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Implementation and Analysis of Hybrid Method to Single Image Visibility Enhancement of Foggy Image

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Abstract- Atmospheric phenomenon such as haze, fog, mist etc is originated by small particles in the air such as dust, smoke or moisture, which reduces the visibility of the outdoor scenes. In this paper, we instigate a single image dehazing approach which enhances the visibility of the hazy images. The phrase single image defogging is used to describe any method that removes atmospheric scattering (e.g., fog) from a single image. In general, the act of removing fog from an image increases the contrast. Thus, single image defogging is a special subset of contrast restoration techniques. The proposed method aim is to measure more accurately atmospheric scattering from digital images of images in order to estimate PM levels accurately in the atmosphere and to develop a process which takes digital images, analyzes the pixel data and measures the amount of atmospheric scattering in the image. The process will include radiometric calibration of the camera being used extracting haze from images using a white-balance algorithm; applying a temporary de-hazing technique and applying a statistical prior of out-door haze filled scenes. Another objective of the work is to produce a more accurate depth map computation method which produces a more accurate depth map of images by using temporal knowledge. The experimental results show that the method is capable to remove the haze competently and it take less time to defogging image.

Keywords:- White-balance algorithm, image processing, single image defogging, fog, Polarization Filter.

I. INTRODUCTION

The visual appearance of scenes are affected by air pollution, it consists has been a challenge for us. Changes in emissions, urban growth, and many other factors influence the amount and type of pollution suspended in the atmosphere. Suspended particles in the atmosphere are known as particulate matter (PM). PM visually degrades urban scenery and is hazardous to human health and the environment. Computer vision is all about achieving and interpreting the rich visual world around us. It is an exciting field of research with a wide spectrum of applications that can impact on our day today lives. Nowadays cameras are pervasive and the amount of visual information of images and videos are generated is overwhelming. Automatic visual information processing has never been more important.

II. DEFOGGING TECHNIQUES

De-hazing techniques are used to enhance the quality and increase the visibility of an image. There are several de-hazing techniques few of them are discussed below.

Haze removal techniques categorized into two categories are:-

- Single image haze removal
- Multiple images haze removal

1. Single Image De-hazing Method:
This mechanism only requires a single input image [22] this mechanism relies upon statistical assumptions and the nature of the scene and recovers the scene information based on the prior information from a single image. Single image fog removal mechanisms were proposed, that has much lower time complexity then multiple image fog removal techniques.

These mechanisms are as follows:-
1.1 Contrast Maximization Method: Haze diminishes the contrast. Removing the haze enhance [23] the contrast of the image. Contrast maximization is a mechanism that enhances the contrast under the constraint. But, the resultant images have larger saturation values because this mechanism does not physically improve the brightness or depth but somewhat just enhance the visibility. Moreover, the result contains halo effects at depth discontinuities.

1.2 Dark Channel Prior: Dark channel prior is used for single image de-hazing method for local visibility enhancement. It is used to measure the statistics of the outdoor fog free image. In this method assume that some pixels are having very low intensity in any one of the color channel.

2. Multiple Images De-hazing Mechanism:
In this haze removal, two or more images or multiple image of the same scene are taken [18]. This mechanism attains known variables and avoids the unknowns.

The mechanisms comes under this category are explained as follows.
2.1 Removal of Fog by Polarization Filter:

- **Fog Removal Process:** Fog from the image can be [21] evacuated by multiple image mechanism by using polarization filter. While capturing an image from a distance z, the reflected light from the object to the camera is called direct light, D. The portion of light scattered due to environmental illumination in the same direction of direct light arriving in the camera is termed as air light, A. The concept of polarization filters was used. These mechanisms used different degree of polarization to evacuate haze from images.

2.2 Depth-Map based Method:
This mechanism uses depth information for haze removal [20]. This mechanism uses a single image and assumes that 3D geometrical model of the scene is provided by some databases such as from Google maps and also assumes the texture of the scene is given (from satellite or aerial photos). This 3D model then aligns with hazy image and depth. This mechanism requires user interaction to align 3D model with the scene and it gives accurate results.

III. PROPOSED METHODOLOGY

In proposed white balancing method, in which take a foggy image and defog the image without any deterioration of the actual image. The work will implement in MATLAB R2009b by using image processing toolbox. The mean-balance defogging model is shown below fig 1.

Removal of fog based on white-balance technique:

Fig 1. The block Representation of mean-Balance Defogging Model.

1. Mean White-Balance Method:
This method has high processing speed. It is the best method used in vehicle camera. It can be apply on color and grey images. This formula assumes solely little objects will have colors with low saturation and is controlled solely by a number of parameters i.e., atmospheric veil, restoration of image and filtering, tone-mapping.

The mathematical model of foggy image is shown in equation (vi)

$$I(x,y) = R(x,y)\left(1 - \frac{V(x,y)}{Is}\right) + V(x,y) \ldots\ldots(vii)$$

Where: I(x, y): foggy image, R(x, y): Defoggy image, V(x, y): Atmospheric veil and Is: Sky intensity

2. Browse and read foggy image:
First of all browse and read the image

I = imread………… (viii)

3. Initialize System Parameters:
Initialize the parameters for which the variables need to execute the algorithm in more productive way.

4. Mean Symmetric Median Filtering:
Perform local white-balance using specified level and mean symmetric median filtering.

5. Normalize foggy image as per white-balance value calculated:
Normalization is a process that changes the range of pixel intensity values. Applications include photographs with poor contrast due to blaze, for example. Normalization is sometimes called contrast stretching.

6. Absolute Saturation Bounds:
The saturation block imposes higher and lower limits on an input signal.

- Wm = medfilt2 (w, [sv, sv], 'symmetric');
- sw = abs(w-wm);
- swm = medfilt2(sw, [sv, sv], 'symmetric');
- Sat bound = wm-swm

7. Atmospheric Veil Inference:
First of all take the minimum intensity value of RGB plane as W(x, y) for each pixel:

- W(x, y) = min (I(x, y,t))
- A(x,y) = median (W(x,y))

Then the local standard deviation (W) is subtracted from A to get B as above,

$$B(x,y) = A(x,y) - median(|W(x,y) - A(x,y)|)$$

In the last step, multiply B with a parameter p [0, 1] for good visibility restoration and then finally atmospheric veil is created:

$$V(x,y) = max(min(pB(x,y),W(x,y)), 0)$$

Where p=0.95 and sv = 41(square block window size)

8. Image Restoration:
Restoration is the operation of taking a corrupted/noisy image and estimating the clean original image, restoration is totally different from image enhancement, the latter meant to emphasize options of an image that build an additional pleasing to the observer, image restoration such as contrast-stretching or deblurring by a bordering process provided by the process that created the image.

9. Smoothing:
Smoothening is frequently applied to diminish noise in image or to create an image which has less pixel. Most smoothening algorithms are used low pass filters to smooth an image. Smoothing is generally based on a single-value representing the image, such as the average value of the image or the middle (median) value.

- If (smax ~= 1)
- sr = med smooth(r, smax, factor);
- r = sr;
- nbr = mean(r,3);
- End

10. Gamma Correction:
Gamma correction controls over-all brightness of an image. Improperly corrected image can appear as bleached-out and dark. So good understanding of gamma-value is mandatory to reproduce colors accurately.

11. Calculate intensities using standard deviation:

- so = std(Io(:));
- sr = std(Ir(:));
- power = gain*so/sr;
- u = r. ^ (power)*exp(mo-mr*power);

12. Tone-Mapping:
It is usually done to make the restored image similar to the original image.

IV. SIMULATION RESULTS

To examine the effectiveness of the white-balance approach for visibility improvement in image scene by using image defogging, apply mean white-balance approach with intensity and tone-mapping on dissimilar foggy scene. MATLAB software is used and images used for experimental task such as visibility of distance objects such as car, traffic light, railway track, sun, house, tree, forest etc.

Results Simulation for i3 Processor and i7 processor
Comparison of results of visibility of distant object from the car on different processors such as i3 on

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4GB RAM & i7 on 8GB RAM are shown below. The optimum defogging time complexity is quite less at i7 on 8 GB RAM. We took more than 10 images as text image for our proposed work one of them shown in below figure3.

1. Results Simulation for i3 Processor:

(a) Input foggy image (b) Median filter

(c) Restored image (d) Smoothing of an image

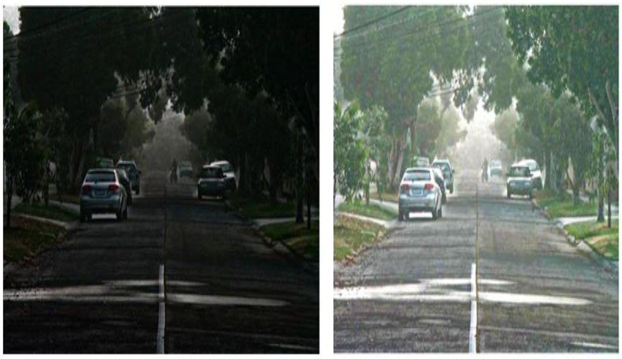
(e) Tone-mapping (f) Output fog free image

Fig 2. Visibility of Distant Objects from Car by White-Balance Method.

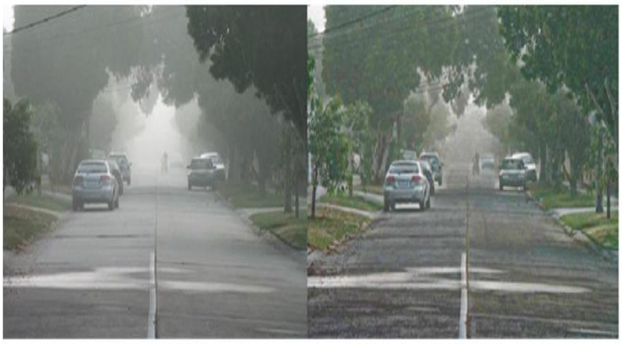
2. Results Simulation for i7 Processor:

The below Fig3 comparison of results of visibility of distance object from the car on different processors such as i3 on 4GB RAM & i7 on 8GB RAM. The optimum defogging time complexity is quite less at i7 on 8GB RAM.

(a) Input foggy image (b) Median filter



(c) Restored image (d) Smoothing of an image



(e) Tone-mapping (f) Output fog free image

Fig 3. Visibility of Distance Objects from Car by White-Balance Method.

The gain of white-balance technique is required computation time to reduce time complexity, shows the step by step process of algorithm, by using local white balancing with mean symmetric median filtering followed by saturation bound, restoration, smoothening and tone-mapping.

3. Simulation of Defogging Time:

The white-balance defogging algorithm is implemented on simulation tool and tested on different foggy images. The defogging time is quite less in i7 on 8GB RAM.

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The benefit of white-balance technique is required computation time to reduce time complexity, the optimum defogging time of a foggy image at i7 on 8 GB RAM is about 1/3rd of i3 on 4GB RAM which is able to process a 387*290 image in approximately 06-20 seconds on i7 PC configuration. We take more than 10 images to analysis of our proposed work.in this paper only one image is shown.

Fig 4. (a) Input Foggy Image of Distance Object from Car (b) Output Image of Image Size 600*450 on i3 on 4GB RAM Defogging Time is 60.0844 sec (c) Output Image of Image Size 600*450 on i7 on 8GB RAM Defogging Time is 19.2829 sec.

4. Simulation for Different Image Size Comparing Computation Time:

To estimate the performance of white-balance defogging technique we implemented our method on Different Foggy Images. In white-balance technique two different processors i3 and i7 are used to defog an image to compare the optimum time complexity to defog a foggy image is about 20 seconds on i3 and 06 seconds on i7.

The defogging time is approximately 1/3 of the previous mechanism. In below table simulation results for different foggy images are discussed. Results shows that our proposed method gives better performance.

Table 1. Computation Time Comparison between Images on Different Processors.

Input foggy image (.jpg)	Output of i7 on 8GB	Image size (Pixel)	(KB)	i3 on 4GB in second	i7 on 8GB in second
 Car	 Car	600*450	48.4	60.0844	19.2829
 Traffic light	 Traffic Light	384*288	39.2	20.8898	06.3901
 Sun	 Sun	614*425	98.5	55.1478	17.3619
 House	 House	244*162	10.5	08.6413	02.9722
 Tree	 Tree	525*392	50.2	36.8819	12.8277
 Forest	 Forest	387*290	50.5	20.7167	06.6589

Graph1 illustrates the time complexity vs. image size. In which blue color represents time complication on i3 processor whereas red color represents time complexity on i7. X-axis represents time complexity in seconds and Y-axis represents image size. The percentage discrepancy between time complexities vs. image size is near about 65 to 70%. Time complexity is directly proportional to image size.

Fig 5. Graph 1 Time Complexity vs. Image Size.

V. CONCLUSION

In this paper a mechanism is used to improve visibility of a foggy image without deterioration of an actual image and reduce time complexity of a foggy image with the help of white balancing technique is having better speed to defog images.

The advantage of white-balance technique is required computation time to reduce time intricacy, the optimum defogging time of a foggy image at i7 on 8GB RAM is about 1/3rd of i3 on 4 GB RAM which is able to process a 387*290 image in approximately 05-10 seconds on i7 PC configuration. The proposed method performs better with other PC configurations having higher graphics.

The advancement of fast computer technology in electronic video sensors defogging mechanism is very essential. Real-time image defogging is rather new to this subject and thus still in the computation of advancement. In future work would like to test on real time images and videos as well.

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