Improved Air Light Estimation Algorithm by Using Fuzzy Filters and Dark Channel with Large Haze Gradients

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ABSTRACT

Fog phenomena bring about air flow gentle generating and also decline this awareness involving made from photograph caught in the camera. To increase awareness, air flow gentle evaluation is essential regarding photograph errors removal. As air flow gentle can be quite dazzling, this conventional methods immediately select dazzling p regarding air flow gentle estimation.In this paper improved/hybrid fuzzy filters based haze removal algorithm is proposed. The dark channel prior can automatically extract the global atmospheric light and roughly eliminate the atmospheric veil. To make dark channel prior more effective, the atmospheric veil has been refined by using hybrid fuzzy filters as well as it able to produce a haze free image in more optimistic manner. The use of improved/hybrid fuzzy filters has improved the coarse estimated atmospheric veil by reducing halo artifacts

Keywords: Image defogging; Dark channel prior; Air light Estimation; Fuzzy filtering.

I.   INTRODUCTION

Poor visibility turns into a problem for many out of doors eyesight applications. Negative climate brought on by atmospheric allergens, including haze, haze, etc., may considerably reduce the visibility and overlook the colors from the scene. The following as a result of the examples below 2 scattering techniques
(i) Light reflected from the surface of item can be attenuated caused by scattering by simply dust; and also
(ii) Some of light flux is definitely spread toward a camera

A.   Image Defogging Effect Assessment

The CNC index, a powerful defogging review sign which often is beneficial in order to slowly move the parameter adjusting procedure [4]. With the source hazy image x and the unique equivalent fog free picture y, the CNC index is received just after undertaking these kinds of steps**:**

* Calculate the velocity *e of seen tips* soon after as well as previous to haze elimination.
* compute the picture colour naturalness index (CNI) and colour colorfulness index (CCI) to measure the colour naturalness of fog free image **y**, and
* Merge several components *e*, CNI in addition to CCI in order to provide an overall defogging consequence.
  CNC(x, y) =h (e(x, y), CNI(y), CCI(y))

For the entire deviation trend of these three indexes, the statistical outcomes depict that the maximum value of CNI curve holds the normal outcome, but it is not inevitably the most effective fog removal impact. Nevertheless, the most effective outcome should have excellent naturalness (high CNI value). Once the picture is over-enhanced, the color is usually deformed, in addition to CNI fails swiftly. With regard to *e* and CCI, they have the most effective influence before getting to their particular highs. Once the picture is over-improved, the curves keep on climbing. Right after attaining the highs, these arcs begin to decrease. Hence, in event of the raising trend of *e and CCI* (from their total capability result issues, hence, to their arc's peaks) often results in negating the falling-trend of CNI, as well as top of CNC arc may be close to the real most effective result level. At the same time, the actual value variant associated with CNI is usually compact, this is among one of *e* and CCI is rather high. Hence, a result of *e* and CCI around the CNC catalog ought to be lessened. This CNC index among graphic x and **y**, i.e. the function *h* in (1) may be considered as:
    CNC(**x, y**) = e(**x, y**) 1/5 · CNI(**y**) + CCI(**y**) 1/5 · CNI(**y**)

As described above, a superb outcome can be tagged by the important valuation on CNC. Hence, the best outcome of the two main factors of defogging algorithm is found once the CNC index defines the greatest value.

B. Differential evolution

Differential Evolution (DE) is a parallel direct search method which utilizes NP D-dimensional parameter vectors

$$X_i G_i = 1,2,...NP$$

NP doesn't modify over the minimization process. The original vector inhabitants are chosen randomly and will handle the complete parameter space. As a rule, we shall think your standard odds distribution forall haphazard judgements except in cases where in any other case stated. Should a preliminary option is offered, the original human population might be earned by building typically distributed haphazard deviations to the small alternative by nom;0. DE yields fresh parameter vectors by building a measured distinction between a pair of human population vectors to a 3 rd vector.

C. Adaptive histogram equalization

The histogram of a photo symbolizes the comparative consistency connected with likelihood connected with dreary quantities in the image. Histogram modelling techniques transform a photo in order that their histogram has a desired shape. This is useful for extending the low-contrast amounts of a photo by using a small histogram, in that way achieving distinction enhancement. Inside histogram equalization (HE), the target is definitely to get a even histogram for that end result picture, in order that a strong "optimal" over-all distinction is definitely perceived. Having said that, the function of curiosity in a picture could need enlargement locally. And also tension wasn't any loss of delectability connected with simulated low distinction stay metastases for a professional visitor [5], radiologists continually discover each side the HE superior illustrations or photos being objectionable in the many of them expose unhealthy artifacts and disturbance [6]. Flexible Histogram Equalization (AHE) computes the histogram of a area home window structured in a supplied pixel to ascertain the maps to the pixel, that provides a local distinction enlargement [7].

D. Visibility Restoration Technique

Regarding eliminating haze, haze with the graphic various tactics are usually used. Regular tactics involving graphic recovery towards haze are usually:

• Dark Channel Prior

Dark channel prior can be useful for your opinion regarding atmospheric gentle within the dehazed impression to discover the much more real result. This approach is mainly useful for non-sky areas; in one coloring funnel have got nominal intensity from couple of pixels. Time frame intensity at midnight funnel can be main 3 factors:

a) Shadows (shadows of car, buildings etc)
b) Dark items or surfaces (dark tree trunk, stone)
c) Colorful items, surfaces

For the reason that out-of-doors illustrations or photos are generally stuffed with eye shadows the dark stations of illustrations or photos are going to be really dark.

Because of errors (air light), a foggy photo is usually happier in comparison with the photo without the need of fog. So that we know dimly lit route involving foggy photo are going to have increased high intensity inside area using increased fog. So, aesthetically a power of dimly lit route is usually an uncertain appraisal with the thickness involving fog. Inside dimly lit route before we apply before along with write-up processing actions pertaining to obtaining results. Inside write-up processing actions we apply soft matting as well as trilateral filter etc.

• Clahe

Contrast restricted versatile histogram equalization small type is usually CLAHE. Contrast Limited Flexible Histogram Equalization (CLAHE) is usually used in advancement involving low distinction images. This procedure doesn't have almost any believed temperature details for any handling involving fogged image. To begin with, the style seized by means of you in foggy problem is usually converted via RGB (red, environment friendly along with blue) coloring living space is usually changed into HSV (hue, saturation along with value) coloring space. The pictures are generally converted due to the fact the human being sense colors in the same way while HSV characterize colors.

• Bilateral Filtering

Bilateral filtration smoothes illustrations or photos looked after saves tips, having nonlinear combination of neighborhood impression values. Bilateral is definitely low iterative, community, and also simple. Grayish

ranges or hues are usually merged by way of the bilateral separate out dependant on both its mathematical area along with their photometric related, and also likes close up values for you to distant values in the domain name and also range. Bilateral separate out sleek tips in the direction of piecewise consistent solutions. Bilateral separate out does not offer healthier sounds reduction.

- Trilateral Filtering

This specific filtration smooth's illustrations or photos without having impacting perimeters, by way of the non-linear mix of neighborhood photo values. Around the heap filter switches every pixel by weighted averages of that neighbor's pixel. The load allotted to each neighbor pixel lessens having the range in the photo airline and also the range to the severeness axis. This filter allows us to obtain result quicker while rival other. When using trilateral narrow all of us employ pre-processing along with publish producing ways with regard to greater results. Histogram stretch is utilized while post-processing along with histogram equalization as a before processing. [4]

- Fuzzy Filtering

The idea driving this filtering is usually to normal your pixel using additional pixel ideals by reviewing the neighborhood, however simultaneously to address critical image structures just like edges. The main priority from the recommended filtering is usually to distinguish between regional variations as a result of noises in addition to as a result of image structure. Your order to accomplish this, each pixel all of us derive a price in which communicates their education where the mixture within a particular path is usually small. This kind of a price is usually derived each path equivalent on the nearby pixels from the refined pixel by way of fluffy rule.

II. RELATED WORK

Atta, et al [1] examined blunders phenomena result in fresh air light-weight get older in addition changed for the worse the field of perspective together with coupled with effect grabbed inside camera. To further improve area associated with perspective, fresh air light-weight quote is essential suitable for effect errors removal. Whenever fresh air light-weight is reasonably brilliant, a fliers as well as business card printing instantly settle on brilliant pixels suitable for fresh air lumination estimation. Bhandari, et al. [2] discussed the way in which lots of simple picture defogging methods accomplish working with a color ellipsoid framework. That formula makes use of enhanced Gaussian union layout to enable you to take into account numerous combinations offering pure instinct in many challenging paying attention a glass windows, like observations in degree discontinuities which was 1 prevalent overuse injury in simple picture defogging. Pathak SS et al. [3] have tried to think about that may, the best ways movie press collection improved for the more serious just by faults endure negative visibility. A new variance minimal flexible histogram equalization (CLAHE)-based procedure began to remove fog. CLAHE determines some sort of the greatest worth so that you can sneak peek this histogram as well as redistributes this linked pixels just as so that you can each dreary level. Ghosh, et al. [4] mentioned that the image resolution along with lousy weather conditions are normally severely improved for your even worse by scattering resulting from dangling allergens in the establishing such as haze, problems in addition to mist. Your fresh new speedy defogging method from a single graphic of the world with different speedy bilateral filtration technique ended up utilized. Ji X, et al. [5] discussed about the development coming from the concept of vision associated with ocean haze pictures in the unmanned expanse ship picture procedure, this work introduced some kind of publication defogging process based on a marriage strategy. The ultimate defogging result's got utilizing a simple enough bright firmness process. Agarwal TK ,et al. [6] discussed just about any excellent pixel answer to the prices within the skies additionally non-sky sections, that lets you mitigate your own halo bedroom throughout the sharpened tips lowering shading physique distortions above region. Negi SS, et al. [7] used the multi-scale stiffness thoughts games formula in order to approximation that atmospheric veil, so that you can shape an awful strengthen plus sort the form a contrast regarding information during different scales. An item can bring about pitiable outcome after does not recognize your regional maxima in addition to local minima accurately. Bouaziz A, et al. [8] discussed photographs transformed for that more serious using haze be afflicted by inferior contrast. So that you can get haze have an effect on, almost any Variety the contrast Small Multipurpose Histogram Equalization (CLAHE)-based approach became presented.

III. METHODOLOGY

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│                    Input image                      │
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│   Apply differential evolution based dark channel prior │
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│      Apply adaptive histogram equilization on R,G and B │
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│                Concatenate each channel             │
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┌─────────────────────────────────────────────────────┐
│                    Final image                      │
└─────────────────────────────────────────────────────┘
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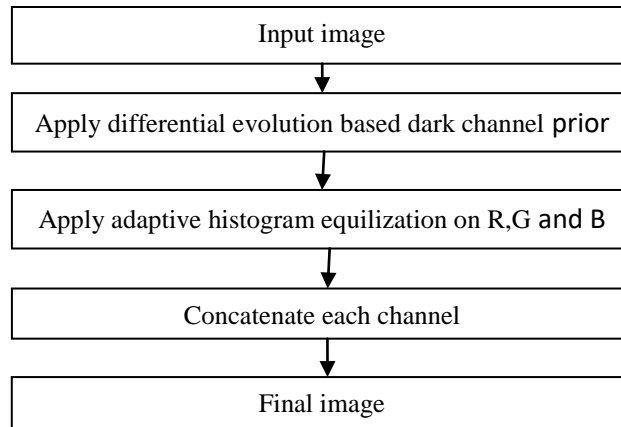
Fig2. Flowchart of the proposed technique

1. In the initial phase, various underwater, remote sensing and road side images will be taken for experimental purpose from various datasets available on internet. and the format of the images will be jpg, png etc.
2. In this phase some well known existing algorithms will be designed and implemented using a suitable tool like MATLAB, JAVA etc
3. In this phase in order to improve the coarse estimated atmospheric veil by using different improved/hybrid filters will be implemented in order to remove the hallo artifacts and to preserve significant detail of restored images with large haze gradients
4. In this phase, the proposed technique will be tested and verified for the secondary data set of road side, underwater and remotely sensed images.
5. Finally, comparative analysis will be developed for the vision research community.

IV. RESULTS

For experimentation and implementation the proposed technique is evaluated using MATLAB tool u2013a. The evaluation of proposed technique is done on the basis of following parameters i.e. Entropy, PSNR, MSE, based on different images.

(a)input img   (b)Existing img   (c)Proposed img

These foggy images have been taken from the google website the images are Landsat foggy image, modis foggy image etc.

A. MSE (Mean Squared Error) -Mean square error will be to compute one indication through subtracting quality indication through the reference, after which it computing the standard power in the blunder signal. It can be explained as:

$$MSE = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}(f(i,j) - f^{'}(i,j))^2$$

Where j(s) is the global normalized histogram of the processed image, i is the brightness level index, pi is the probability of occurrence of level i in the enhanced image

Table1. Mean Square Error

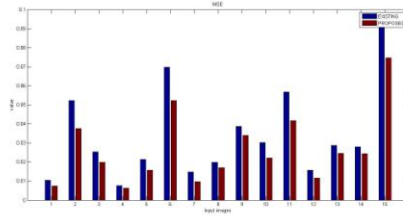| IMAGES	MSE exiting	MSE proposed
1	0.010441	0.0074939
2	0.052299	0.037504
3	0.025238	0.019927
4	0.007563	0.0063939
5	0.021295	0.015651
6	0.069858	0.052203
7	0.01487	0.0096616
8	0.019892	0.017061
9	0.038723	0.034069
10	0.030221	0.022114

Fig 3. Mean Square Error

B. BER (Bit error rate) - It is defined as the rate in which faults arise inside of a transmission system. This really is immediately converted into the quantity of faults of which arise inside of a chain of a mentioned variety of bits. The definition of bit error rate can be translated into a simple formula:

$$BER = \frac{Number\ of\ errors}{Total\ number\ of\ bits\ sent}$$

Table2. Bit Error Rate

IMAGES	BER (existing)	BER (proposed)
1	0.014718	0.014413
2	0.016408	0.016028
3	0.015598	0.015352
4	0.014421	0.014271
5	0.015421	0.015109
6	0.016754	0.016406
7	0.015059	0.014646
8	0.015351	0.015195
9	0.016064	0.015922
10	0.015791	0.01546
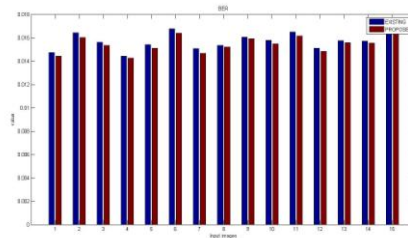
Fig4. Bit Error Rate

C. Normalized cross correlation
Normalized Cross-Correlation (NCC) should to be close to1, therefore planned algorithm is showing better effects compared to the available techniques as CC is near to 1 in every case.

$$NCC = \sum_{i=1}^{a} \sum_{j=1}^{b} (M_{ij}\ N_{ij}$$

Table 3. Analysis of Normalized cross correlation

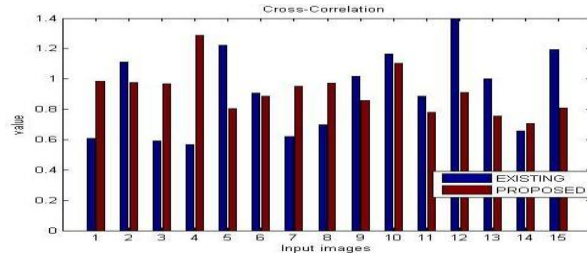| IMAGES	NCC (existing)	NCC (proposed)
1	0.97828	0.98559
2	0.97659	0.98397
3	0.9774	0.98465
4	0.97858	0.98573
5	0.97758	0.98489
6	0.97625	0.98359
7	0.97794	0.98535
8	0.97765	0.9848
9	0.97694	0.98408
10	0.97721	0.98454

Fig5.graph of NCC

Figure 5 is showing the quantized analysis of the Cross-Correlation of different images using existing method (Pink Color), proposed method (blue Color). It is very clear from the plot that value of CC is close to1 in every case with the use of proposed method over other methods. This represents improvement in the objective quality of the image.

D. Contrast gain

Contrast gain for all haze removals algorithms ought to be positive. Great form a contrast obtain indicates much better effectiveness in the algorithm. Distinction obtain is a [27,28] signify form a contrast distinction between de-foggy and also foggy image. In the event that CIdef and also CIfog tend to be signify form a contrast associated with de-foggy and also foggy graphic respectively, then contrast gain is defined as.

$$C_{gain} = \overline{C}_{Idef} - \overline{C}_{Ifog}$$

Table 4. Contrast gain

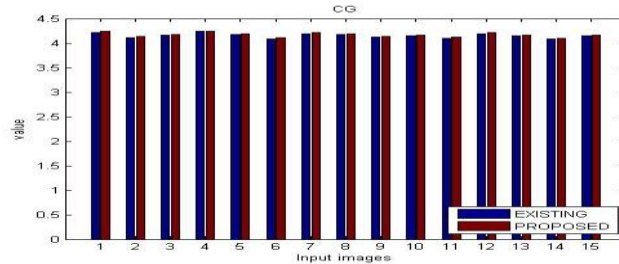| IMAGES	CG of existing work	CG of proposed work
1	3.7187	4.2397
2	3.61	4.1334
3	3.6606	4.1765
4	3.7391	4.2495
5	3.672	4.1925
6	3.5891	4.1101
7	3.6958	4.2236
8	3.6766	4.1868
9	3.6312	4.1401
10	3.6483	4.1695

Fig6. Graph of contrast

E. NSP(Number of Saturated Pixels)

The pixels of the output image become saturated so contrast gain should not be so high Therefore, together with the substantial comparison attain, it is usually required to determine the quantity of soaked pixels. Portion of your soaked p σ can be denoted while wherever in can be the quantity of p which have been soaked (either entirely dark-colored or perhaps white) following restoration yet were not before. Lower importance of σ shows better overall performance of the algorithms.

$$\sigma = \frac{m}{(M \times N)} \times 100$$

Table 5. Analysis of number of saturated pixels

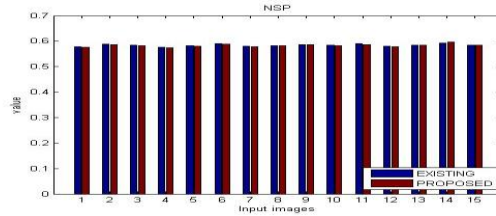| IMAGES	NSP (existing)	NSP(proposed)
1	0.82813	0.57603
2	0.839	0.58666
3	0.83394	0.58235
4	0.82609	0.57505
5	0.8328	0.58075
6	0.84109	0.588899
7	0.83042	0.57764
8	0.83234	0.58132
9	0.83688	0.58599
10	0.83517	0.58305

Fig7. Graph of NSP

F. PSNR(Peak square noise ratio)
Peak square noise ratio is the ratio between the maximum possible value of the signal and the power of the corrupting noise. It is measured in decibels (db). It can be explained as:

$$PSNR = 10.\log_{10}\left(\frac{MAX_I^2}{MSE}\right)$$

Table 6. Peak square noise ratio

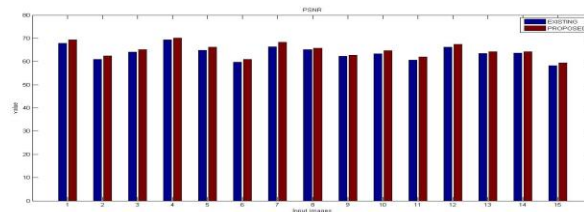| IMAGES	PSNR (existing)	PSNR (proposed)
1	67.9435	69.3837
2	60.9458	62.39
3	64.1103	65.1363
4	69.3439	70.073
5	64.8479	66.1853
6	59.6886	60.9538
7	66.4076	68.2803
8	65.144	65.8108
9	62.2511	62.8072
10	63.3277	64.6842

Fig8. Graph of psnr

V.   CONCLUSION

This paper has proposed the improved air light estimation algorithm by using fuzzy filters and dark channel prior to preserve significant detail of restored images with large haze gradients. It has been designed and implemented in Matlab tool 2013.The comparison of various parameters like Peak signal to noise ratio, Median angular error, Mean square error, Root mean square error, Cross correlation has been taken which has been improved the coarse estimated atmospheric veil by reducing halo artifacts as well as it is able to produce the haze free image in more optimistic manner.

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