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HAZE REMOVAL WITH FUSION OF LOCAL AND NON-LOCAL STATISTICS

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***Abstract* - Remote sensing images (RSIs) taken in hazy conditions, such as haze, fog, thin could, snow, silt, dust, off gas, etc., suffer from sever color and contrast degradations. Dehazing algorithm is therefore highly demanded to restore hazed RSIs from their degradations. In the literatures, most dehazing algorithms were originally designed for natural images dehazing (NID). For our analysis, the physical model of NID is different from that of RSI dehazing (RSID), which was not clearly addressed yet. In this paper, a new concept of "virtual depth" concerning physical model of RSI is firstly raised. Virtual depth is different from real depth of nature image in that the former gives the distance of an object departing from the foreground, while the later measures the coverings of the earth's surface, such as snow, dust, cloud and haze/fog. These coverings act as the hazes in a natural image, providing the hint of foreground and background. Secondly, an Iterative Dehazing for Remote Sensing image (IDeRS) is proposed, in which dehazing operator is implemented iteratively to remove haze progressively until arriving at a satisfied result. In IDeRS, we also raise a fusion model for combining patch-wise and pixel-wise dehazing operators to overcome both halos and over-saturation caused by them respectively. Extensive experimental results tested on publicly available databases demonstrate that the proposed IDeRS outperforms most state-of-the-arts in RSID.**

I INTRODUCTION

Digital image is defined as "An image is not an image without any object in it". Human visual system has ability to perceive the objects in digital image using edges in efficient manner. Halo artifacts introduces blur in digital image which makes perception of content difficult. Various filtering techniques have designed in literature to preserve the global and local statistics but none can meet the desired requirements and various algorithms yields high complexity which fails them to achieve practical reliability. Digital image processing domain has different research fields and all these research fields have applications ranging from low level to high level. Edge preservation in all these research fields attains attention and implementation of smoothing filters has ability to filter noise content by preserving the edge information. Smoothing algorithms can be classified into two types namely global filters such as bilateral filter , tri-lateral filters , and finally guided image filter. Global filters attain images with good quality but these filters are highly expensive. Local filters are considered as alternative to global filters which are simple and cost effective but fail to conserve the sharp edges information like global filters. When local filters are forcefully adopts to smooth edges it results halo artifacts. Halo artifacts produced by bi-lateral filter and guided image filter are fixed in equipped way using similarity parameter in terms of range and spatial. Bi-lateral filtering mechanism is considered as adaptive filter and this adaptive mechanism helps to handle the halo artifacts and on negative side it destroys the 3D convolutional form an interesting algorithm named weighted guided image filtering scheme is proposed in this paper by combining the edge-based weighting scheme along with guided image filtering. Calculation of edge based weighting scheme is calculated by using 3×3 local variance in a guidance image. This local variance scheme of one individual pixel is normalized by all pixels local variance in guidance image. The acquired normalized weights of all pixels are then adaptively adapted to WGIF. WGIF helps to avoid halo artifacts in accurate manner for excellent visual quality. The intricacy of WGIF is same as GIF. The proposed weighted guide image filtering (WGIF) is applied for multiple purposes as single image mist removal, single image detail enhancement and different exposed images fusion.

In human visual perception, edges provide an effective and expressive stimulation which is important for neural interpretation of a scene. In the fields of image processing and in many computational photography employ smoothing techniques which could preserve edges better. In smoothing process an image to be filtered is typically decomposed into two layers: a base layer composed by homogeneous regions with sharp edges and a detail layer formed by either noise, e.g., a random pattern with zero mean, or texture, e.g, a repeated pattern with usual arrangement. There are two types of edge-preserving image smoothing techniques: global filters such as the weighted least squares (WLS) [8] filter and local filters such as bilateral filter (BF) [3], trilateral filter, and their accelerated versions [4], as well as guided image filter (GIF) [11].Though the global optimization based filters frequently yield excellent quality, they have high computational cost. Comparing with the global optimization based filters [1], [2], [8] and [9], the local filters are generally simpler. However, the local filters cannot conserve sharp edges like the global optimization based filters. Halo artifacts were usually produced by the local filters when they were adopted to smooth edges. Major reason that the BF/GIF produces halo artifacts was both spatial similarity parameter and range similarity parameter in the BF [3] were fixed.

II LITERATURE SURVEY

2.1 Topic: A nonnegative factor model with optimal utilization of error estimates of data values.

Author: P. Paatero and U. Tapper

The fundamental principle of source/receptor relationships is that mass conservation can be assumed and a mass balance analysis can be used to identify and apportion sources of airborne particulate matter in the atmosphere. This methodology has generally been referred to within the air pollution research community as receptor modelling [Hopke, 1985; 1991]. The approach to obtaining a data set for receptor modelling is to determine a large number of chemical constituents such as elemental concentrations in a number of samples. Alternatively, automated electron microscopy can be used to characterize the composition and shape of particles in a series of particle samples.

2.2 Topic: "Underwater image processing: state of the art of restoration and image enhancement methods.

Author: R. Schettini and S. Corchs

The authors provide an overview of state-of-the-art image enhancement and restoration techniques for underwater images. Underwater imaging is one of the challenging tasks in the field of image processing and computer vision. Usually, underwater images suffer from non-uniform lighting, low contrast, diminished colour, and blurring due to attenuation and scattering of light in the underwater environment. It is necessary to pre-process these images before applying computer vision techniques.

Over the last few decades, many researchers have developed various image enhancement and restoration algorithms for enhancing the quality of images captured in underwater environments. The authors introduce a brief survey on image enhancement and restoration algorithms for underwater images. At the end of the chapter, we present an overview of our approach, which is well accepted by the image processing community to enhance the quality of underwater images. Our technique consists of filtering techniques such as homomorphic filtering, wavelet-based image denoising, bilateral filtering, and contrast equalization, which are applied sequentially. The proposed method increases better image visualization of objects which are captured in underwater environment compared to other existing methods.

2.3) Topic: "Underwater image super-resolution by descattering and fusion.

Author: H. Lu, Y. Li, S. Nakashima, H. Kim, and S. Serikawa

Underwater images are degraded due to scatters and absorption, resulting in low contrast and colour distortion. In this paper, a novel self-similarity-based method for descattering and super resolution (SR) of underwater images is proposed. The traditional approach of pre-processing the image using a descattering algorithm, followed by application of an SR method, has the limitation that most of the high-frequency information is lost during descattering. Consequently, we propose a novel high turbidity underwater image SR algorithm. We first obtain a high resolution (HR) image of scattered and bespattered images by using a self-similarity-based SR algorithm. Next, we apply a convex fusion rule for recovering the final HR image. The super-resolved images have a reasonable noise level after descattering and demonstrate visually more pleasing results than conventional approaches. Furthermore, numerical metrics demonstrate that the proposed algorithm shows a consistent improvement and that edges are significantly enhanced.

2.4) Topic: "Colour constancy using natural image statistics and scene semantics.

Author: A. Gijsenij and T. Gevers

Existing colour constancy methods are all based on specific assumptions such as the spatial and spectral characteristics of images. As a consequence, no algorithm can be considered as universal. However, with the large variety of available methods, the question is how to select the method that performs best for a specific image. To achieve selection and combining of colour constancy algorithms, in this paper natural image statistics are used to identify the most important characteristics of colour images.

To capture the image characteristics, the Weibull parameterization (e.g., grain size and contrast) is used. It is shown that the Weibull parameterization is related to the image attributes to which the used colour constancy methods are sensitive. AMoG-classifier is used to learn the correlation and weighting between the Weibull-parameters and the image attributes (number of edges, amount of texture, and SNR). The output of the classifier is the selection of the best performing colour constancy method for a certain image. On a data set consisting of more than 11,000 images, an increase in colour constancy performance up to 20 percent (median angular error) can be obtained compared to the best-performing single algorithm. Further, it is shown that for certain scene categories, one specific colour constancy algorithm can be used instead of the classifier considering several algorithms.

2.5) Topic: "Contrast restoration of weather degraded images,"

Author:S. G. Narasimhan and S. K. Nayar

Images of outdoor scenes captured in bad weather suffer from poor contrast. Under bad weather conditions, the light reaching a camera is severely scattered by the atmosphere. The resulting decay in contrast varies across the scene and is exponential in the depths of scene points. Therefore, traditional space invariant image processing techniques are not sufficient to remove weather effects from images. We present a physics-based model that describes the appearances of scenes in uniform bad weather conditions. Changes in intensities of scene points under different weather conditions provide simple constraints to detect depth discontinuities in the scene and also to compute scene structure. Then, a fast algorithm to restore scene contrast is presented. In contrast to previous techniques, our weather removal algorithm does not require any a priori scene structure, distributions of scene reflectances, or detailed knowledge about the particular weather condition. All the methods described in this paper are effective under a wide range of weather conditions including haze, mist, fog, and conditions arising due to other aerosols. Further, our methods can be applied to gray scale, RGB colour, multispectral and even IR images.

III EXISTING SYSTEM

An image histogram is a type of histogram that acts as a graphical representation of tonal distribution describes the distribution of various bright and dark tones with in an image. During the scanning or image editing stage tones can be redistributed lightening a dark image (or) darkening a bright image. This histogram plots the no of pixels for each tonal value. By looking at the histogram for a specific image a person will be able to judge the entire tonal distribution. Image histograms are present on many modern digital cameras. The horizontal axis of the graph represents the tonal variations and the vertical axis represents the no of pixels in that particular tone.

3.1 Normalized histogram

In this normalized histogram, normalized by dividing each value by the tonal no of the pixels in the image and it is denoted by the product MN where M and N are the row and column dimensions of the image. Here p (r_k) represents the probability of occurrence of gray levelrk. Some of all the components of a normalized histogram is 1. Histogram manipulation can be used for image enhancement the information which is inherent in histogram is also useful in other image processing applications like image compression and image segmentation.

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3.2 Histogram Equalization

The probability of occurrence of intensity level rk in a digital image Histogram equalization is a technique for adjusting image intensities to enhance contrast. Histogram equalization is used to enhance contrast. It is not necessary that contrast will always be increase.

Normally, the histogram is a graph showing the number of pixels in an image at each different intensity value found in that image. For an 8-bit gray-scale image there are 256 different possible intensities, and so the histogram will graphically display 256 numbers showing the distribution of pixels amongst those gray-scale values. Histogram equalization is the technique by which the dynamic range of the histogram of an image is increased. Through this adjustment, the intensities can be better distributed on the histogram.

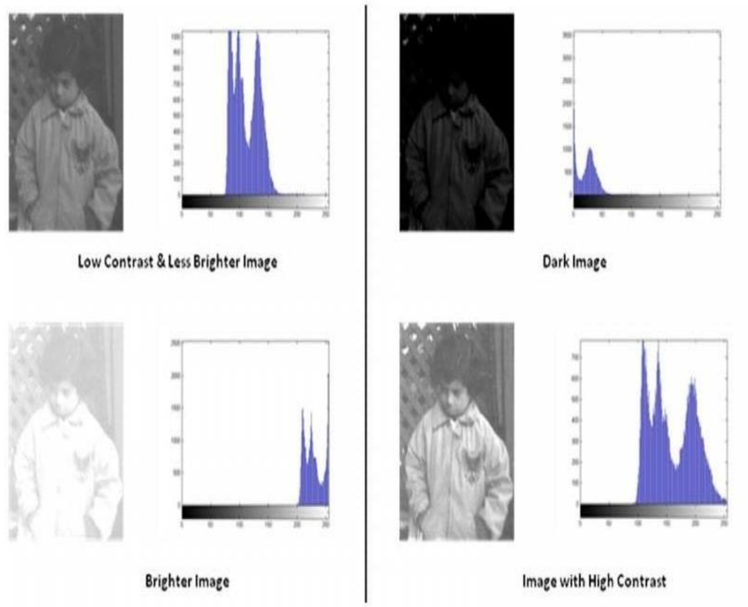
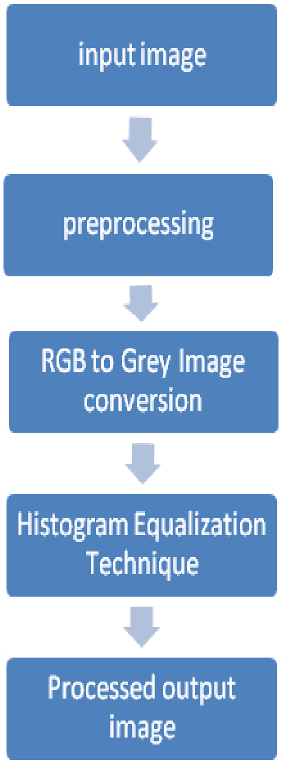


Figure: Different Types of Histogram Images with Different Contrasts

3.3 Adaptive Histogram Equalization

In Adaptive Histogram Equalization the image is divided into several rectangular domains, compute an equalizing histogram and modify levels so that they match across boundaries. Adaptive Histogram Equalization (AHE) computes the histogram of a local window centered at a given pixel to determine the mapping for that pixel, which provides a local contrast enhancement, Therefore regions occupying different gray scale ranges can be enhanced simultaneously.



Most of the outdoor images suffer from contrast degradation caused by fog and haze. Two statistical frame works have been proposed in recent years that exploit local(dark channel prior)and non-local (haze-lines) characteristics of hazy images for the estimation of scene configuration and the restoration of scene albedo. Both frameworks show intrinsic limitations due to the basic assumptions they rely on .In this paper we pro-pose a novel de hazing method that combines the advantages of local and non-local de hazing methods. Exploiting their complementary statistical properties, we use the local features to regulate the estimation of non-local haze-lines for a better final restoration at challenging regions. Both quantitative and qualitative results validate the effectiveness of our proposed method over state-of-the-art frame works.

IV. PROPOSED SYSTEM

The current image fusion methods are divided into two categories. One is to directly fuse source images in spatial domain. However, this kind of methods is not good in dealing with edge. The other one is to integrate source images in transform domain. This type of approaches could remove the block effect and get more consistent fusion result. Image fusion methods based on MSD draw researcher's attention in recent years. For example, Discrete wavelet transform based method[8, 9], stationary wavelet transform based method[10], double-tree complex wavelet transform based method[11], curvelet transform based method[7], contour let transform based method[12], non-sub sampled contourlet transform based method

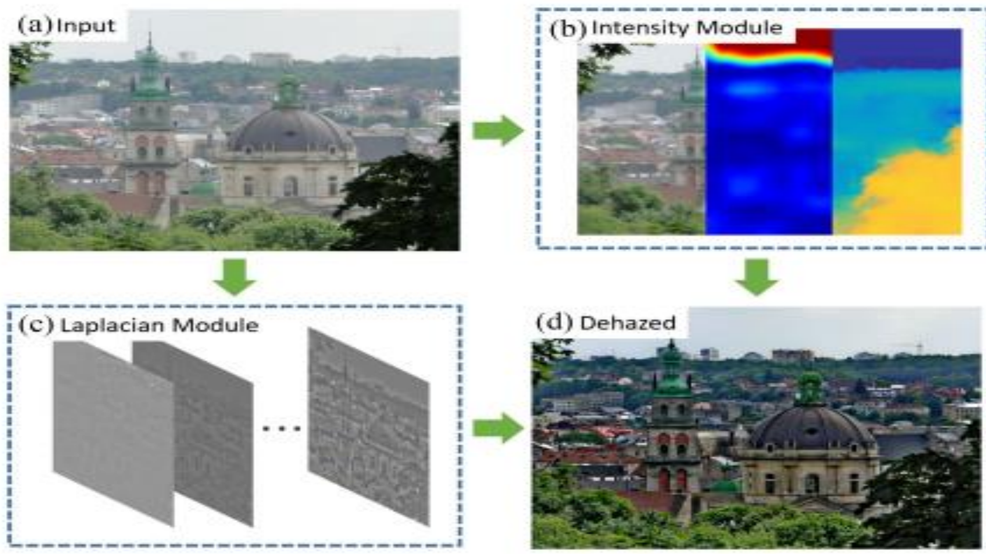


Fig. Functional diagram

IN recent years, image fusion technology becomes more and more important, which has been widely used in many fields such as multi-focus image medical image infrared-visible image and remote sensing image The purpose of image fusion is to combine images containing the same scene from different sensors to generate a more comprehensive and accurate image including all useful information of these source images.

DWT, as a popular MSD tool, is first proposed, It provides a richer scale space analysis for image compared to other MSD tools because it can decompose image into magnitude and phase information. The magnitude of DWT is near shift invariant so it have better texture representation than wavelet and complex wavelet, and the phase of DWT contains richer geometric information.

V. IMAGE FUSION

In computer vision, Multi sensor Image fusion is the process of combining relevant information from two or more images into a single image. The resulting image will be more informative than any of the input images. In remote sensing applications, the increasing availability of space borne sensors gives a motivation for different image fusion algorithms. 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.

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In satellite imaging, two types of images are available. The panchromatic image acquired by satellites is transmitted with the maximum resolution available and the multispectral data are transmitted with coarser resolution. This will be usually, two or four times lower. At the receiver station, the panchromatic image is merged with the multispectral data to convey more information.

Image fusion methods can be broadly classified into two - spatial domain fusion and transform domain fusion.. Another important spatial domain fusion method is the high pass filtering based technique. Here the high frequency details are injected into up sampled version of MS images. The disadvantage of spatial domain approaches is that they produce spatial distortion in the fused image. Spectral distortion becomes a negative factor while we go for further processing, such as classification problem distortion can be very well handled by transform domain approaches on image fusion. The multi resolution analysis has become a very useful tool for analyzing remote sensing images. The Discrete wavelet transform has become a very useful tool for fusion. Some other fusion methods are also there, such as Lapacian pyramid based, curve let transform based etc. These methods show a better performance in spatial and spectral quality of the fused image compared to other spatial methods of fusion. The images used in image fusion should already be registered. mis registration is a major source of error in image fusion. Some well-known image fusion methods are

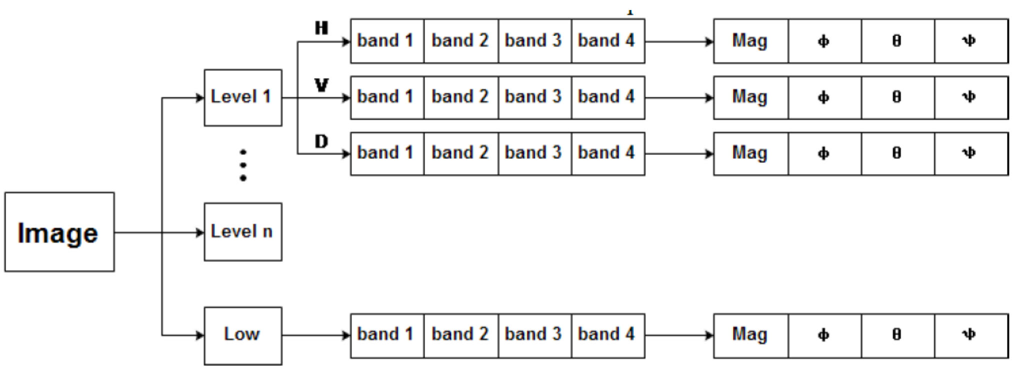

Fig. The DWT decomposition structure of image**.**

VI. RESULTS

We can institute the experimental flow correspond the fusion algorithm designed in this paper, the corresponding flow shown in Figure 4:
The whole experiment is divided into three parts: the first step is pre-process the remote sensing images, including the band combinations, registration, etc.; followed by is image fusion of remote sensing, create high-quality map sources; last get the road layers by road extraction.

VII. CONCLUSION

Haze removal algorithms have become a need for various computer vision based applications. But in already existing approaches, many aspects have been neglected i.e. No technique is accurate in different situation. Survey has displayed the neglected points in the presented methods like the noise reduction methods. The problem of uneven and over illumination is also an issue for dehazing methods. So there is a need of modification in the existing methods so that existing methods work in better way. An integrated dark channel prior, CLAHE and bilateral filter combined algorithm can be used to get better results.

VIII REFERENCES

[1] Tan, Robby T, "Visibility in bad weather from a single image" IEEE Conference on Computer Vision and Pattern Recognition, CVPR, pp. 1-8, Year 2008.

[2] Tarel, J-P. and Nicolas Hautiere, "Fast visibility restoration from a single color or gray level image", 12th International Conference on Computer Vision, pp. 2201-2208, Year 2009.

[3] Yu, Jing, Chuangbai Xiao and Dapeng Li, "Physics-based fast single image fog removal.",10th IEEE International Conference on Signal Processing (ICSP), pp. 1048-1052, Year 2010.

[4] Fang, Faming, Fang Li, Xiaomei Yang, Chaomin Shen and Guixu Zhang, "Single image dehazing and denoising with variational method", IEEE International Conference on Image Analysis and Signal Processing (IASP), pp. 219-222, 2010.

[5] He, Kaiming, Jian Sun and Xiaoou Tang, "Single image haze removal using dark channel prior.",IEEE Transactions on Pattern Analysis and Machine Intelligence, vol.33, no. 12, pp. 2341- 2353,2011.

[6] Long, Jiao, Zhenwei Shi and Wei Tang, "Fast haze removal for a single remote sensing image using dark channel prior", International Conference on Computer Vision in Remote Sensing (CVRS), pp.132-135, 2012.

[7] Zhang, Yong-Qin, Yu Ding, Jin-Sheng Xiao, Jiaying Liu and Zongming Guo, "Visibility enhancement using an image filtering approach", EURASIP Journal on Advances in Signal Processing, no. 1, pp. 1-6, 2012.

[8] Xu, Haoran, Jianming Guo, Qing Liu and Lingli Ye, "Fast image dehazing using improved dark channel prior", IEEE International Conference on Information Science and Technology (ICIST), pp. 663-667, 2012.

[9] Ullah, E., R. Nawaz and J. Iqbal, "Single image haze removal using improved dark channel prior",Proceedings of International Conference on Modelling, Identification & Control (ICMIC), pp. 245-248, 2013.

[10] Hitam, M. S., W. N. J. H. W. Yussof, E. A. Awalludin and Z. Bachok, "Mixture contrast limited adaptive histogram equalization for underwater image enhancement", IEEE International Conference on Computer Applications Technology (ICCAT), pp. 1- 5, 2013.

[11] Ghani, Ahmad Shahrizan Abdul, and Nor Ashidi MatIsa. "Underwater image quality enhancement through integrated color model with Rayleigh distribution."Applied Soft Computing 27 (2015): 219- 230.

[12] Wang, Jin-Bao, Ning He, Lu-Lu Zhang, and Ke Lu. "Single image dehazing with a physical model and dark channel prior." Neurocomputing 149 (2015): 718-728.

[13] Wang, Yan, and Bo Wu (2010) Improved single image dehazing using dark channel prior IEEE International Conference on Intelligent Computing and Intelligent Systems. Vol. 2. IEEE.

[14] Cheng, F-C., C-H. Lin, and J-L. Lin (2012): Constant time O (1) image fog removal using lowest level channel Electronics Letters 48.22, 1404-1406.

[15] Zhiyuan Xu. "Fog Removal from Video Sequences Using Contrast Limited Adaptive Histogram Equalization", International Conference on Computational Intelligence and Software