Image Fusion using Eigen Features and Stationary Wavelet Transform

S.B.G.Tilak Babu, K.H.K.Prasad, Jyothirmai Gandeti, Devi Bhavani Kadali, V.Satyanarayana, K.Pavani

Abstract: Image fusion is a technique of fusing multiple images for better information and more accurate image compared source images. The applications of image fusion in modern military, multi-focus image integration, pattern recognition, remote sensing, biomedical imaging etc.In this paper discussed, pros and cons of various newly arrived existing techniques in spatial and transform domain image fusion techniques. The individual advantages of Stationary Wavelet Transform (SWT) and Principal Component Analysis (PCA) is become great advantage to the proposed method.Standard dataset is used to evaluate the performance of proposed method, the obtained results are compared with exiting methodologies and shows robustness in terms of entropy, standard deviation and Peak Signal to Noise Ratio (PSNR).

Key Words: Fusion, multi-focus image integration, SWT, PCA, PSNR, standard deviation.

1. INTRODUCTION

Image fusion helps to extract more information from a single composite image over two separate images. The image fusion method having many applications likemulti-modality (e.g., visible and infrared) image fusion, multi-focus image integration, multi exposure image fusion, remote sensing, biomedical imaging etc.Proper design of fusion rule for specific application like multi-modality is very important task in research. Very few articles are identified in literature on a fusion rule applied on multiple image fusion applications[1], more over efficient design of a fusion rule that is applicable to multiple fusion applications is much needed to present industries.

The image fusion can be achieved in spatial domain or frequency domain. Jiayi Ma et al., proposed a technique of fusing infrared image and visible image [15]. The fusion of two images is depended on Gradient Transfer Fusion (GTF), GTF is a combination of gradient transfer with minimization of total variation. Jiayi Ma et al., are succeeded image fusion without any registration of source images [5]. Yanfei and Nong [6] proposed a multi sensor image fusion technique based on hierarchical multi resolution along with attention. Important areas are identified by using visual attention model and maximum entropy. Based on adoptive weighing rules, first level of fused image is obtained from visible image and infrared image. Finally,Non-Subsampled Counterlet Transform (NSCT) is used to obtain final fused image. Huafeng Li [7] also proposed for the fusion of multi sensor image combination based on NSCT. Jun Lang and Zhengchao image fusion technique [8] provides less spectral distortion and good spatial resolution based onadaptive pulse coupled neural network (PCNN) anddiscrete fractional random transform.Various datasets are available to test fusion algorithm thoroughly, example source images are shown in table1. Usually, infrared and visible images are fused to extract more information from images.

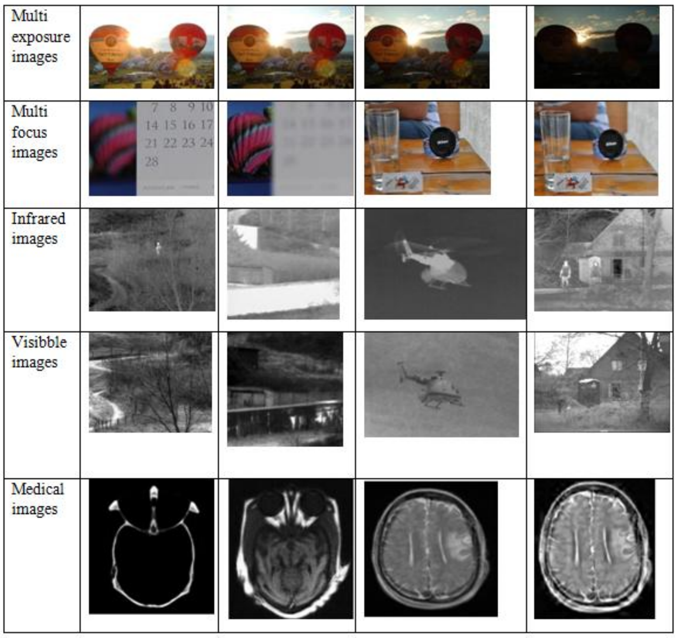

Table1. Various source images for fusion

Revised Manuscript Received on May 22, 2019.

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PCA [2] increases the spatial resolution butit creates distortion in spectrum of remotesensing image fusion. SWT has advantage of translation invariance over DWT along with DWT advantage of time frequency localization. The paper set as follows, in section 2 proposed methodology, its flow diagrampresented. In section 3, results, performance calculations and performance comparison of proposed method with exited methods are presented. Finally, conclusions along with future directions are given in section 4.

2. PROPOSED METHOD

The main advantage of SWT [11]-[14] is translations invariance and the advantage of PCA is able to reduce the redundancy present in the data [16].Due to presence of up-samplers and down-samplers in DWT, it lacks translation invariance, this drawback in discrete wavelet transform is overcomes in stationary wavelet transform by removing the up-samplers and down-samplers, so SWT also called as Translation invariant wavelet transform. The output of SWT contains same number of samples as the input, so it is also called redundant wavelet transform.

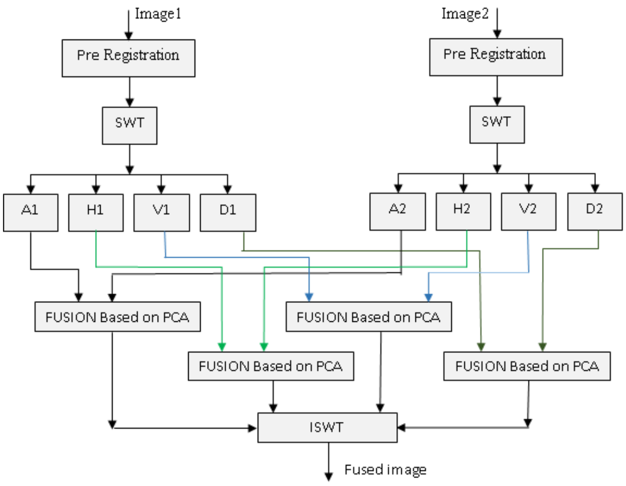

Fig1: Flow diagram of proposed method

PCA is a statistical method based on orthogonal transformation, it results dissimilar linear variables from set of possible similar variables, this resultant set called “principle components”.The individual advantages SWT and PCA are used to fuse two images in proposed method.With the above review of image fusion approaches, it can be inferred that SWT not only provided good time and frequency localization; but also detects the curved shapes more precisely than DWT. However, processing via SWT leads to a high level of non-directionality in the decomposed coefficients. As a remedy, the same could be balanced by applying PCA based fusion rule. PCA which is a highly directional fusion rule not only counters the non-directionality limitation of SWT, but also enhances the feature which makes it more suitable for fusion of medical images. Although, usage of PCA along with SWT can pose improvements via removal of its non-directionality

In the first step of proposed method, the input images of any size are registered into same size, and then the two source images applied to SWT separately. The SWT converts an image into four different subbands Approximation coefficient (A), Diagonal coefficient (D), Vertical coefficient (V) andHorizontal coefficient (H).In figure1 A1 and A2, H1 and H2, V1 and V2, D1 and D2 are approximate coefficients, horizontal details, vertical details, diagonal details of image1 and image2 respectively. The approximate coefficients of two source images are given to the PCA separately, obtained redundancy reduced data of input images are fused based on max-max rule. Similar to the fusion process of approximate coefficients,Diagonal coefficients, Vertical coefficients andHorizontal coefficients also fused individually. After fusion of respective coefficients, the fused coefficients are given to ISWT, which results final required fused image.

3. RESULTS

The results of proposed methodology are displayed in below tables and here the testing database downloaded from standard organizations[9], [10].

Table2: Comparison of Fused results for dataset1.

Image1	Image2	Fused image by SWT	Fused image by PCA	Fused image by SWT+PCA
				
				
				

Table 2 displays, proposed method results from dataset 1 [10], In below Tables, image1 means source image-1 similarly image2 means source image-2, images under column of ‘fused image by SWT’ means the two source images are fused with help of SWT only. Similarly, images under column of ‘fused image by PCA’ means the two source images are fused with help of PCA only. The proposed algorithm resultant images are presented under column of ‘fused image by SWT+PCA’.Table 3 displays, proposed method results from dataset 2 [9] titled with ‘The whole brain atlas’. All the process done on personal computer with RAM 2GB, Matlab version 2013.

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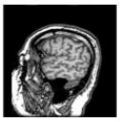
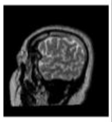
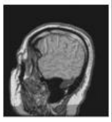
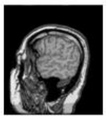
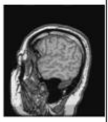
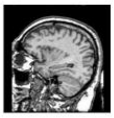
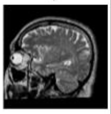
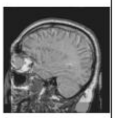
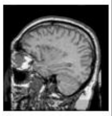
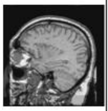
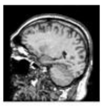
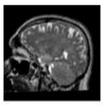
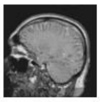
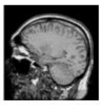
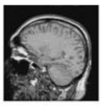
Table3: Comparison of Fused results for dataset2.

Image1	Image2	Fused by SWT	Fused by PCA	Fused by SWT+PCA
				
				
				

3.1 Performance Calculations

For testing of proposed methodology, Peak Signal to Noise Ratio, Standard Deviation and Entropyare used [4], [3], [17]. The performance calculations are presented in below table4 and table5. PSNR1 represents for peak signal to noise ratio of fused image with image1 and PSNR2 for peak signal to noise ratio with image2. Here 'Pair1' means performance calculations of first row images in 'table1'. similarly, 'Pair2, Pair3' means performance calculations of second, third row images in 'table1'. Usually, if the reference image is not available, the quality of the fused image is evaluated by using Standard Deviation, Entropy.

Image\Measurement	PSNR 1			PSNR 2		
	PCA	SWT	PCA+SWT	PCA	SWT	PCA+SWT
Pair1	23.00	22.86	33.60	21.20	21.19	31.80
Pair2	26.65	24.19	38.45	26.70	24.23	36.99
Pair3	20.84	27.00	39.27	23.29	17.21	38.98

Table4: Performance calculations comparison in PSNR

Image\Measurement	ENTROPY			STANDARD DEVIATION		
	PCA	SWT	PCA+SWT	PCA	SWT	PCA+SWT
Pair1	6.25	6.99	7.40	25.62	25.98	29.73
Pair2	4.66	4.65	5.68	41.87	42.19	41.89
Pair3	6.08	6.59	7.43	11.99	13.32	15.70

Table5: Performance calculations comparison in Entropy and Standard Deviation.

4. CONCLUSIONS

The proposed fusion methodology is done by the help of SWT and PCA, SWT has the advantage of shift invariance over Discrete Wavelet Transform. The comparative analysis of performance calculations showing robustness over remaining two techniques. The future idea is to fuse infrared images.

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