Enhancement of Remote Sensing Images Using Multi Exposure Fusion

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Abstract: ***Poor atmosphere situations are able to reduce perceptibility of pictures acquired exterior, falling their image eminence. The picture progression assignment worried on the subject of the mitigation of this crash is identified as image dehazing. Several such dehazing methods have been established. On the other hand, these methods cannot dehaze the remote sensing and high hazy images. In this effort a novel method is proposed to defeat these problems. In this technique, initially the new foggy picture is beneath depiction throughout the series of gamma correction actions. After that the ensuing pictures with dissimilar experience can be combined into a haze free picture throughout a multi level Laplacian pyramid blending Technique. Investigational outcomes on a group of hazy pictures conclude that the suggested technique maintains the perceptibility of far flung sensing foggy pictures.***

Keywords: ***Dehazing, MEF, CLAHE***

I. INTRODUCTION

Usually, the atmosphere between the observer and the scene degrades the visibility of images that are captured outdoors. This phenomenon is termed as the haze that attenuates the radiance, it should reach the camera. Thus, obtained images and videos are with undesirable effects such as loss of contrast and color quality degradation, reducing visibility on far away regions in the scene. The improvement of image defogging or dehazing algorithms for the restoration of image quality has turned into a task of incredible significance.

Generally, the current defog or dehaze algorithms can be divided into two groups of single and multiple-image based techniques. A single image dehazing method doesn't take the external knowledge of the scene into consideration. But haze is a depth dependent phenomenon that results in the image degradation to be spatially variant with different areas of the image being more affected. Usually this degradation varies in accordance with depth in the imaged scene.

But the lack of depth information in two dimensional images cause ambiguity, due to which previous methods remove haze depends on external sources of information. However this external information is usually available in generic situations. Fortunately, this unavailable depth information is typically alleviated by resorting to physical models of haze formation. But these models need to hold depth information, either implicitly or explicitly. As a result, most existing single-image dehazing techniques enforce prior information on the image the user expects to retain, e.g. an increased contrast or less attenuated colors.

Single image haze removal is considered as a spatially varying contrast and saturation enhancement problem. In this problem different areas require distinct levels of processing. Hence, a new method is introduced to increase the visibility only in those regions. In this method the original hazy image is under-exposed through the sequence of gamma-correction activities there by generating multiple exposure images. These images contain areas with increased saturation and contrast. These images can be fused into a haze free image through a multi-scale Laplacian pyramid blending method. This work can be done in two steps, First one is Multiple Exposure Fusion (MEF) removes the haze at for away regions of hazy image and second one is Contrast Limited Adaptive Histogram Equalization (CLAHE) to reduce the heavy contrast enhancement in the process of MEF.

Haze is traditionally an atmospheric phenomenon in which dust, smoke, and other dry particulates obscure the clarity of the sky. The World Meteorological Organization manual of codes includes a classification of horizontal obscuration into categories of fog, ice fog, steam fog, mist, haze, smoke, volcanic ash, dust, sand, and snow. Sources of haze particles include farming, traffic, industry, and wildfires.

According to the theory of atmospheric scattering, an imaging model of a hazy scene consists primarily of two parts, which is shown in Fig.1.1. The first part is the attenuation process of the reflected light from the object surface to the camera. The second part is the scattering of air-light reaching the camera. Both parts constitute the theoretical basis of blurred hazy images.

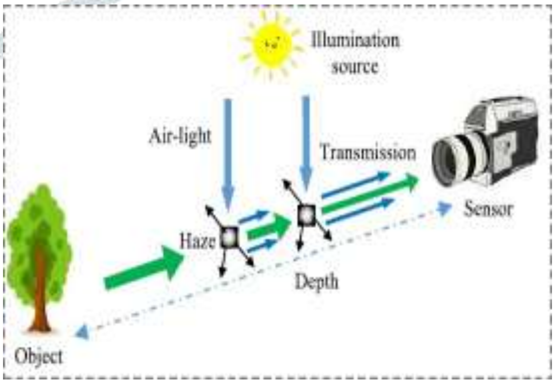

Fig.1.1: Atmospheric scattering model

A. Objectives of Image Fusion

- Extract all the useful information from the source images.
- Do not reduce artifacts or inconsistencies which will distract human observation or the following processing.
- Reliable and robust to imperfection such as

missing-registration.
- To produce more information than any of input images.

B. Functions of Image Fusion
- Sharpen the image.
- Improve geometric connection.
- Substitution the missing information in one image with signals from another image.
- Replace defective data.

C. Advantages of Image Fusion
- Improve system performance-detection, recognition, resolution.
- Improve situation assessment.
- Improve reliability of redundant information.
- Improve capability by complementary Information.

II. EXISTING WORK

In this work first two types of inputs are derived from the original hazy image. These two derived inputs are weighted by three normalized weight maps. Finally, the Laplacian of the inputs and Gaussian of the weights is blended in a multi-scale fashion that avoids introducing artifacts. The overview of existing work is shown.

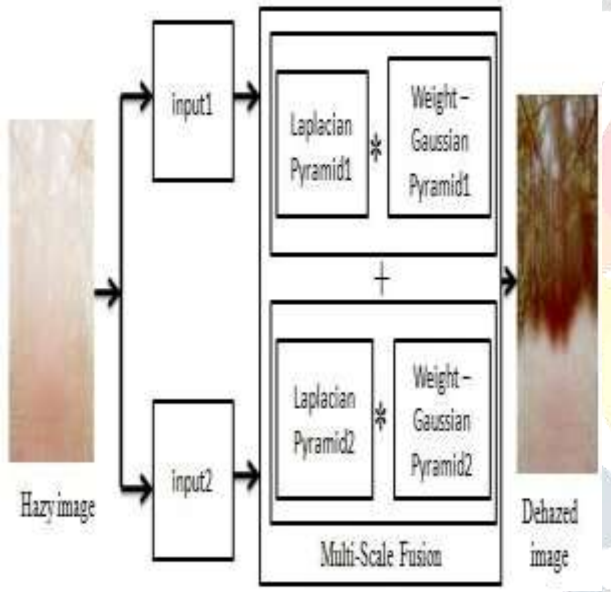

Fig.2.1: Block diagram of the Single Image Dehazing by Multi-Scale Fusion method

Fusion-based approach can be used to effectively enhance hazy and foggy images. This is the fusion-based strategy that is able to solve such problems using only one degraded image. As shown in the above figures that, by choosing appropriate weight maps for two inputs and a multi-scale fusion strategy can be used to dehaze the hazy images effectively. Based on this work the proposed algorithm can be developed to get better dehazed images for input hazy images.

Image Restoration is the process of taking a corrupt/noisy image and estimating the clean, original image. Corruption may come in many forms such as motion blur, noise and camera mis focus. Image restoration is performed by reversing the process that blurred the image and such is performed by imaging a point source and use the point source image, which is called the Point Spread Function (PSF) to restore the image information lost to the blurring process.

Image restoration is different from image enhancement in that the latter is designed to emphasize features of the image that make the image more pleasing to the observer, but not necessarily to produce realistic data from a scientific point of view. Image enhancement techniques (like contrast stretching or de-blurring by a nearest neighbor procedure) provided by imaging packages use no a priori model of the process that created the image, which the image enhancement, noise can effectively be removed by sacrificing some resolution, but this is not acceptable in many applications. In a fluorescence microscope, resolution in the z-direction is bad as it is. More advanced image processing techniques must be applied to recover the object.

The objective of image restoration techniques is to reduce noise and recover resolution loss. Image processing techniques are performed either in the image domain or the frequency domain. The most straightforward and a conventional technique for image restoration is de-convolution, which is performed in the frequency domain and after computing the Fourier transform of both the image and the PSF and undo the resolution loss caused by the blurring factors. This de convolution technique, because of its direct inversion of the PSF, which typically has a poor matrix condition number, amplifies noise and creates an imperfect de-blurred image. Also, conventionally the blurring process is assumed to be shift-invariant. Hence, more sophisticated techniques, such as regularized de-blurring, have been developed to offer robust recovery under different types of noises and blurring functions.

The term fusion means in general an approach to the extraction of information acquired in several domains. The goal of image fusion (IF) is to integrate complementary multi sensor, multi temporal and /or multi view information into one new image containing information the quality of which cannot be achieved otherwise. The term quality, its meaning and measurement depend on the particular application.

Image fusion is important in many different image processing fields such as satellite imaging, remote sensing and medical imaging. Several fusion algorithms have been evolved such as pyramid based, wavelet based, curve let based, HIS (Hue Saturation Intensity), color model, PCA (principal component analysis). All of them lack in one criterion or the other.

Several situations in image processing require high spatial and high spectral resolution in a single image. Most of the available equipment is not capable of providing such data convincingly. The image fusion techniques allow the integration of different information sources. The fused image can have complementary spatial and spectral resolution characteristics. But, the standard image fusion techniques can distort the spectral information of the multispectral data, while merging.

III. PROPOSED WORK

Single image dehazing by multi scale fusion is considered as a spatially varying contrast and saturation enhancement problem. In this problem different areas require distinct levels of processing. Hence, a new method is developed to increase the visibility only in those regions. In proposed method original hazy image is under-exposed through the sequence of gamma-correction activities there by generating multiple exposure images. These images contain areas with increased saturation and contrast. These images can be fused into a haze free image through a multi-scale Laplacian pyramid blending method. It can be done in two steps shown in Fig.3.1. First is Multiple Exposure Fusion (MEF) removes the haze in remote sensing images and the second is Contrast Limited Adaptive Histogram Equalization (CLAHE) to reduce the heavy contrast enhancement in the process of MEF.

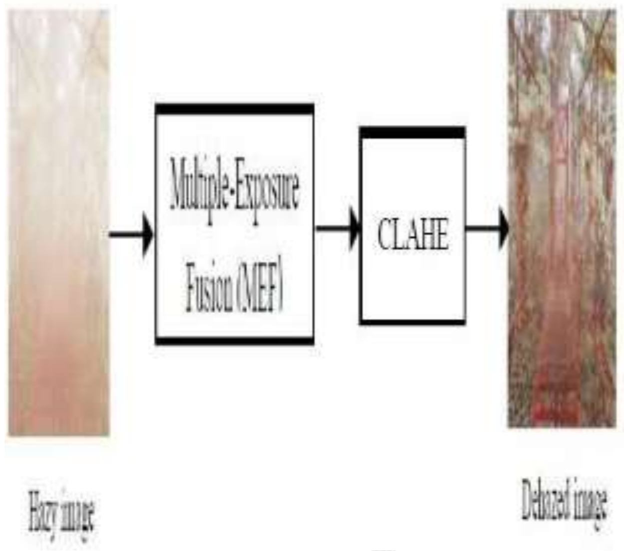

Fig.3.1: Enhancement of Hazy Image using Multi-Exposure Image Fusion

The main aim of this work is to design a spatially-varying image enhancement method which can remove the visual effects of haze to avoid the need of evaluating transmission t(x) and airlight A. In this work three steps are done to get a quality dehazed image. First the original hazy image divided into multi - exposure images through the gamma corrections. Second the MEF can be applied to all exposed images. In the third step the Contrast Limited Adaptive Histogram Equalization (CLAHE) is applied to the resulting image of MEF algorithm, as shown in the flow chart Fig.3.2.

In photography, exposure is characterized as the measure of light that is permitted to enter the camera and achieve the sensors while obtaining an image. Exposure can be balanced during the acquisition by differing the shutter speed of the camera or on the other hand its aperture, yet it is normally difficult to accomplish a generally optimal exposure for any scene. In addition, multiple regions of the imaged scene may require completely distinct exposures.

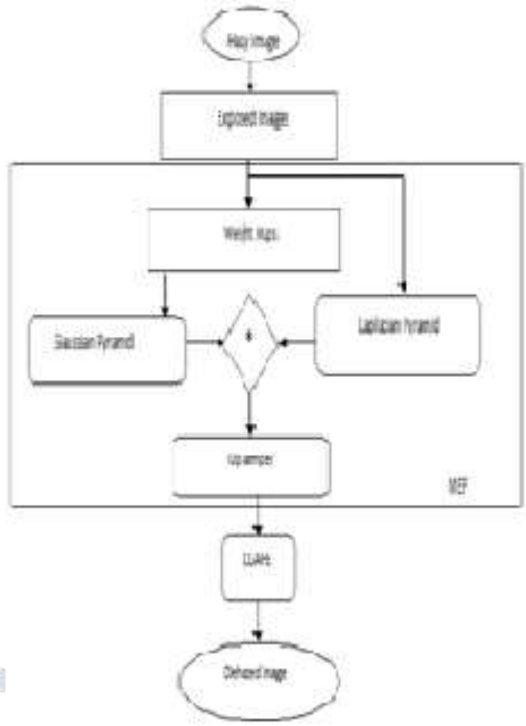

Fig.3.2: Flow chart of proposed method

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In controlled brightening circumstances, a possible solution is to shed light into the dark regions of the scene to diminish its dynamic range. A second approach consists of gaining multiple images of a similar scene under various exposures and combining data on every one of these images into a single one containing sharp details both on bright and dark areas. This image processing problem is named as Multi Exposure Image Fusion.

The data structure used to represent image information can be critical to the successful completion of an image processing task. One structure that has gained considerable attention is the image pyramid. This consists of a set low pass and band pass copies of an image, each representing the pattern information on a different scale.

By applying only enhancing operations to derive the inputs, still suffer from low visibility mainly in those regions with dense haze and low light conditions. The idea that global contrast enhancement techniques are limited to dealing with hazy scenes has been remarked previously by Fattal.

It is because of the reason that the optical density of haze varies across the image, and affects the values differently at each pixel. Practically, the limitation of the general contrast enhancement operators (e.g. Gamma correction, histogram equalization, white balance) is due to the fact that these techniques perform (constantly) the same operation across the entire image. In order to overcome this limitation, we introduce three measures (weight maps). These maps are designed in a per-pixel fashion to better define the spatial relations of degraded regions.

The original image is repeatedly filtered and sub sampled to generate the sequence of reduced resolution images. This comprises a set of low pass filtered copies of the original image in which the bandwidth decreases in one octave steps. Gaussian pyramid has the different levels for an image. Pyramid levels of the image are shown as left to right in the Fig.3.3. Each level of this band pass pyramid represents the difference between successive levels of the Gaussian pyramid. The pyramids are easy to compute, indeed pyramid filtering is faster than the equivalent filtering done by Fourier Transforms.

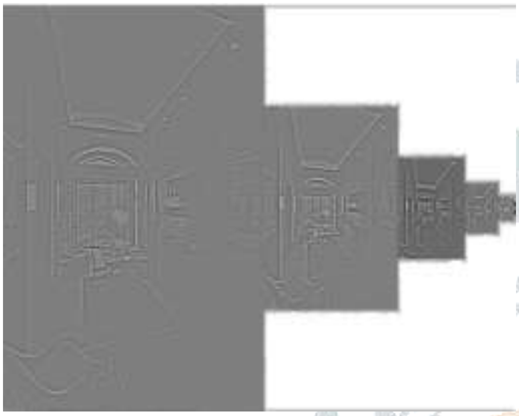

Fig.3.3 Gaussian Pyramid Levels

The information is also available in a format that is convenient to use, since the nodes in each level represent information that is localized in both space and spatial frequency. Substantial data compression can be achieved by pyramid encoding combined with quantization and entropy coding. Texture analysis can also be done rapidly and simultaneously at all scales. An additional benefit is that in computing the Laplacian pyramid, one automatically has access to band pass copies of the image shown in Fig.3.4. In this representation, image features of various sizes are enhanced and are directly available for various image processing and pattern recognition tasks.

Unfortunately, a few point in time the customer has no organize on the light of the scene or the image has been already captured and stored with no option to obtain extra multiple gamma correction algorithm is used to acquire different exposure images.

Fig.3.4 Laplacian Pyramid Levels

It can be uncertainly authenticated that when the input foggy picture holds some fine contrasted regions, then the ensuing picture will be more exposed generating too dark products. All jointly to blend extra disparity in the dehazed product exclusive of initiating a lot of additional constraints in the suggested method, a fundamental contrast increased from of the input picture can be added to the original arrangement of under rendered pictures. For this kind of condition, the well-known Contrast Limited Adaptive Histogram Equalization was selected. This computation relies on the clip range and it can generate the products with highly progressed eminence. It can be recognized how the local histogram equalization changes the occurrence of regions in the pictures that were not understanding disparity or diffusion defeat, mainly the regions closure to the camera. Saturated areas approaching from the middle range deepness of the sight are appropriately added into the ending product.

IV. RESULTS AND DISCUSSION

The projected technique for image dehazing has small number of parameters that must be stabilized. Among them, the quantity of disparity that the customer allows to be enhanced in the adaptive histogram equalization picture that balances the under exposed group of images. Fig. 4.1 shows some other examples for existing method single image dehazing by multi-scale image fusion and proposed method Enhancement of remote sensing hazy image using multi-exposure image fusion. From this we can conclude that the above technique provides the best outcome not including loss of disparity and dispersion of the original image, and moreover it eliminates the fog in the remote sensing images.

PSNR is most easily defined via the mean square error (MSE). Given a noise free m×n monochrome image I and its noisy approximation K. MSE is defined as:

$$\text{MSE}=\frac{\sum_{i=0}^{m-1}\{\sum_{j=0}^{n-1}||I(i,j)-K(i,j)||^2\}}{m\ x\ n} \quad (4.1)$$

The PSNR (in dB) is defined as:

$$\text{PSNR} = 20.\log_{10}\left(\frac{\text{MAXI}}{\sqrt{\text{MSE}}}\right) \quad (4.2)$$

Here, MAX_I is the maximum possible pixel value of the image. When the pixels are represented using 8 bits per sample, this is 255.

Table 4.1: PSNR comparison between Existing method and Proposed method

Hazed Image	Dehazed Image	Existing Method PSNR (dB)	Proposed Method PSNR (dB)
		43.76	47.62
		44.62	49.34
		58.41	62.73

V. CONCLUSION

The suggested technique is developed on Multi Exposure Fusion and Contrast Limited Adaptive Histogram Equalization algorithms. This method can generate pictures of enhanced eminence and in a better competent mode. It demonstrates a high quality presentation for the assignment of picture dehazing. In this technique, the haze occurs in the remote areas of foggy pictures can be eliminated and the yielded dehazed picture has the superior image eminence. Furthermore, the practical multi scale Laplacian combination agreement is a fundamental technique inside the meadow of multiple exposure fusion and dissimilar sophisticated methods could be discovered to outlook the presentation or discover other applications.

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