An Innovative Enhancement Approach for Images Acquired in Presence of Dusty Weather

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ABSTRACT

An inclement dusty weather can significantly reduce the visual quality of captured images, which consequently hampers the observation of important image details. Capturing images in such weather often yields undesirable artifacts such as poor contrast, deficient colors or color cast. Hence, various methods have been proposed to process such unwanted events and recover lucid 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 (FI) 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.

Index Terms: Color image enhancement, Degraded image, Dusty weather, Histogram equalization, contrast limit adaptive histogram equalization and Fuzzy intensification operators.

1. INTRODUCTION

An inclement dusty weather can altogether impact the nature of pictures since capturing pictures in such climate regularly prompts unwanted corruption, for example, poor complexity [1], lacking hues [2] or color cast [3]. As a rule, pictures caught during a dusty climate will encounter a shading shift towards a darker tone, orange, or hazy yellow [4]. Consequently, such undesirable antiques must be prepared proficiently to make caught pictures increasingly solid for further elucidations. Appropriately, such antiques can influence many picture handling and PC vision applications including, reconnaissance frameworks [5], astute transportation frameworks [6], movement location [7], object discovery [8], object following [9], etc. Furthermore, these antiques can extensively hamper the perception of valuable data in the captured images.Fig. 1 shows sample images taken in a severe dusty climate. Consequently, giving a dependable handling procedure is exceptionally required to get adequate quality outcomes [10]. This can be accomplished through the improvement of a particular equipment or determined programming, inwhich the last is favoured as a rule. For the most part, the plans that are engaged with this territory join various picture upgrade and reclamation procedures [11]. These systems may incorporate edge honing, picture deblurring, picture denoising, enlightenment improvement, complexity or shading upgrade and some more. In any case, difference or color improvement systems have been utilized broadly for this reason [1-3].

(a)

(b)

Fig. 1 Images (a) and (b) are captured in a dusty weather

The point of such procedures is to enhance the presence of a picture by furnishing a superior perceivability with an improved differentiation or shading constancy [12]. Lately, the examination in this field expanded because of the upsurge of dust storms and dusty climate conditions. The trouble of the presented techniques by prestigious scientists differs because of the variety of the utilized preparing ideas. In [1], the creators proposed a plan that uses an adjusted rendition of a histogram balance procedure in the fuzzy area, while in [3] the creators presented an imaginative Laplacian based perceivability upgrade plan to effectively illuminate the shading cast corruption. Furthermore, the creators of [11] exhibited a plan which procedures a given picture in a CIELAB shading space with a neighbourhood Laplacian channel to address the poor colors of a tainted dusty picture. In this article, the attention is on improving the shading devotion of pictures caught in a dusty atmosphere. The aforementioned can be accomplished by proposing an imaginative strategy that uses tri-limit fuzzy intensification (FI) administrators which are tuned by a novel adjustment technique. To test the productivity of the proposed strategy, serious examinations have been made with different true debased pictures procured from various sources and the got discoveries are given in the forthcoming sections.

The rest of this article is organized as follows: in Section II, a concise review about the use of fuzzy intensification operators by other researchers is given. In addition, a detailed clarification about the proposed method is provided in Section III, while in Section IV, the indispensable experimental results and their related discussions are presented. Finally, a brief closure is given in Section V.

2. PROPOSED METHODOLOGY

In this section, the proposed enhancement method is clarified in detail. Likewise, a brief portrayal for the used handling structure is given in Fig. 2. Going into subtleties, the proposed procedure begins with the gathering of zeta (ζ), which is a tuning parameter that is utilized to control hues fidelity of the prepared picture. At that point, the debased picture is inputted and crumbled into its fundamental channels of Red, Green and Blue (RGB). To figure the strengthening administrators, two variables are required. In the first place, the estimation of parameter tau (τ) which speaks to the thresholding furthest reaches of the administrators. The utilization of (τ) helps in handling picture pixels by the administrators. Second, membership capacity is required in light of the fact that it sets the pixels' estimations of an offered channel to the default go somewhere in the range of zero and one. This capacity must be executed with the goal that the escalation administrators can capacity well. The membership work for each channel is calculated as follows [13]:

$$f_R = \frac{[r - min(r)]}{[max(r) - min(r)]}$$

$$f_G = \frac{[g - min(g)]}{[max(g) - min(g)]}$$

$$f_B = \frac{[b - min(b)]}{[max(b) - min(b)]}$$

Where $\{f_R, f_G, f_B\}$represent the output of the membership functions for the Red, Green and Blue channels. $\{r, g, b\}$ represent the inputted Red, Green and Blue channels. $\{min, max\}$ represent the minimum and maximum pixel values of the inputted channel.In many image processing applications, FI operators have been used to improve the contrast or color fidelity of a given image [14] operator for each channel is computed as follows [15]:

$$k_R = \begin{cases} 2*(f_R(x,y))^2, & if \quad f_R(x,y) \le \tau_R \\ 1-2*(1-f_R(x,y))^2, & otherwise \end{cases}$$

$$k_G = \begin{cases} 2*(f_G(x,y))^2, & if \quad f_G(x,y) \le \tau_G \\ 1-2*(1-f_G(x,y))^2, & otherwise \end{cases}$$

$$k_B = \begin{cases} 2*(f_B(x,y))^2, & if \quad f_B(x,y) \le \tau_B \\ 1-2*(1-f_B(x,y))^2, & otherwise \end{cases}$$

where, $\{\tau_R, \tau_G, \tau_B\}$ are predetermined scalars with the values of 0.5, 0.6 and 0.4, respectively. $\{k_R, k_G, k_B\}$ represent the processed channels by intensification operators. $\{x, y\}$ are spatial coordinates. $\{f_R(x,y), f_G(x,y), f_B(x,y)\}$ are pixels of the inputted RGB channels. Once these operators are applied, the obtained result of each channel is then tuned using the proposed tuning method, which can be expressed as:

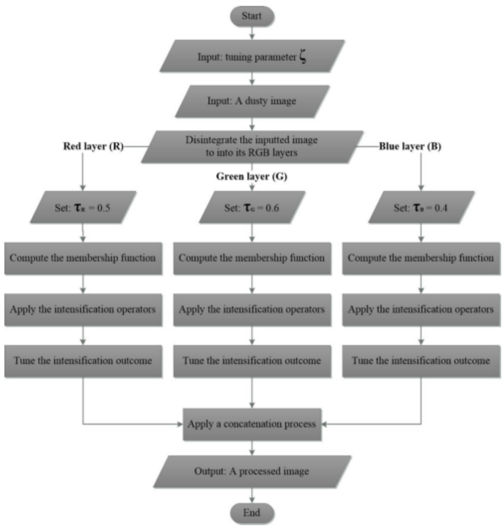

Fig. 2 Proposed visibility enhancement system

$$u_R = (k_R)^{\tau_R + \zeta}$$

$$u_G = (k_G)^{\tau_G + \zeta}$$

$$u_B = (k_B)^{\tau_B + \zeta}$$

Thereafter the tuned outputs $\{u_R, u_G, u_B\}$ are concatenated to form the coloured image which represents the final output of the proposed technique. In image processing context, concatenation is the process of linking coloured channels together in such a way that the output is a single coloured image. The concatenation process is achieved using a $\{cat\}$ function in MATLAB. The proposed technique was implemented with a 2.3 GHz core i5 processor and an 8 GB of memory. As a summary, refer to the subsequent framework for a visual illustration about the proposed processing technique.

3. RESULTS AND DISCUSSION

In this section, the results, talks and arrangements of PC analyses are accounted for. The proposed procedure was assessed utilizing a dataset of normally debased shading pictures of various scenes caught in a nasty dusty climate. The dataset pictures were gathered from various sources over the web. For appraisal purposes, it is prescribed to utilize an unbiased and particular examination strategy so as to assess the degree of improvement for the handled pictures. In this way, different surely understood examination strategies were concentrated to assess the exactness, shading devotion and complexity of dusty pictures. Nonetheless, none of these techniques conveyed important outcomes with the normally debased pictures, in that they conveyed unreasoned yields that don't coordinate with the genuine watched pictures. In this manner, the histograms for each of the corrupted and the improved pictures were given to demonstrate the accomplished upgrade utilizing the proposed method. Likewise, visual assessments remain the best strategy to gauge the degree of improvement in shading pictures. The proposed strategy was tried with various certifiable debased pictures and a few consequences of such are shown in Fig. 4 and Fig. 5.

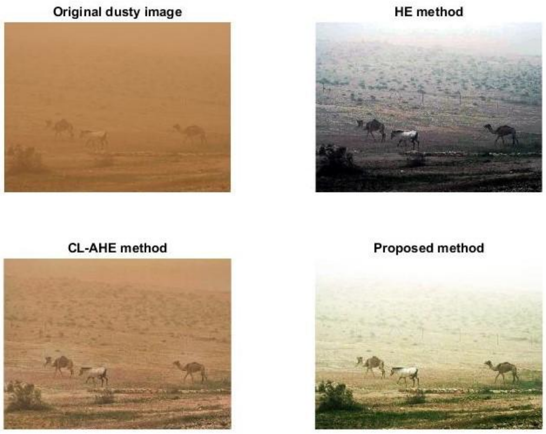

Fig. 3 Obtained enhanced image of dataset 1 using existing and proposed methodologies

From the acquired experimental results, it very well may be seen that the proposed method performed well as far as hues recuperation and visual quality, as these perspectives improved hugely contrasted with the first perceptions. By contrasting the histograms of the first and the prepared pictures, it very well may be seen that there is a tremendous distinction as far as hues dispersion. The histograms of the first pictures demonstrate an unsound appropriation, where the hues are constrained in a specific range. Such irregular conveyance demonstrates that the visual nature of these pictures is seriously debased. In any case, the histograms of the prepared pictures demonstrate a critical improvement in the portion of hues, where they become all around disseminated to the whole range. This is noteworthy in light of the fact that it shows that the recuperated pictures have better color quality. Hence, such satisfactory results are practical for use with various genuine picture handling applications. Building up a speed up strategy that proficiently recuperate clear outcomes and divulge improved picture subtleties with satisfactory hues is basic. Such a task is plainly cultivated, in which thedisplayed outcomes are clearer and consequently give a larger number of subtleties than their original counterparts.

Fig. 4 Obtained enhanced image of dataset 2 using existing and proposed methodologies

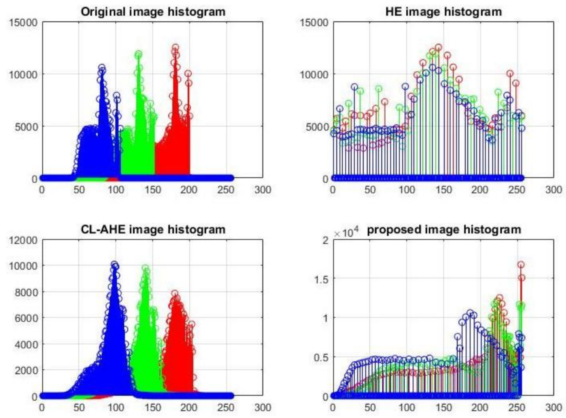

Fig. 5 Histogram outputs of dataset 1 with existing and proposed enhanced approaches

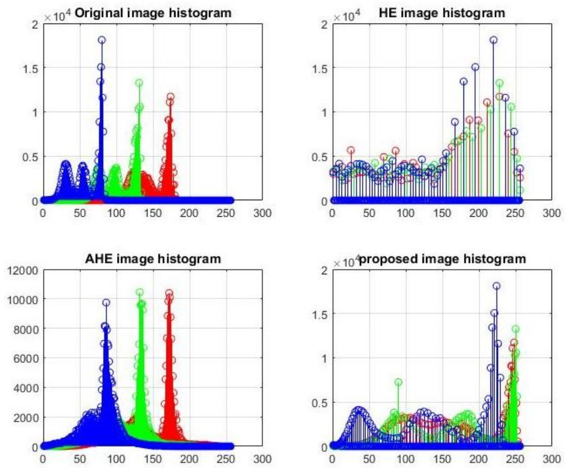

Fig. 6 Histogram outputs of dataset 2 with existing and proposed enhanced approaches

Fig. 5 and Fig. 6 discloses the obtained color histograms for the dataset 1 and dataset 2 using existing HE, CL-AHE and proposed enhancement approaches. It can be noticed that histogram of proposed approach produced equalized distribution of R, G and B colors with normalized range compared to HE and CL-AHE approaches. Further, visual enhancement is also demonstrated in terms of image quality assessment metric called peak signal-to-noise ratio (PSNR). As shown in Fig. 7, proposed enhancement approach got a PSNR of 52.49 dB and 52.33 dB for dataset 1 and dataset 2 respectively while the existing HE and CL-AHE got very lower values compared to it.

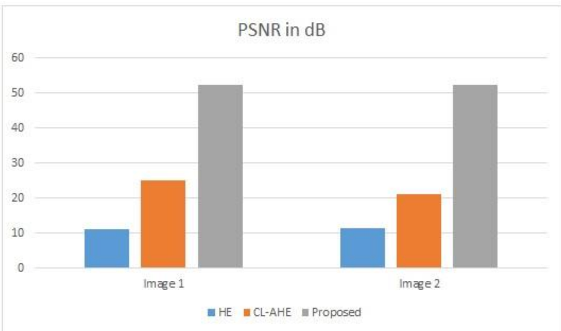

Fig. 7 Performance comparison of PSNR with existing and proposed enhancement approaches

4. CONCLUSIONS

An innovative fuzzy based detectable quality getting ready technique is familiar in this article with improve the visual idea of undermined pictures discovered during an unforgiving dusty atmosphere. The proposed system utilizes a direct support work that sets the pixels' estimations of an offered channel to the range some place in the scope of zero and one, FI overseers that are associated depending upon different edges and a novel change methodology, which is organized unequivocally for this strategy. The previously mentioned frameworks are associated with each concealing channel of the took care of picture. Exploratory results showed that the proposed framework gave striking results refined colors and clear features. This deduction came through performing visual assessments between the primary pictures and their readied accomplices similarly as by understanding the offered histograms to each image. Finally, it is acknowledged that this strategy can be extended to process other dusty or degraded pictures taken in diminish, foggy or cloudy weather conditions.

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