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EDGE AND LAPLACE BASED RESTORATION OF HAZY IMAGES

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Abstract: - As the digital world is increasing day by day so numbers of digital image processing issues are covered by different researchers. Out of those this work focuses on Fog removal which is also known as visibility restoration refers to different methods that aim to reduce or remove the degradation that have occurred while the digital image was being obtained. The degradation may be due to various factors like relative object-camera motion, blur due to camera miss-focus, relative atmospheric turbulence and others. This paper has utilized the Laplace base distortion detection with edge information preserving. Combination of both these techniques helps in identifying the actual color values present in the original image scene. Experiment is done on many images of different environment or category. Results shows that proposed work is better as compare to previous work in [8].

Index Terms— Digital Image Processing, Haze, Information Extraction, Fog removal. Visibility restoration

1. INTRODUCTION

Most outdoor visual systems such as video surveillance, target tracking, remote sensing and navigation control and vehicle autonomous driving and others are highly vulnerable to harsh environment, especially because of fog and haze. Images of outdoor scene can be significantly degraded due to the bad weather condition such as fog and haze. Thus it lead to the atmospheric scattering of tiny water droplets and atmospheric aerosol on the scene point, causing image fuzzy, bad visibility, and seriously affecting the performance of an outdoor system. This happens because of the presence of numerous atmospheric particles which absorbs and scatters light. Such degraded images lose all its contrast and become dim especially in the distant regions and get blurred with their surroundings area. In order to make the system robust and reliable in bad weather conditions, it is necessary to dehaze that degraded image.

In long distance photography or foggy scenes, this process has a substantial effect on the image in which contrasts are reduced and surface colors become faint. Such degraded images, photographs lack visual vividness and appeal and moreover, they offer a bad visibility of the contents of the scene. This may also be the case for satellite imaging which is used for various purposes like web mapping, land-use planning and environmental studies etc.

In this process light which should have to travel in straight lines is scattered and replaced by the previously scattered light called the airlight. The main objective here is to enhance the images which are taken under poor visibility and even restore the clear-day visibility of that scene. There are many circumstances for which accurate haze removal algorithms are needed. The major goal of the haze removal algorithms is to enhance and recover the detail of the scene from the haze
image.

Visibility restoration [1] refers to different methods that aim to reduce or remove the degradation that have occurred while the digital image was being obtained. The degradation may be due to various factors like relative object-camera motion, blur due to camera misfocus, relative atmospheric turbulence and others. In this we will be discussing about the degradations due to bad weather such as fog, haze, rain and snow in an image. The image quality of outdoor screen in the fog and haze weather condition is usually degraded by the scattering of a light before reaching the camera due to these large quantities of suspended particles (e.g. fog, haze, smoke, impurities) in the atmosphere. This phenomenon affects the normal work of automatic monitoring system, outdoor recognition system and intelligent transportation system. Scattering is caused by two fundamental phenomena such as attenuation and air light. By the usage of effective haze removal of image we can improve the stability and robustness of the visual system.

Haze removal is a tough task because fog depends on the unknown scene depth information. Fog effect is the function of distance between camera and object. Hence removal of fog requires the estimation of air light map or depth map. The current haze removal method can be divided into two categories: image enhancement and image restoration. Image enhancement does not include the reasons of fog degrading image quality. This method can improve the contrast of haze image but loses some of the information regarding image. Image restoration firstly studies the physical process of image imaging in foggy weather. After observing that degradation model of fog image will be established. At last, the degradation process is inverted to generate the fog free image without the degradation. So, the quality of degraded image could be improved.

2. Related Work

[1] introduced an experience fusion method for various images by way of moving objects. The proposed method consist a ghost removal algorithm in a low dynamic series domain and a exposure fusion algorithm. The proposed ghost removal algorithm includes a bidirectional normalization-based method for the finding of non-reliable pixels and a two-round hybrid method for the correction of non-constant pixels. A exposure fusion algorithm consist a content adaptive bilateral filter, that extracts superior details from all the corrected images concurrently in ascent domain. The final image is synthesized by selectively adding the extracted fine details to an in-between image that is generated by fusing all the corrected images via an existing multi-level algorithm.

In [2] described a novel and efficient single image enhancement algorithm for haze image. As they monitor that, the contrast and intensity of haze image
After using dark channel prior approach will necessarily tend to be lower than those of the real scene, they used histogram requirement to make an enhancement on image after dark channel prior approach. They made a large number of experiments and find that, if dealing with a haze image with large
Background area and low contrast, dark channel prior result will become dark, also a general haze image after dark channel occurs different degree of anamorphous. They introduced an adaptive algorithm to repair the different kinds of an amorphose on the hazy image after dark channel prior.

Vol.4 Issue 5, Pg.: 62-70
May 2016

In [3] projected a fast yet tough technique to enhance the visibility of video frames using the dark channel prior united with fuzzy logic-based technique. The dark channel prior is a arithmetical uniformity of outdoor haze-free images based on the examination that most local patches in the haze-free images have pixels which are dark in at least one color channel, where the fuzzy logic-based technique is used to plan an input space to an output space using a collection of fuzzy membership functions and policy to decide delicately in case of doubts. The combination of the dark channel and the fuzzy logic-based technique will make high quality haze-free images in real-time.

In [5] has discussed that the within the last decades, improving the quality of an underwater image has one problem that is poor visibility of the image which is aroused by physical properties of the water medium.

In [6] proposed perceptual models that can be able to forecast the value of distorted images with as little prior information of the images or their deformation as possible. The new IQA model, which is known as Natural Image Quality Evaluator is based on the production of a “quality aware” collection of statistical features based on a simple and successful space area natural scene statistic model.

In [7] proposed novel widespread guided image filtering method with the suggestion image generated by signal sub-space projection technique. It accepts complicated parallel study through Monte Carlo imitation to choose the dimensions of signal subspace in the patch-based noisy images. The noise free image is reconstructed from the noisy image expected onto the significant images by component analysis. Test images are utilized to decide the relationship between the most favorable parameter value and noise divergence that maximizes the output peak signal-to-noise ratio.

In [8] has presented a new method called mixture CLAHE color models that specifically developed for underwater image enhancement. The process performs CLAHE method on RGB and HSV color models. The projected technique has considerably enhanced the visual superiority of underwater digital images by enhancing illuminate, as well as dropping noise and artifacts.

3. Proposed Methodology

This paper focus on the digital hazy image restoration. Here image store the edge region of the image then apply Laplace distribution for pixel value restoration. Here whole work is explained in fig. 2.

3.1 Pre-Processing

Here as the image is the collection of pixels where each pixel is representing a number that is reflecting a number over there now for each number depend on the format it has its range. So read a image means making a matrix of the same dimension of the image then fill the matrix correspond to the pixel value of the image at the cell in the matrix.

3.2 Edge Detection

In order to find the edges in the image convert it into gray format then apply the canny algorithm. This is the method to convert an gray scale image into binary image. For this analysis of each pixel is done.

Vol.4 Issue 5, Pg.: 62-70
May 2016

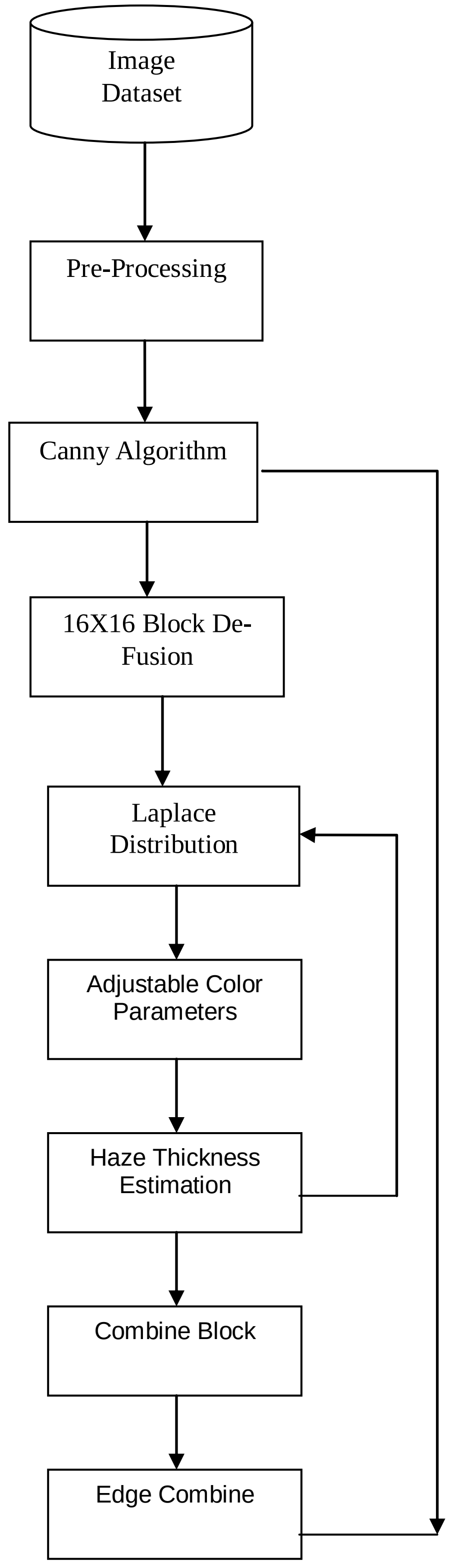


Fig. 3. Block diagram of proposed Restoration Image Work.

Edge feature: In case of edge feature canny algorithm is applied

- Smooth the Image with Gaussian Filter.
- Compute the Gradient Magnitude and Orientation using finite-difference approximations for the partial derivatives.
- Apply non-maxima suppression to the gradient magnitude.
- Use the double thresholding algorithm to detect and link edges.

16X16 Block: As work is done on color image so embedding is done on the red matrix of the image, so whole operation of embedding is done this red matrix. Whole red, green, blue matrix is divided into 16X16 blocks for restoration of image.

3.3 Laplace Distribution

Laplacian disibution help to find are non-directional changes because they enhance linear features in any direction in an image. They do not look at the gradient itself, but at the changes in gradient. In their simplest form, they can be seen as the result of taking the second derivative. In this step μ is mean of the block or region S of image I having three color channel c {red, green, blue}. So first σ is estimate which act as the scaling parameter of the laplace distribution.

$$\sigma = \frac{1}{\alpha}\sum_{L\in S}\left|I^c(L)-\mu\right|$$

$$P(\Delta^c(L)\,|\,S) = \frac{1}{\alpha}\sum_{L\in S}\frac{1}{2\sigma}e^{\frac{(I^M(L)-I^c(L))-\mu}{\sigma}}$$

3.4 Haze Thickness Estimation

In this step color adjustment parameter is calculate with the help of Laplace distribution values of each block. Here color adjustment parameter is the ratio of the color chromatic parameter to the maximum value of the color chromatic parameter of each channel of the image.

$$a^c = \frac{\upsilon^c}{\max I^c}$$

Here υ^c is the color chromatic parameter obtain by the ratio of the maximum laplace distribution value of the color region to the laplace distribution of the block.

Finally color adjustment in the haze image is done by change in pixel value

$$J^c(x) = \frac{\alpha^c(I^c(x)-A^c)}{\max(t(x),t_o)} + \alpha^c A^c$$

Vol.4 Issue 5, Pg.: 62-70
May 2016

Here A^c is atmospheric light adjustment parameter in the block so for each block it is evaluate by

$$A^c = \min(\max(S)$$

$$t(x) = \min\left(\frac{I^c}{A^c}\right)$$

3.4 Edge Combination

Here edge obtain from initial image is combine in the new edge position obtain after applying laplace and haze thickness steps. This involve following working:

1. Loop 1:m
2. Loop 1:n
3. If I(m,n) //edge pixel in old but not in processed image.
4. I_new(m,n) ←I(m,n)
5. EndLoop
6. EndLoop

4. Experiment And Result

In this section, first introduce experimental settings, and then present the experimental results that validate the effectiveness of the approach. The experiments actually contain two parts. This work is compare with other previous work in [8] which have utilize the laplace and haze thickness estimation only.

4.1 Data Sets

In order to conduct the experiment an artificial dataset which is a collection of images from different category are utilize. As images are of different format so first it is necessary to make it in readable format for experiment tool MATLAB. Now this collection of images of different category is shown in table 1.

Category
Garden
Jungle
Animal
Person

Table 1. Dataset of Different category.

Vol.4 Issue 5, Pg.: 62-70
May 2016

4.2 Results

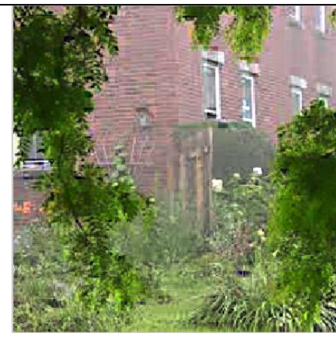
Original Image	Image After Restortation
	
	
	
	

Table 2. Results of various image from proposed restoration work.

Images		Visible Edge Restoration	
		Proposed Work	Previous Work
1	Garden	3.1503	2.6447
2	Jungle	3.9960	3.2902
3	Animal	4.4907	0.7239
4	Person	5.9658	0.6490

Table 3. Comparison of proposed work and previous work on visible edge restoration parameter.

In table 3 It is obtained that proposed work is better as compare to previous as edge restoration value of proposed work is higher as compare to previous. So inclusion of edge feature in haze removal has increase the performance of the work.

Images		Contrast Restoration Image	
		Proposed Work	Previous Work
1	Garden	7.7194	1.3662
2	Jungle	8.1391	3.3467
3	Animal	10.7419	7.7275
4	Person	9.4774	-4.4575

Table 4. Comparison of proposed work and previous work on visible edge restoration parameter.

In table 4 it is obtained that proposed work is better as compare to previous as contrast restoration image value of proposed work is higher as compare to previous. So inclusion of edge feature in haze removal has increase the performance of the work.

Images		Over or Under Exposed Metric	
		Proposed Work	Previous Work
1	Garden	2.7487	0.2838
2	Jungle	2.7253	0.2802
3	Animal	2.6916	0.0171
4	Person	2.6238	0.0030

Table 5. Comparison of proposed work and previous work on visible edge restoration parameter.

In table 5 It is obtained that proposed work is better as compare to previous as Over or Under Exposed Metric of Restoration image value of proposed work is higher as compare to previous. So inclusion of edge feature in haze removal has increase the performance of the work.

5. Conclusions

A new combination of laplace and edge feature is done in this work for dehazing image from different scene. The algorithm removes spatially varying haze based on the haze thickness estimation. As experiment is done on images of different environment and it is obtained that proposed work is better on all the evaluation parameters of de-hazing images. In Future improvements of the method will deal with possible corner, and histogram effects caused by the image processing.

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