based on the mean and standard deviation of color histograms. The red and blue histograms were then transformed into the green histogram using a color normalizing that preserved the green mean. The examination of luminance-chrominance is done . Finally, CLAHE for brightness is performed to enhance the image's visual quality and noise amplification problem reduce. The parametric functions evaluated shows that the proposed work achieves good results.

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