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Hybrid Approach based Image Fusion Method for Image Enhancement

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Abstract: ***Image fusion is a process of integrating information from multiple sensors, which enhances the quality of images quantitatively and qualitatively. Image fusion provides an effective way of reducing this increasing volume of information while at the same time extracting all the useful information from the source images. Various types of image fusion method are developed which has their own merits and demerits. This paper used the advantages of Wavelets transform and principal components analysis (PCA) based image fusion to develop a hybrid image fusion.***

Keywords: Image Fusion, Entropy, PCA, Wavelets transform

1. Introduction

Digital image processing is important field for the rapid growing organization in various applications such as remote sensing, medical imaging, machine vision and the military applications. In this organization use the various instruments and sensor for collecting information. The result of the use of instruments and sensors are huge increase of the amount of data available in a form of images. [1-2]. These huge amount of information required the storage issue as well as increases time of information extraction. This can be reduced by using the image fusion.

Image fusion is a process of integrating two or more images generated from multiple sensors or methods into a signal images is called image fusion. Image fusion merges the different information and obtains a new and improved image from several images of same object which provides different information based on different resolution and viewing angle [3]. Various researcher has studied and developed different types of image fusion method which has its own advantages and disadvantages.

Mirajkar et al. studied the wavelet based image fusion techniques. They used different from of wavelet transform and found that stationary wavelet based image fusion method at level 2 perform better as compared to all other methods [4]. Jing et al. proposed a novel PCA based Pixel-level multi-focus image fusion algorithm. For this new adaptive algorithm is used for generation of sample matrix of principal components. Jing are found that the proposed algorithm is more informative and also found that the method is less complex than the PCA method, which could save a lot of execution time in embedded system [5]. Comparative study of different fusion techniques are performed by Thirunavukkarasu et al. and found that by using different fusion method has its own advantages and disadvantages [6]. Navita et al. reviewed the different image fusion method and found that the use of individual methods in integrated form is providing more superior results as compare to the individual form [7].

Metwalli et al. [8] developed hybrid fusion method based on PCA and high pass filter for pan sharpened image with superior spatial resolution and less spectral distortion. This method is used in remote sensing data with different spatial and spectral properties. Metwalli is found that the developed method are significantly reduced the spectral distortion compared with the PCA, HPF, and GS fusion methods. Changtao et. al. [9] studied on multimodal medical image fusion based on IHS and PCA. Changtao used features of IHS and PCA methods and integrated the merits both preserving spatial information of the IHS transform and minimizing redundancy of PCA transform. Naidu et al. developed the pixel level image fusion using wavelet and PCA. They found that that image fusion using wavelets with higher level of decomposition showed better performance in some metrics and in other metrics, principal components analysis showed better performance [10]. In this paper hybrid approach of the image fusion method is used which is based on the wavelet and PCA method.

2. Proposed Method

Proposed image fusion is integrated form of wavelet transform and PCA. In this algorithm input images are decomposed in wavelet sub-domain. Wavelet decomposed images change the input images into four sub domain i.e. Low-Low (LL), Low-High(LH), High-Low (HL) and High-High (HH). This sub domain contains the information at different frequency level and LL contains the highest information about images. These sub-domain images used for PCA based fusion for enhancement of contrast as well as SNR of images. Finally inverse wavelet transform is performed to regenerate the fused image. Figure 1 shows the proposed image fusion method.

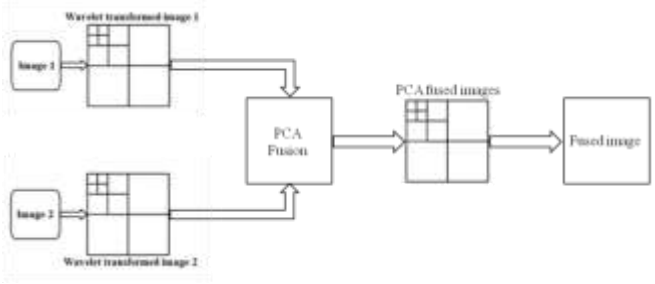


Figure1: Proposed image fusion method.

3. Performance Evaluation

Performance evaluation of image fusion can be done by two ways. First is based on the human vision system (HVS). In this, qualitative assessment of fused image based on the visibility of the features in fused images. Second is the objective evaluation metrics. There are several metrics presents for assessments of the images objectively and they classified in to two categories, first one required a reference image while other do not. For objective evaluation of the fused image, the proposed fusion method used entropy and standard deviation.

A. Standard deviation

Standard deviation is used to measure the amount of variability around the mean of the image. It is defined as the square root of the variance as given in equation 1 below:

$$Standard\ deviation\ (\sigma) = \sqrt{\sum_{i=0}^{m}\sum_{j=0}^{n}\frac{(I(i,j)-\mu)^2}{m\times n}} \quad (1)$$

where $\mu = \frac{1}{m\times n}\sum_{i=0}^{m}\sum_{j=0}^{n} I(i,j)$ (2)

where I is the image, μ is the mean of the image, m and n refers the number of rows and column in image I.

B. Entropy

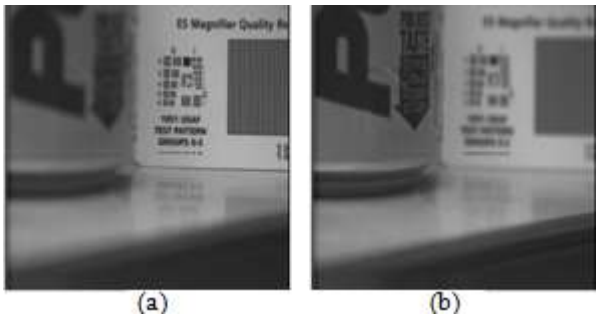
The entropy of an image describes the amount of information present in the image. The entropy (H) of the image is defined as:

$$H = -\sum_{i=1}^{m}\sum_{j=1}^{n} P(i,j)\ \log_2 P(i,j) \quad (3)$$

where P is the probability of intensity at pixel level of image.

4. Results and Discussions

For the performance evaluation of the proposed method two sets of multi-focused standard images (these images are taken from internet) are used which are shown in figure 2.



(a) (b)

(c) (d)

Figure 2: Multi-focused input Images (a) pepsi1.gif (b) pepsi2.gif (c) saras1.jpeg and (d) saras2.jpeg.

Figure 3 shows the fused images of the sets of input images. From the figure it is clearly visible that fusion can be able to enhance the performance of the input images, which is a focused image.

Further the performance of the images is analysis based on the SNR, entropy and standard deviation. Table 1 shows the measured values of the different sets of images. From the table it is observe that the fused image has improved the entropy (E) and standard deviation (SD) value. From the table it is clearly seen that the standard deviation of the image is high as compare to the input images. An image with high contrast would have a high standard deviation, because of the higher dispersion (higher range of data) around the mean of the image. It is also shown that the entropy of the fused images is low as compare to its input images, which shows the high contrast information.

(a) (b)

Figure 3: Fused image (a) pepsi.gif (b) saras.jpeg

Table 1: Performance evaluation parameters

S. No	Image		SD	E
1.	Test image 1	pepsi1.gif	43.8158	0.0104
		pepsi2.gif	44.9985	0.0094
		pepsi.gif	60.0065	0.0001
2	Test image 2	saras1.jpeg	45.5422	0.0336
		saras2.jpeg	48.0445	0.0060
		saras.jpeg	49.5837	0.0010

5. Conclusion

In this paper the hybrid image fusion method is presented and studied with different set of input images. Performance of this method is studied using the entropy and standard deviation and found that the fused image has enhanced quality of images.

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