International Journal of Engineering & Technology, 7 (2.8) (2018) 432-435

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research Paper

Image enhancement with contrast coefficients using wavelet based image fusion

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Abstract

The future is mainly focused on image brightness and the capacity that required storing the image. The sharp images provide better information than the blur images. To overcome from the blurriness in the image, we use image enhancement techniques. Image fusion used to overcome information loss in the image. This paper is provided with image enhancement and fusion by applying wavelet transform technique. Wavelet transform is mainly used because due to its inherent property that is they are redundant and shift invariant. It transforms the image into different scales. Image enhancement will be decided based on the levels of transformation. Low contrast results from poor resolution, lack of dynamic range, wrong settings of sensor lens during acquisition and poor quality of cameras and sensors. To avoid the information loss there is an interesting solution that is for the pictures of the same image but focused on different regions. Then using image fusion concept, all images which are captured are combined to get a single image which contains the properties of both the source images. The image entropy is composed to determine the quality of the image. The paper shows the image fusion method for both multi-resolution and images captured at different temperatures.

Keywords: *DWT, image enhancement, image fusion, low contrast, multi- resolution images, wavelet transform.*

1. Introduction

Image enhancement is mainly focusing on processing an image in such a way that giving the output image better than the input image in the means of quality by improving the number of pixels.[1-7]. This method works well for low contrast images, satellite images, X-ray topographic images [8]. In other words this can be described as improving the attributes of the image to make it more. Enhancement doesn't increase the inherent information of the data, but it increases the dynamic range of the chosen features so that they can be detected easily. Image enhancement methods can be either spatial or frequency domain techniques [8]. Spatial domain techniques are performed to the image plane itself and they are based on direct manipulation of pixels in an image. Frequency domain methods enhance an image by convoluting the image with a linear, Position invariant operator [8]. Image fusion became a challenging area for research in present years. Image fusion applies in the areas like military, medical imaging, satellite imaging, remote sensing etc. The process of image fusion is to combine the information content of the same scene from two or more images. The image can be taken at different temperature conditions or with different cameras. So by combining those images we get a finalized image containing the information of input images. Image fusion is of three types, which are pixel, feature and decision level. Comparing to this three methods pixel based is preferable because it preserves the original information of input image. So it is considered as primary method for the image fusion. Image fusion based on Wavelet transform becomes an important research area according to the image fusion research which considers both multi-scale and multi-resolution. Image fusion gains the visual or important information from the multiple images. So the resultant image contains the whole information that is the image contains all the information of selected images or fusion images. The method of implementation is like [9]:-

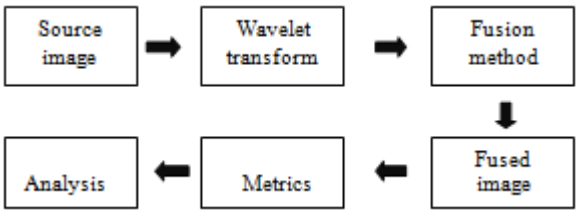


Fig. 1: Method of Implementation

This paper gives the information about image enhancement using wavelet fusion method. And this method is applied to the various images like multi-resolution images, images captured at different temperature. The metrics is calculated for the resultant image. Finally the experiment results and conclusion is provided.

2. Wavelet Transform

Wavelets are the functions of finite length and wavelets are a more general way to represent and analyze multi resolution images. By using wavelets we can remove the noise. Wavelet transform is a global mathematical analysis method, which has a good position capability in both time and frequency domains, which selects the appropriate frequency band adaptively based on the characteristics

of the signal [10, 11]. Wavelet transforms process data at different scales or resolutions. It is a mathematical technique in which a particular signal is analyzed in time domain by using different versions of contracted and shifted basis function called the wavelet prototype or mother wavelet. Wavelet transform is a process of filtering and re-sampling of images [8]. The process of wavelet transform can be performed by two steps, wavelet decomposition and reconstruction. Wavelet method is very good with both time and frequency domains. This wavelet process is done in two ways: wavelet decomposition and wavelet reconstruction. The process wavelet reconstruction is reverse to the decomposition. The wavelet transformation and decomposition mainly used in image fusion which represents the image variations at different scales. This wavelet transform approach is like filtering and re-sampling of images [12]. Wavelet transform decomposes image into different frequency bands which consists of detailed information and approximate information. The decomposed levels are like Low-Level (LL), Low-High (LH), High-Low (HL) and High-High (HH). In which it contains three levels of detailed information they are LH, HL, HH and one approximation level that is LL. In first level decomposition it divides into the above mentioned frequency bands [9, 15].

2.1. Wavelet Decomposition

LL is the Low-Level decomposition which contains image information. LH contains the horizontal information, HL contains vertical information and HH contains diagonal information [12, 15]. After first level decomposition the frequency components are LL1, LH1, HL1, HH1 respectively as shown in figure 2. For the next level LL1 is decomposed into LL2, LH2, HL2, HH2 as shown in figure 2 [9].

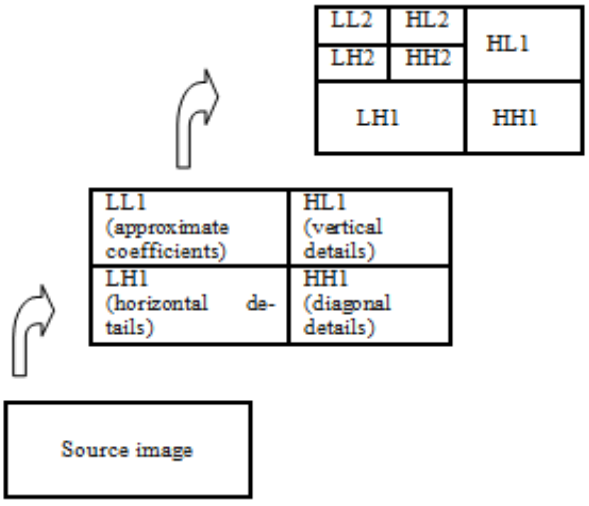


Fig. 2: Steps of decomposition levels

2.2. Image Fusion

Wavelet decomposition is mainly used for image fusion. The process is like combining the two images in which the images are wavelet decomposed.

From figure 3 the images A and B are wavelet decomposed images [9]. Those images have undertaken same level of decomposition. By fusing the images A and B we get resultant as fused image. The output contains the information of the two decomposed or source images. The decomposition is done because to get the accuracy in source image that is we are filtering or eliminating unwanted coefficients which are detailed coefficients [10, 13].

Mainly it takes three steps to perform fusion [14]

Step 1: Firstly decompose the two source images to get lower decomposed images.

Step 2: Secondly apply fusion method to each of the decomposed image

Step 3: Apply inverse discrete wavelet transform and fuse rule, which is to reconstruct the Image and that image, is the fused image F. Which shown in figure 3.

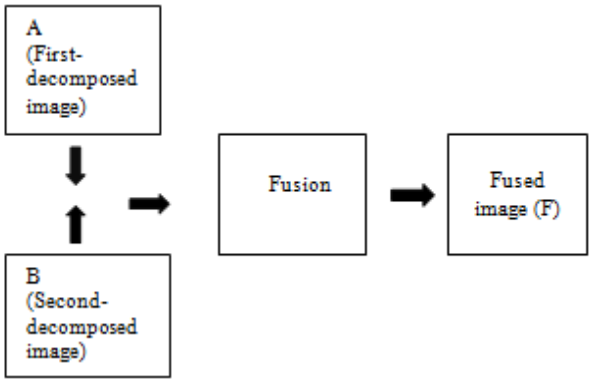
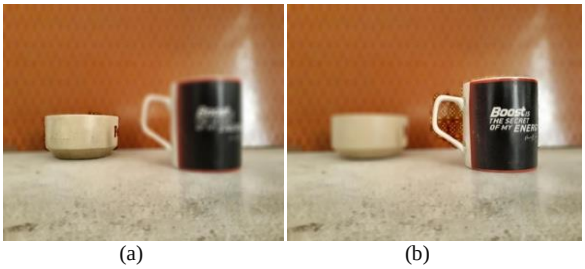


Fig. 3: Wavelet based image fusion

Image F contains the enhanced and fused image, which contains the content information from the both images A and B [9].

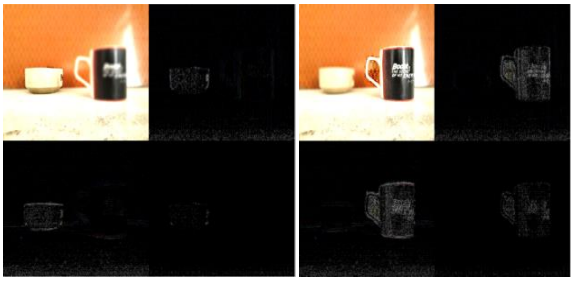
3. Experimental Analysis

In this paper we done the fusion method for two types of images, they are multi-resolution, and images captured at different temperatures. Fig 4 shows the analysis of multi-resolution image and Fig 5 shows the analysis of images at different temperatures. In Fig 4 and 5 (a) and (b) represents the two input images in which it is focused on one of the object and rest of the object is not focused.



(a) (b)

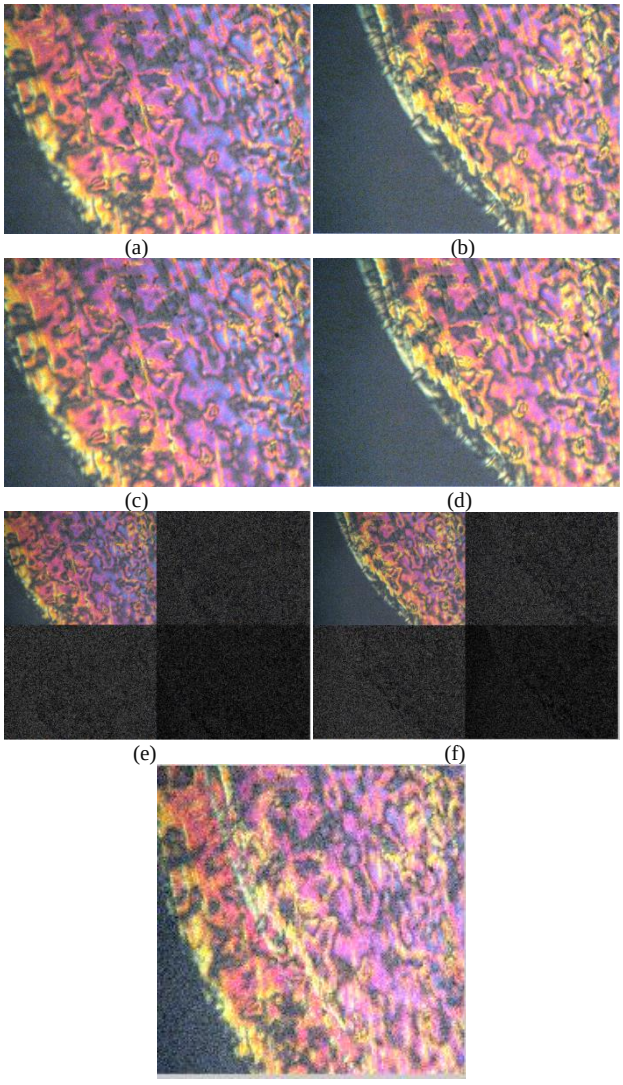
(C) (d)



(e) (f)

(g)

Fig. 4: Original image and its decomposition levels
(a) Image focused at left (image 1) (b) Image focused at right (image 2) (C) approximate coefficient of image1.(d) approximate coefficient of image2. (e) First-level decomposition of image1. (f)First-level decomposition of image2.(g) Fused image.



(g)

Fig. 5: Images at different temperatures and its decomposition
(a)Image 1 at low temperature (b) Image 2 at high temperature
(c) Approximate coefficients of image 1 (d) approximate coefficients of image 2 (e) First-level decomposition of image 1 (f) First-level decomposition of image 2 (g) Fused image.

In fig 5 image 1 is taken at low temperature and image 2 taken at high temperature that is the information will change according to the temperature level. So to get the total information we apply the fusion method to both the images.

4. Performance Metrics

There are number of techniques to implement fusion algorithm. So for estimation we need to calculate metrics. The source images we are considering are of different types, to estimate the difference or to estimate the quality of an image quantitative measures been included than by observing with human eye. The following quantitative analysis helps to judge the performance of fusion methods.

Mean square error
It is measurement of quality of an image index. It is the square of average of noise or distortions present in the final fused image and loss of energy included in this image, which we given as input. It should be positive or equals to zero. If mean square error is very high that indicates that image quantity is less.

Signal to noise ratio
It defines the sensitivity and the quality of the reconstructed image. Signal to noise ratio is the ratio of the highest power of the signal and square root of noise present in the image. It represents in the terms of decibels. PSNR is the peak signal to noise ratio. It is used to compare image compression quality.

Entropy
It gives the information present in the image after performing all the operations to the fused image. If the value of entropy is high then it is good to consider the fused image than reference image.

Table 1: Table of performance metrics

Parameter	Multi-Resolution Image	Image At Different Temperature
ENTROPY	2.6359	7.4122
MSE	149.7231	95.1572
SNR	13.7310	13.1508
PSNR	26.3779	28.3564

Table 1 contains the parameters which are used to compare the different images. The above four parameters are calculated for the final fused output image.

5. Conclusion

Fusion method based wavelet transform is proposed in this paper on multi-resolution image that has the combination of High contrast and Low contrast images. By applying the wavelet decomposition method, the quality of the image is increased and by segmenting the detailed information, the approximate coefficients are preserved. Finally to know the image quality, the difference between images and the performance parameters are reviewed. Image fusion technique is applied to enhance the image quality without disturbing the contrast coefficients.

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