A Novel Fog Detection Technique for Image Enhancement

Ashok Kumar Shrivastava, Sanjay Jain

***Abstract:** Under foggy weather conditions, images taken by digital camera suffers from* **contrast and color shading and debased drastically, which causes an accident on road, in sea and in air. To eradicate the number of accidents on road, in sea and in air through vision improvement in turbid weather, methodical fog eradicate technique plays significant role. But there are few algorithms that can judge whether the current scene has fog or not. The existing fog eradicating techniques only have the capability to restore a debased image. Image enhancement algorithm should be judgmental enough to decide whether it has to process the image or not. So it is important to overcome this difficulty. Our paper introduces a novel fog detection technique for image improvement. The goal of the proposed algorithms is to reduce the unnecessary overhead of the vision enhancement technique in processing of the fog free image.**

Index Terms: Turbid weather, Pixel value, Visibility test, Fog detection.

I. INTRODUCTION

On ground and sea both fog and haze are the common facts. In foggy and dim climate, there are numerous air speck of notable size. In this way, the picture gained by the camera is debased and for the most part has low differentiation and poor perceivability [1], [2]. To clear the picture, defogging methods are in every case directly try on the picture, paying little respect to the appearance or nonappearance of fog. However, in real-life applications, it is important to know whether the picture procured in the present condition should be handled by a defogging technique. The fundamental reason is as per the following: perceivability of the re-established picture gained by the defogging technique might be more regrettable than the first picture if no judgment is made [3]. Likewise, the utilization of the defogging technique is tedious, or, in other words to understand the continuous target finding, tracking, and recognition.

II. BACKGROUND

Two technique exist in previous work, which can pass judgment on the existence or nonexistence of fog in scene. The main technique is fog finding strategy which consider the imperceptible zone in the picture as foggy region. The second technique is classification of foggy picture.

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A. Detection of Foggy Region in Images

Two techniques can distinguish the foggy regions of the picture. The main strategy depends on the semi-inverse picture, and the second strategy depends on the meteorological perceivability distance.

1) Semi-Inverse Picture Based Foggy Region Detection

Ancuti et al. first proposed a foggy region detection technique depends on the 'semi-inverse' image [4]. The semi-inverse picture S is obtained by choosing the most extreme of the first picture pixel and its inverse picture pixel which is detailed as

$$S^c(x) = \max\,[I^c(x), 1 - I^c(x)] \quad (1)$$

where c represents one of the RGB channels, I is very first picture, and $1 - I^c(x)$ represents the inverse picture of the very first picture.

In the wake of renormalizing the inverse picture, Ancuti recognized the foggy region. foggy region finding strategy depends on the way that the intensity estimations of pixels in the foggy zone of the picture are typically significantly greater than those of pixels in the clear region. In the sky or foggy region of a picture, pixels for the most part have a high intensity in all shading channels, In the sky or foggy zones of a picture, pixels typically have a high power in all shading channels. Therefore, the semi-inverse picture will have indistinguishable incentive from the first picture in these regions. In any case, in clear regions, there is somewhere around one channel of the semi-inverse picture where pixel esteems will be supplanted by the inverse picture. In the other words, the yield of (1) is separating the first picture in foggy regions and the inverse picture in clear region. At that point the foggy zone can be effectively recognized by the distinction between the first picture and its semi-inverse picture. This method is straightforward and powerful for finding of foggy regions in foggy pictures, yet it isn't reasonable for the judgment of whether the present scene has fog or not. This is on account of the sky zone or white region of an unmistakable picture will be confused for a foggy region through this method.

2) Meteorological Visibility Distance Based Foggy Region Detection in Image

For a foggy picture, Hautiere and Tarel. proposed a daytime foggy region recognition method by means of computing the meteorological perceivability gap [5]. They originally utilized the

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Canny-Deriche channel to separate the picture forms in order to feature the edges of roadways. At that point the region growing method was performed to find the road surface layer.

Then, they set up four conditions to get the objective region. At long last, the perceivability gap of the picture was secure by computation of bandwidth calculation. Hautiere and Tarel utilized a horizontal line to signify the perceivability gap. Bronte et al. additionally distinguished the foggy region of a picture by means of evaluating the perceivability gap [6].

The fog recognition technique dependent on the meteorological perceivability distance partitions the foggy picture into two areas: obvious detectable and undetectable region. Despite the fact that the haze recognition technique can identify the foggy region in pictures, it additionally has few limitations. The imperceptible region over the level line of the picture does not implies that it ought to be totally relegated to the foggy region. Some inaccessible scenes of natural clear pictures likewise look hazy and might be confused for imperceptible regions or foggy region by the fog recognition technique. In addition, for some foggy pictures with inhomogeneous mist diffusion, it is difficult to identify level line to divide the foggy region and clear region. However, the meteorological perceivability distance can be utilized to pass judgment on which region has thin haze or thick haze.

A. Classification Technique of Foggy Images

The foggy picture classification technique needs to build up a picture library which contains a lot of clear pictures and foggy pictures. The strategy separates a few characteristics which have vast contrast between the two sorts of pictures, and afterward utilizes a successful classifier for training the attributes and acquire the grouping hyperplane. At last, a question picture can be named a foggy picture or clear picture. The flowchart of foggy picture classification is depicted in Fig.1

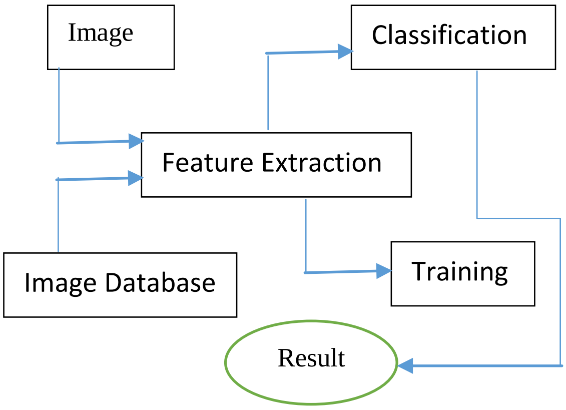

Fig. 1 The flowchart of foggy picture classification [21]

In the haze classification technique, the attributes are the most salient and straightforwardly decide the classification exactness. There is no attribute that can precisely categorise the foggy picture and clear picture. Li et al. brought up that for picture perceivability, dark channel's intensity and picture contrast could be utilized as an element for the categorise the foggy and clear pictures [7]. Yu et al. extracted the picture perceivability, the picture visual contrast, and the intensity of the dull channel picture as attributes and utilized the support vector machine (SVM) for foggy picture classification [8].

Exploiting the barometrical dispersing model, Zhang took the angular deviation between each foggy picture and clear picture of indistinguishable scene from characteristics for foggy picture order [9]. They likewise utilized the SVM to order the foggy picture. Despite the fact that their technique can acquire great classification performance, it is difficult to at the same time get a reasonable picture and foggy picture of a similar scene in true applications. Pavlic provided a foggy picture classification method by utilizing the worldwide characteristics, as far as the ability scope of the Fourier transform and the SVM for vehicle visual framework on highways [10]. Table- 1 shows the summary of fog detection techniques.

Table 1 Summary of fog detection techniques

S. No.	Reference	Limitation/ Advantages
1	[11]	Works efficiently on high resolution image.
2	[12]	Fog detection done through super resolution reconstruction technology.
3	[13]	Applicable only for specific cases but not for general.
4	[14]	Fog detection limited to day time only.
5	[15]	Fast, gives exact output by utilizing low cost stereo cameras sensor and, able to work with moving cameras.
6	[16]	Only work for No Fog, Low Fog and Dense Fog labelled images, not work for white background images.
7	[17]	Day time fog detection, not capable to detect fog from low clouds.
8	[18]	Work better only that roads are not very crowed.
9	[19]	Fail in foggy sequence, detect fog when sun is very bright, fail in dense fog
10	[20]	Algorithm is able to detect fog in day/night, dark/lit environment

III DETECTION OF FOG

Detecting fog in images is trivial task. In proposed technique, threshold values are used to check visibility on each pixel value. On the bases of visibility test proposed technique decides whether fog is existing or not in the given picture. Process flow of proposed technique is depicted in fig.2.

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IV. PROPOSED ALGORITHM FOR FOG DETECTION

This section demonstrates the list of steps for proposed fog detection method which is based on visibility test on pixel value in image.

Input: I(Image)

Output: O1, O2, O3

Algorithm:

Step 1: Obtaining Image: reading the image I;

Step2: Size the taken RGB color Image.

[x, y] = size(I);

Step3: Declare weights as $weight_1$, $weight_2$, $weight_3$ and $weight_4$ such that

$1 \leq$ weight value ≤ 256;

Step4: Assign weights

$weight_1 = 9$, $weight_2 = 18$, $weight_3 = 25$, $weight_4 = 5$;

Step5: Check for visibility test on each pixel with weight values repeatedly. If true increase the value of FS(counter).

$FS=f(weight_1, weight_2, weight_4)$;

Step6: Repeat step 5 with interchanging weights for increasing the value of LS(counter).

$LS=f(weight_2, weight_3, weight_4)$;

Step7: Calculate values of PF and PL respectively.

PF= round((FS/(x*y))*100);

PL= round((LS/(x*y))*100);

Step8: Find sum of counters and normalize it with the values of x and y and assign it with RP.

Step9:

if (RP gt PF & PL)
then
O1=msg('fog free image');
if (PF gt PL & RP)
then
O2=msg('foggy image');
if (PL gt PF & RP) then
O3=msg('dense fog image');

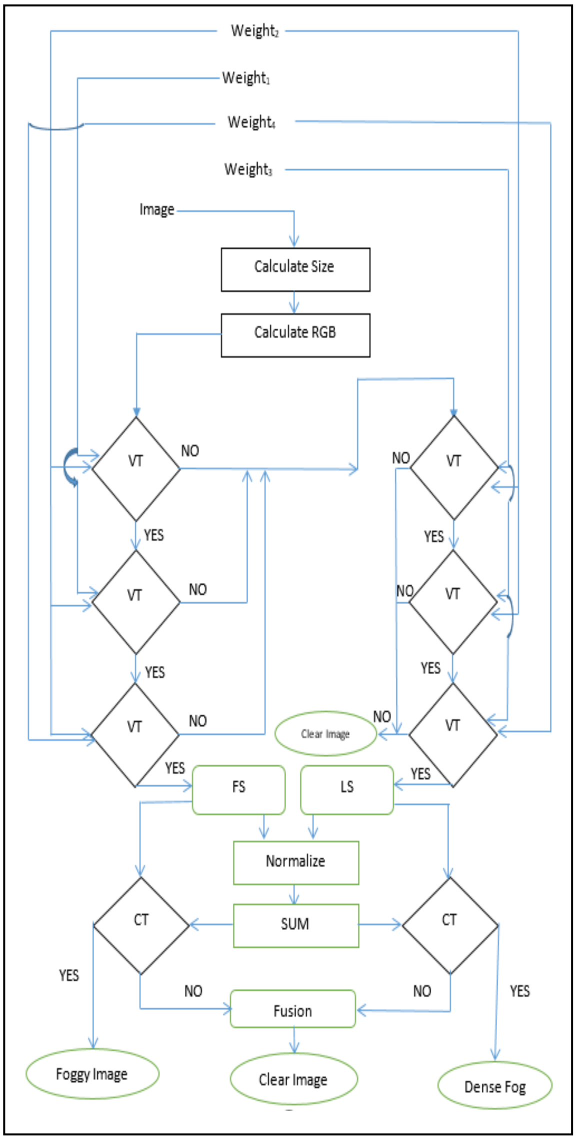

Fig. 2 The process flow of proposed fog detection technique.

V. EXPERIMENTAL RESULT AND ANALYSIS

The experiment carried out to enhance the image clarity in foggy weather. The author chooses 270 images of diverse climate which includes 100 image of thick fog climate days, 100 images non foggy climate days, 70 images of light fog climate days. Proposed technique primarily compares the existing standard techniques to detect the fog in the single image for better image enhancement purpose. The fog perceivability recognition strategy and fog level detection methods of HSV and gray histogram method were compare with our proposed methods. Further we also show that the proposed method shows better result as shown in the fig 3.

The relative outputs are shown in Table2, clearly shows the better results, further we also test the 20 white background images for more authentication of our proposed technique.

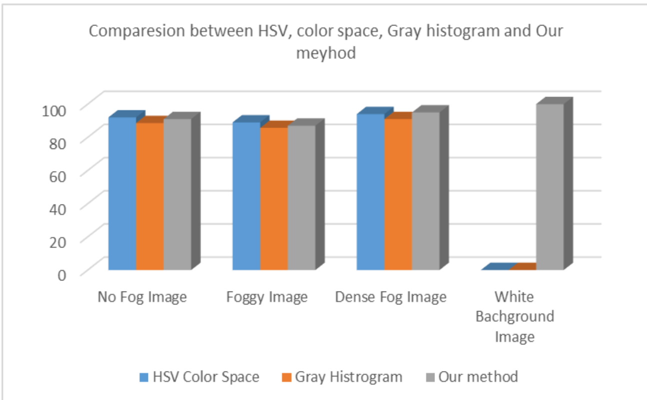

Fig. 3 Correct fog detection count comparison between previous and our method

We have done all the experiments for fog recognition on fog free images, foggy images, dense fog images and white background images in MatLab 2018a.

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Table 2 Comparison between HSV color space, Gray histogram and Our method for fog detection.

Input Image	Images in number	Correct detection count (accuracy)		
		HSV color space based fog detection[16]	Gray histogram based fog detection[17]	Our Techni--que
No fog	100	92(92.0%)	89(89.0%)	94(94%)
Light fog	70	62(88.6%)	60(85.7%)	64(91%)
Dense/Thick fog	100	91(91.0%)	87(87.0%)	95(95%)
Images with white Background	20	-	-	20(100%)

VI. CONCLUSION

This paper firstly introduces the problem that the existing fog removal algorithms have, as they directly process the image whether the image having fog or not. This paper also discussed the issues in detecting fog in image. Then it presents a novel fog detection technique for image enhancement. Our technique uses threshold values to check visibility on each pixel value of RGB image then normalize the output of the processed components, and after that it characterizes the foggy climates of various perceivability into relating bunches as per a making a decision about threshold in order to accomplish the fog detection. The technique utilizes data contained in the picture. Proposed strategy decreases the quantity of the threshold parameter and its calculation is basic and recognition results are more exact. It is conceivable to enhance the exactness of the fog level identification if the resolution of the picture is comparatively high. Detection of white background images is the main characteristics of the proposed algorithm.

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