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Novel-Fl Operators Based Visibility Processing Techniques of Denoising Algorithm Using Exdark Dataset Simulation

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Abstract: An inclement dusty weather can significantly reduce the visual quality of captured images and this consequently leads to hamper the observation of meaningful image details. Capturing images in such weather often leads to undesirable artifacts such as poor contrast, deficient colors or color cast. Hence, various methods have been proposed to process such unwanted event and recover vivid results with acceptable colors. These methods vary from simple to complex due to the variation of the used processing concepts. In this article, an innovative technique that utilizes tuned fuzzy intensification operators is introduced to expeditiously process poor quality images captured in an inclement dusty weather. Intensive experiments were carried out to check the processing ability of the proposed technique, wherein the obtained results exhibited its competence in filtering various degraded images. Specifically, it performed well in providing acceptable colors and unveiling fine details for the processed images. This study expanded upon earlier methods of low-light picture enhancement that relied on DCP. After the light reflection direction was initialised, it was refocused using the red channel estimate. Separating the region with strong lighting characteristics from the background darkness zone is another usage of DCP. The next step was to create and assess new anthropogenic light quality by estimating and refining transmission maps. An image free of black areas is also produced by recovering the picture light radiance using the updated transmission map data. The last step in achieving high-quality output images is using the denoising algorithm. Results from the ExDark dataset simulations shown that the proposed strategy achieved better subjective and objective performance than state-of-the-art methods.

Index Terms: Color cast, Color image enhancement, Degraded image, Dusty weather, Fuzzy Intensification(FI) operators, Dark channel prior (DCP)

I. INTRODUCTION

Pictures taken in bad, dusty conditions tend to have unwanted deterioration, such as low contrast, inadequate colours, or colour cast [1-3], which may have a major impact on the final product's quality. Dusty weather often causes a colour shift towards brown, orange, or opaque yellow in pictures [4]. In order to ensure the reliability of the collected pictures for subsequent interpretations, it is crucial to quickly handle such undesired artefacts. Many image processing and computer vision applications, including intelligent transportation systems, might be affected by these kinds of artefacts. [6], object identification, tracking, motion detection [5], and many more. Furthermore, these aberrations might greatly impair the ability to discern valuable information in the recorded pictures.

Fig. 1 The weather was dusty when images (a) and (b) were taken.

Figure 1 displays some photos captured during a dust storm. Therefore, it is crucial to provide a dependable processing method in order to get satisfactory outcomes in terms of quality [7]. The creation of tailored hardware or software may do this, with the latter being the more common choice. Typically, many picture restoration and enhancement approaches are included into the algorithms that operate in this domain [8]. Edge sharpening, deblurring, denoising, lighting, contrast, and colour enhancement are just a few examples of the numerous possible methods. Nevertheless, this function has made heavy use of contrast or colour enhancement approaches. Improving an image's visibility via increased contrast or colour fidelity is the goal of such procedures [9-10].

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II. LITERATURE REVIEW

In this part, you will find a brief summary of the literature about FI operators. A number of academics have studied these operators and put them to use in solving different problems in digital image processing; this much is known. The proposed research initiatives span the spectrum from very simple to very complex, reflecting the wide variety of real-world situations. The common thread across these investigations is the need to restore important details when fixing corrupted images[11-12].

S. Lam, A. Girardin and S. Srihari, “Gray-scale character recognition using boundary features”, Proceedings of SPIE 1661, Machine Vision Applications in Character Recognition and Industrial Inspection, vol. 98, February 09, 1992, San Jose, USA, pp. 98-105.

This article explains how to enhance images using grayscale optical character recognition, and the FI operators are a part of that process. N. Fang and M. Cheng, "An automatic crossover point selection technique for image enhancement using fuzzy sets", Pattern Recognition Letters, vol. 14, no. 5, pp. 397406, 1993. By using an improved FI operator with adaptive crossover element selection, this study enhanced digital image contrast, building upon the findings of Lam et al. (1992).

W. Lei and Q. Feihu, "Adaptive fuzzy Kohonen clustering network for image segmentation", International Joint Conference on Neural Networks, vol. 4, 10-16 July 1999, Washington, USA, pp. 2664-2667.

This article described the operators mentioned before in order to enhance image segmentation while decreasing computing cost.

III. EXISTING SYSTEM

Histogram equalisation, a spatial domain technique, ensures that all pixels in an image have the same brightness. The histogram of the final picture is therefore flattened and stretched in a consistent manner. Due to its simplicity and relative superiority over other conventional approaches, this methodology is often used for picture improvement paradigms. Histograms of input images are used to derive PDF and CDF, or cumulative density functions. The input picture's grey levels are replaced with the new ones using the two functions PDF and CDF. The processed image and histogram are then created. Grey level intensities are constantly extended and lowered when comparing the raw picture histogram to the processed image histogram. Consequently, the produced image has a regularly distributed histogram. Nevertheless, this enhances the perceived range of the actual greyscale. No matter what the input mean is, the processed image's mean brightness remains the middle grey level throughout the histogram equalisation method[13].

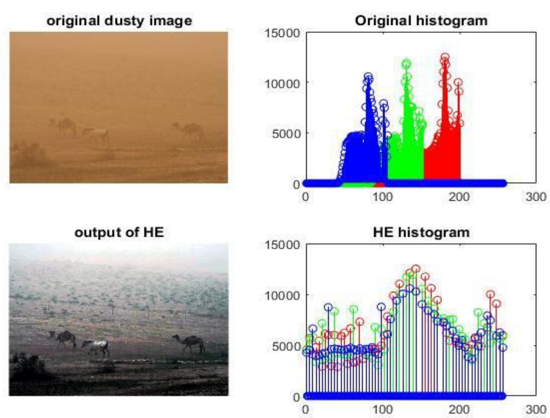

Fig. 2. Demonstration of HE for dusty weather image enhancement

The technique causes undesired visual deterioration, such the concentration effect, making it unsuitable for usage in consumer devices like television. There is a specific cause for this problem, and the solution lies in preserving the average brightness of the input picture within the output picture. One way to use HE to boost image contrast is as shown in Figure 2. Dynamic Histogram Equalization (DHE), which gained widespread use in 2007 [14-16], By regulating the amount of grey level spreading and separating the histogram at local minima, it is possible to objectively enhance the image's look by reducing the impact of higher histogram components on lower histogram components.

IV. PROPOSED SYSTEM

The problem with light reflection in the low-light shots is seen in Figure 3. Concerns over the state of the world's seas have prompted many large-scale research initiatives to investigate the issue [17]. Tracking the motions of marine organisms is done using the low-light video sequences. Photos taken in low light levels are ruined by the lack of contrast and colour saturation caused by the overpowering effects of low light levels.

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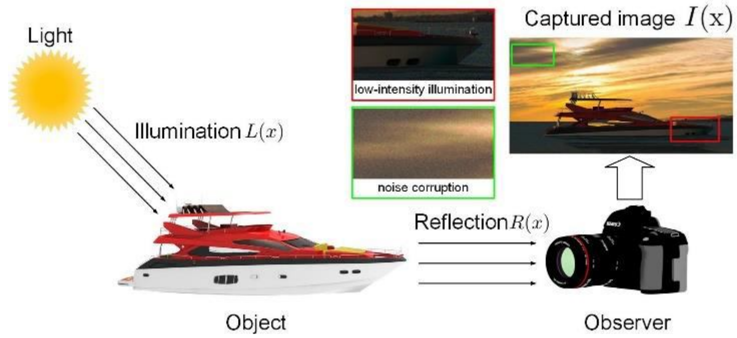

Figure 3. An difficulty with reflection in an image taken in dim light.

V. SYSTEM REPRESENTATION

Depending on the turbidity of the medium, low-light imaging can only be accomplished up to a certain depth of view. Unlike in an outdoor shot, the most black opaque pixel in this case need not be located on the horizon. In low-light conditions, getting the greatest intensity of black opaque pixels is therefore a formidable problem. Research done using imaging applications also makes low-light body characteristics like colour, shape, and texture more apparent due to the limited imaging range[18].

To reduce blocking artefacts and maintain crisp features near transmission discontinuities, this study used a pixel-level light removal method instead of a patch-based one. The suggested approach is shown in Figure 4 by the block diagram. When compared to outside situations, the darkness phenomenon seen in low-light settings is distinct. Instead of taking the average ambient light level A and applying it to the whole image, we tried separating it into the foreground and background images according to intensity, which reflects the disparity in darkness homogeneity[19-20]. The final product has a little depth effect while still seeming natural. After the darkness reduction method is applied to a DCP-based final image, it will naturally be darker. In post-processing, the usual approach to image normalisation is employed to boost the treated picture's overall brightness.

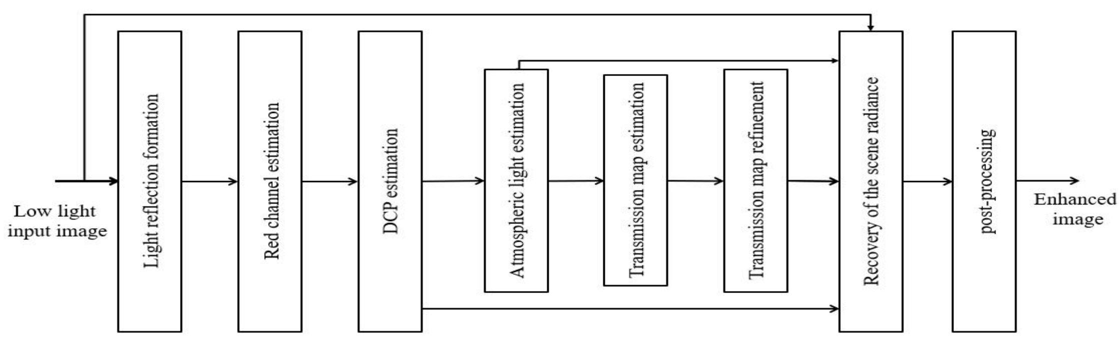

Figure 4. Schematic depicting the building pieces of the proposed approach

Enhanced attenuation of the red colour channel is a characteristic that might be used in this suggested study to determine the level of darkness. Secondly, in low-light photographs, details stand out more than in outside shots. It is common practise to shoot outdoor scenes from great distances, sometimes even reaching the horizon, while taking pictures. Darkness along the transmission channel causes the visibility to decrease with increasing distance from the objects to the camera. Compared to the low-light scenario, which produces the final output picture, the degree of detail under these circumstances is reduced[21-23].

VI. RESULTS AND APPLICATIONS

We go further into the simulation's findings here. Also, we use a variety of qualitative indicators to evaluate how well the suggested technique performs in comparison to state-of-the-art methods.

We used the Exclusively Dark dataset, which is comprised entirely of low-light images taken in visible light and annotated at the object and image levels, to circumvent this data constraint. In addition, by contrasting the representations of learnt and hand-crafted characteristics, we provide intriguing insights into how low-light affects the object identification task. Crucially, we found that low-light impacts go far further into features than "illumination invariance" alone. Together, this study and the Exclusively Dark project aim to inspire further research in the low-light realm across disciplines.

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Example of visual performance (Figure 5). One, the original picture; two, the DCP map; three, the darkened image; and four, the denoised image.

Picture 6. Input picture, DCP map, light-removed image, and denoised image are the visual components used to evaluate sample 2's performance. Figures 4 and 5 show how the proposed method effectively removes dark backgrounds from low-light images.

Metric	DWT [12]	SLAM [14]	LIME [15]	Proposed
Entropy	9.826076	9.975571	11.1846	12.032
MI	1.754657	1.868678	2.38377	2.5412
PSNR	31.1404	35.06779	36.3682	58.3312
SSIM	1.073064	1.108157	1.136643	1.25643
STD	0.0581	0.514197	0.0428	0.02583
QF	1.073064	1.133495	1.1933	1.28431
RMSE	0.020093	0.260817	0.01188	0.00049

Table 1. Impartial results on dataset

We assess the proposed method using a number of performance measures, such as q-factor, root mean square error, peak signal-to-noise ratio, SSIM, mutual information, and entropy (QF). Table 1 shows the mean objective performance on a set of dark images. According to the data in the table, the proposed method outperformed the standard DWT, SLAM, and LIME methods with respect to objective performance.

VII. CONCLUSION AND FUTURE SCOPE

This study expanded upon earlier methods of low-light picture enhancement that relied on DCP. After the light reflection direction was initialised, it was refocused using the red channel estimate. Separating the region with strong lighting characteristics from the background darkness zone is another usage of DCP. The next step was to create and assess new anthropogenic light quality by estimating and refining transmission maps. An image free of black areas is also produced by recovering the picture light radiance using the updated transmission map data. The last step in achieving high-quality output images is using the denoising algorithm. Results from the ExDark dataset simulations shown that the proposed strategy achieved better subjective and objective performance than state-of-the-art methods.

In order to repair damaged photos captured in very dusty environments, this study introduces a novel fuzzy logic-based visibility processing technique. An unique adjustment mechanism tailor-made for this technique, FI operators applied according to various thresholds, and a simple membership function that limits pixel values in a particular channel to integers are all part of the suggested approach. Each of the picture's colour channels goes through the processes listed above. The testing results show that the proposed method yielded outcomes that were lively, with refined colours and clear features. Visual comparisons of the processed and original images, together with analysis of the histograms provided for each, led to this result. Finally, this technology is expected to be expanded to tackle more damaged photographs captured in hazy, foggy, or misty environments.

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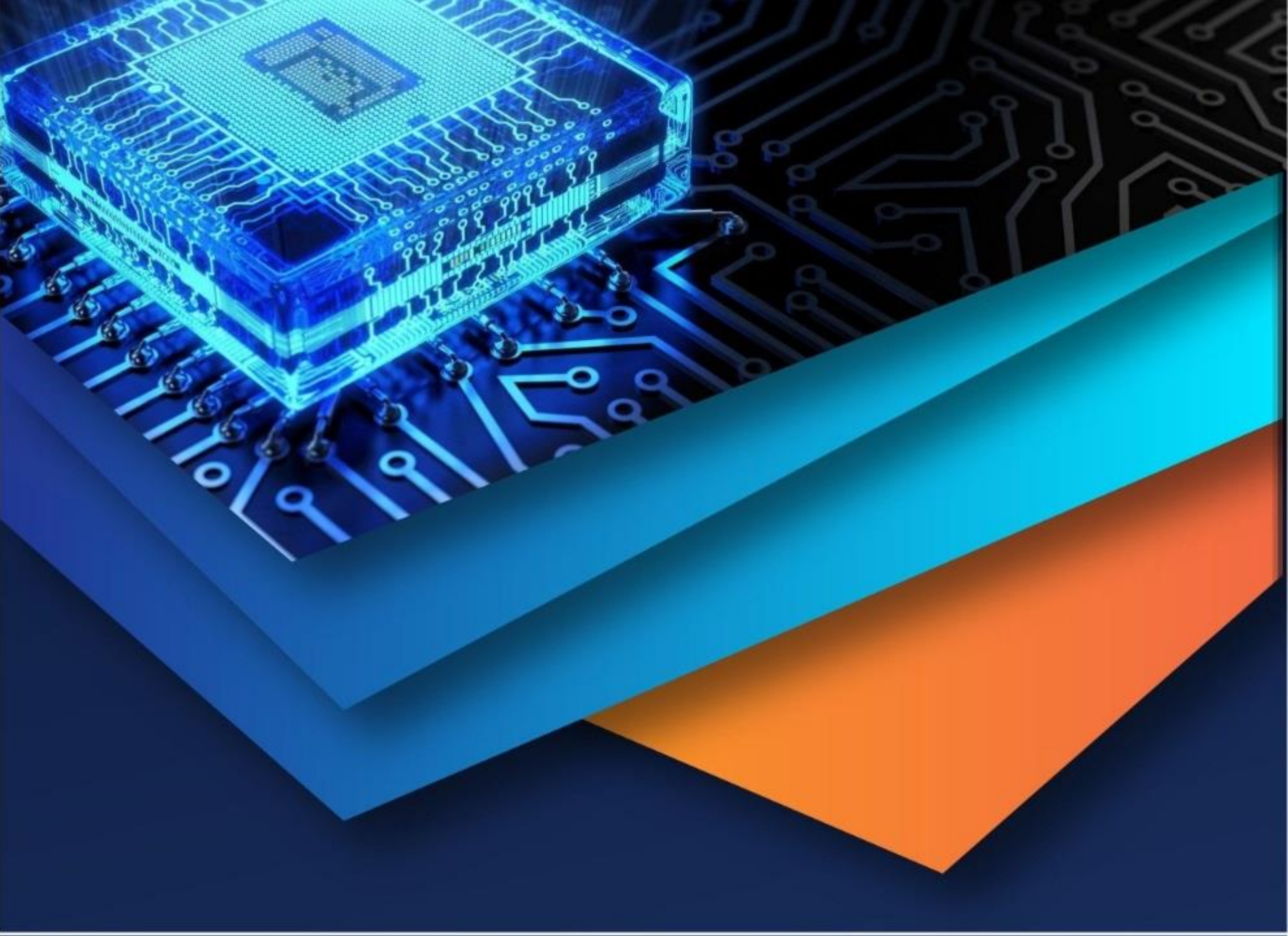

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