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International Journal Of Engineering And Computer Science ISSN:2319-7242
Volume 3 Issue 8 August, 2014 Page No. 7890-7894

Pyramid Based Image Fusion

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Abstract:*Many images are degraded by the bad weather conditions due to smoke, fogs, dust and ash which are obstacle in clarity of images. Image processing techniques improve the quality of an image and enhance the maximum information from the degraded image. It is the process of combining two or more images into a single image; method is a fusion-based strategy that derives from two original hazy images inputs by applying a white balance and contrast enhancing procedure.The method performs in a pyramidal method, which is straightforward to implement. Then the resulting image will be more clear and enhanced from the prior. This thesis reports a detailed study performed over a set of image fusion algorithms regarding their implementation. The thesis demonstrates the utility and effectiveness of a fusion-based technique for dehazing based on a single degraded image.*
Keywords: Single image dehazing, Weight maps, Fusion Method, Pyramid Technique.

1. Introduction

Images of outdoor scenes often contain haze, fog, or other types of atmospheric degradation caused by particles inthe atmospheric medium absorbing and scattering light as it travels from the source to the observer. Image Fusion is a mechanism to improve the quality of information from a set of images. By the process of image fusion the good information from each of the given images is fused together to form a resultant image whose quality is superior to any of the input images. This is achieved by applying a sequence of operators on the images that would make the good information in each of the image prominent. The resultant image is formed by combining such magnified information from the input images into a single image [1]. The term fusion in general means, the process is to integrate multisensory or multi-view or multifocal information into a new image that contains better quality features and is more observable. Image fusion is called Pan sharpening used to integrate the geometric details of the high resolution images and colour of the low resolution or multispectral (MS) images. Image fusion finds application in various fields such as satellite imaging, medical sciences, military applications digital cameras multi-focus imaging etc.

Image fusion methods can be broadly classified into spatial domain and transform domain fusion Brovey method, Principal Component analysis (PCA), IHS (intensity hue saturation) and High pass filtering methods fall in the spatial domain fusion techniques. Spatial image fusion work by combining the pixel values of the two or more images. The simplest is averaging the pixelvalues of the input images wavelet transform[2] and Laplacian transform[1] come in the transform domain. In the transform domain method the multi-scale decomposition of the images is done and the composite image is constructed by using the fusion rule. Then Image Fusion finds it application in vast range of areas. It is used for medical diagnostics and treatment. A patient's images in different data formats can be fused. These forms can include magnetic resonance image (MRI), computed tomography (CT), For example, CT images are used more often to ascertain differences in tissue density while MRI images are typically used to diagnose brain tumours.

2. Review of Literature

In [12], Fattal proposed an algorithm based on independent component analysis. This algorithm estimates the surface shading and the medium under the assumption transmissions which are locally uncorrelated, and gets the image local albedo and restore image contrast. However, a distinct lack of enough color in heavily haze images makes heavily haze images cannot be handled well. In [14], Tarel proposed an improved image defogging algorithm based on bilateral filtering.Tan [11] developed a system for estimating depth from a single weather degraded input image. Motivated by

the fact that contrast is reduced in a foggy image, Tan divided the image into a series of small patches and postulated that the corresponding patch in image should have a higher contrast (where contrast was quantified as the sum of local image gradients). In [13], He proposed a simple but effective image prior-dark channel to remove haze from a single input image. However, as the haze imaging model assumes common transmission for all color channels, this method may fail to recover the haze images. Fattal [12] assumed every patch has uniform reflectance, and that the appearance of the pixels within the patch can be expressed in terms of shading and transmission. He considered the shading and transmission signals to be unrelated and used independent component analysis to estimate the appearance of each patch. Significant progress in single image haze removal has been made in recent years. Tan[11] made the observation that a haze-free image has higher contrast than a hazy image, and was able to obtain good results by maximizing contrast in local regions of the input image. However, the final results obtained by this method are not based on a physical model and are often unnatural looking due to over-saturation. Fattal [12] was able to obtain good results by assuming that transmission and surface shading are locally uncorrelated. With this assumption, he obtains the transmission map through independent component analysis. This is a physically reasonable approach, but this method has trouble with very hazy regions where the different components are difficult to resolve. Lastly, a simple but powerful approach proposed by He [13] uses dark pixels in local windows to obtain a coarse estimate of the transmission map followed by a refinement step using an image matting technique. Their method obtains results on par with or exceeding other state-of-the-art algorithms, and is even successful with very hazy scenes.

3. TheoreticalLevel

3.1*Discrete Wavelet Transform*

The discrete wavelet transform (DWT) of image signalproduces image representations which provides better spatialand spectral localization of image formation compared withother multi scale representations such as Gaussian andLaplacian pyramid[4] . Recently, DWT has attracted more and more interest in imagefusion. An image can be decomposed into a sequence ofdifferent spatial resolution images using DWT[5].

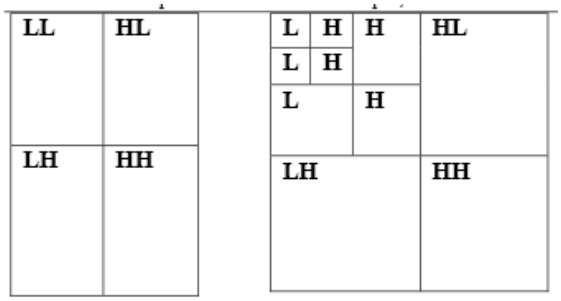


Figure 1: Pixel Level

Image fusion technique [2]is a powerful tool forextracting high quality information from large number ofremotely sensed images and limiting redundancy among theseimages. Image fusion technique, with an image fusion engineto organize, join, and combine multi source and multitemporal data, provides a powerful tool for these dataprocessing problems[9]. Wavelet transform is first performedon source images. Then a fusion decision map is generatedbased on a set of fusion rules. Then fused wavelet coefficientmap can be constructed from the wavelet coefficients of thesource images according to the fusion decision map. Finallythe fused image is obtained by performing the inverse wavelet.

3.2 Pixel Level Fusion

This section focuses on the so-called pixel level fusionprocess, where a composite image has to be built of severalinput images[1]. In pixel-level image fusion, some genericrequirements can be imposed on the fusion result:

a) The fusion process should preserve all relevant informationof the input imagery in the composite image (patternconservation)

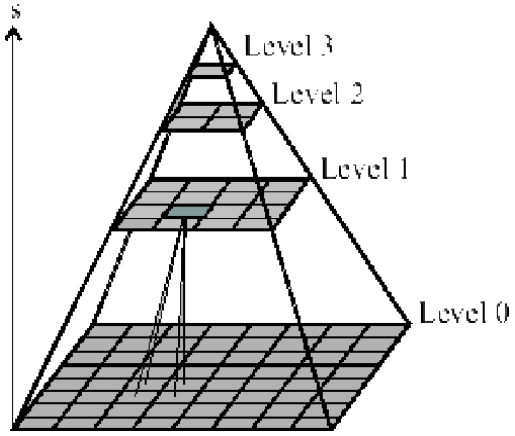


Figure 2: Laplacian Method

b) The fusion scheme should not introduce any artifacts orinconsistencies which would istract the human observer orfollowing processing stages[1].

c) Image fusiontakes place at three different levels i.e. pixel, feature and decision. Image fusion methods can bebroadly classified into two that is special domain fusion and transform domain fusion. Averaging,Brovery method, Principal Component Analysis (PCA), based methods are special domainmethods. But special domain methods produce special distortion in the fused image .Thisproblem can be solved by transform domain approach. The multi-resolution analysis has becomea very useful tool for analysing images. The discrete wavelet transform has become a very usefultool for fusion. The images used in imagefusion should already be registered. Pixel level fusion technique is used to increase thespecial resolution of the multi-spectral image. Application of image fusion include improvinggeometric correction, enhancing certain features not visible in either of the single data alone,change detection using temporal data sets and enhancing provide a complete information forDiagnosis [2].

4. Fusion Process

The images are first decomposed using a Laplacian

Pyramid decomposition of the original image into a hierarchyof images such that each level corresponds to a different band of image frequencies [1]. The Laplacian pyramid decomposition is a suitable MR decomposition for the present task as it is simple, efficient and better mirrors the multiple scales of processing in theHVS. The next step is to compute the Gaussian pyramid of the weight map. Blending is then carried out for each level separately [1] [2].

A. Inputs

As mentioned previously, the input generation process seeksto recover optimal region visibility in at least one of theimages.In practice, there is no enhancing approach that is ableto remove entirely the haze effects of such degraded inputs.Therefore, considering the constraints stated before, since weprocess only one captured image of the scene, the algorithmgenerates from the original image only two inputs that recovercolor and visibility of the entire image. The first one better depicts the haze-free regions while the second derived inputincreases visible details of the hazy regions.Inherently inspired by the previous dehazing approachessuch as Tan [11], Tarel and Hautiere [14] and He et al. [13],we searched for a robust technique that will properly white.

B. Weight Maps

As can be seen in figures by applying only theseenhancing operations, the derived inputs still suffer from lowvisibility mainly in those regions dense haze and lowlight conditions. The idea that global contrast enhancementtechniques are limited to dealing with hazy scenes has beenremarked previously by Fattal [12]. This is due to the fact thatthe optical density of haze varies across the image and affectsthe values differently at each pixel. Practically, the limitationof the general contrast enhancement operators (e.g. gammacorrection, histogram equalization, white balance) is due tothe fact that these techniques perform (constantly) the sameoperation across the entire image. In order to overcome thislimitation, we introduce three measures (weight maps). Thesemaps are designed in a per-pixel fashion to better define thespatial relations of degraded regions.Our weight maps balance the contribution of each input andensure that regions with high contrast or more saliency froma derived input, receive higher values [1].

The ***luminance weight map*** measures the visibility of eachpixel and assigns high values to regions with good visibility and small values to the rest. Since hazy images present lowsaturation, an effective way to measure this property is toevaluate the loss of colorfulness. This weight is processedbased on the *RGB* color channel information. We make useof the well-knownproperty that more saturated colors yieldhigher values in one or two of the color channels [1].

5. Results and discussion

Image Fusion aims to enhance the information apparent in the images as well as to increase the reliability of the interpretation by integrating disparate images. This leads to more clear data and increased visualises in application fields like medical imaging, foggy images, etc. This paper discusses different techniques for pixel level image fusion and their performance evaluation parameters. Depending upon the use of the given application, some users may wish a fusion outcome that would show more color details, some may desire more analysis or mapping; while some may want improved accuracy of application; and some others may wish for a visually beautiful and appealing fused color image, solely for visualization purposes. Thus, we can conclude that fusion algorithm with pixel level and weight maps. A combination of weight maps including luminance map, chromatic map, saliency map

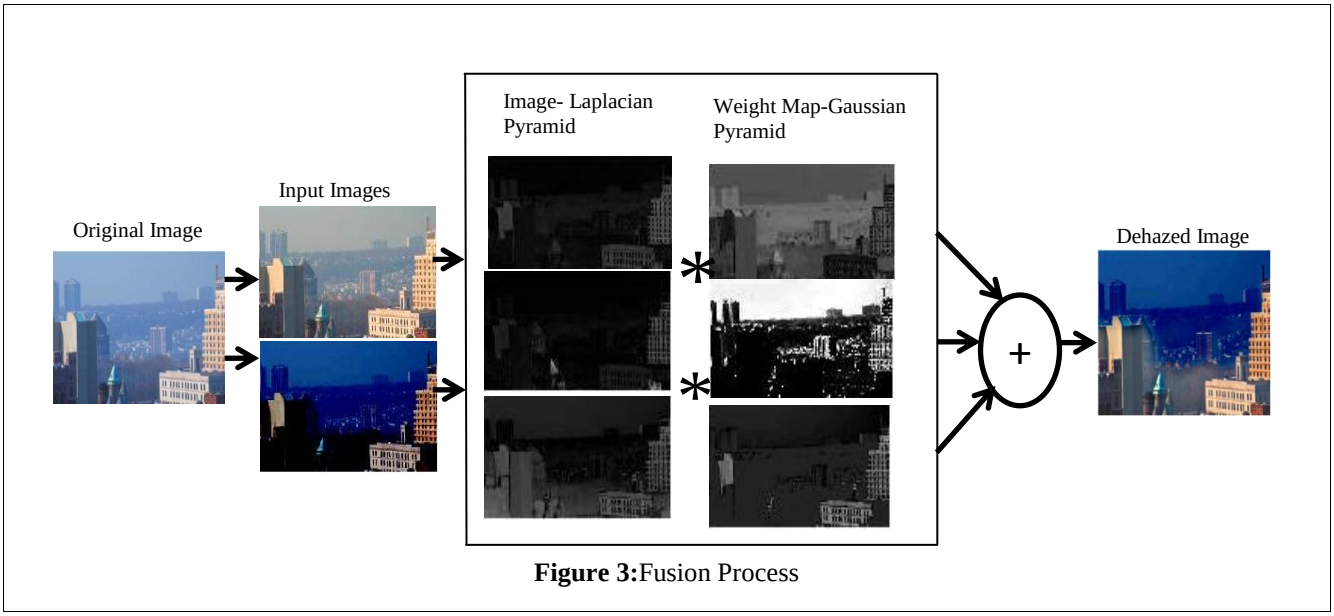
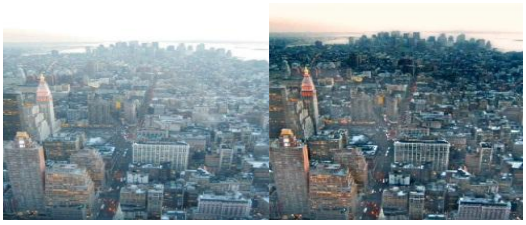


Figure 3: Fusion Process

(a)Haze1 (b)Our Result

(a)Haze 2 (b)Our Result

(a)Haze 3 (b)Our Result



(a)Haze 4 (b)Our Result

(a)Haze 5 (b)Our Result

(a)Haze 6 (b)Our Result

Figure 4: Output Result of Many Hazy Images.

Which increase the clarity of foggy image this approach may be the correct way to find out which fusion algorithm is most appropriate for an application.

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