International Journal of Engineering Research and General Science Volume 3, Issue 3, May-June, 2015
ISSN 2091-2730

Survey On Image Fusion Techniques

Aparna Vijayan[1], Sreeram.S[2]
PG scholar[1], MEA Engineering College[1], aparnavijayan22@gmail.com[1]
Head of Department[2], MEA Engineering College[2], sreeram@meaengg.in[2]

Abstract— Image fusion is the process of combining information from two or more images into a single image. The resulting image will be more informative than any of the input images. There is a number of existing image fusion methods. This survey paper discusses about five different image fusion methods such as Discrete Wavelet Transform, Laplacian pyramid, SVM, Higher Order Singular Value Decomposition and Guided filter based weighted average scheme. These methods are mainly based on wavelets, pyramids and filters.

Keywords— Laplacian pyramid, DWT, DWFT, SVM, Weighted average, Guided filter, Local Edge Preserving Filter.

INTRODUCTION

Generally image fusion is the process of joining the information from two or more images of same scene. The fused output image will provide more information regarding the scene, hence it will be more utilizable for many applications and provides more precise results while processing. An efficient image fusion must state the following conditions: it must be able to preserve the paramount information in input images, should not produce any artifacts or color and/or disorders in output image. Fig 1 shows the inputs and outputs of a basic fusion process.

Fig 1: Image Fusion Sample Inputs and Output

The basic step in image fusion process is shown in Fig 2. The decomposition scheme generally includes multi scale decomposition using wavelets or pyramids and two scale decomposition using filters. The image fusion methods discussed in this literature are Discrete Wavelet Transform [3][4], Laplacian Pyramid [5], Support Vector Machines [6], Higher Order Singular Value Decomposition [7] and Guided Filtering based [8] method.

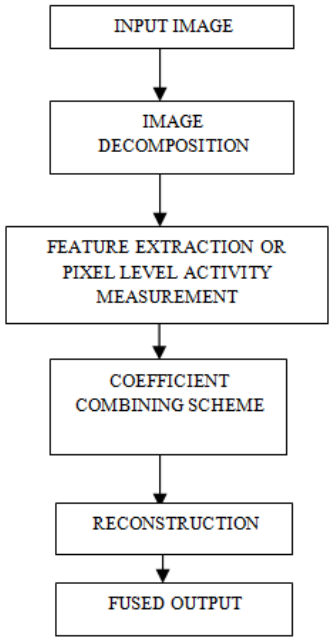

Fig 2: Image Fusion Basic steps

LITERATURE SURVEY

Discrete wavelet transforms (DWT) [3][4]based image fusion is one of the most simplest kind of image fusion. The major step in image fusion is the multi scale decomposition of source images. The source images are divided into lower and higher sub bands. The pixel having largest wavelet coefficients are selected for operation. DWT performs a transformation of image in spatial domain to image in frequency domain. The fusion operators used in this method vary for different decomposition levels. The major advantage by using DWT is that it preserves coefficient information since it uses different fusion rules so it provides better SNR. The final step in DWT based technique is the application of inverse discrete wavelet transform to the processed image. The basic steps in image fusion process using discrete wavelet transforms is shown in Fig 3.

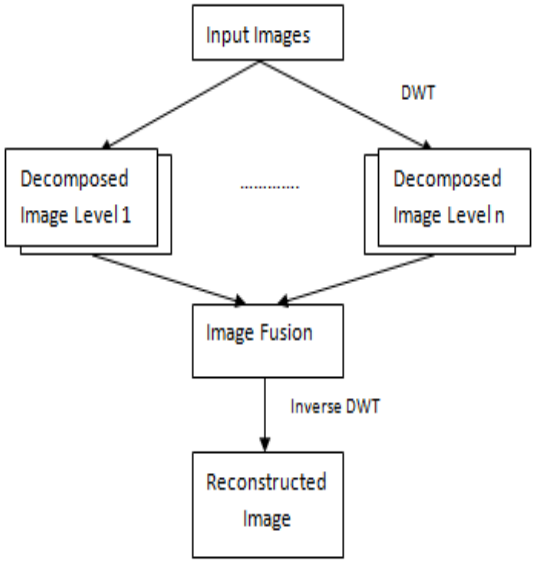

Fig 3: DWT Based Image Fusion Basic steps

Wang, Wencheng and Chang, Faliang [5] proposes a multi-focus image fusion method based on Laplacian pyramid. Image fusion

based on laplacian pyramid is using pyramid based decomposition. The input image is decomposed into different pyramid levels using laplacian pyramid. The advantage of this decomposition scheme is it well preserves edge information in image. Basically this laplacian pyramid is derived from a low pass gaussian pyramid using recursive filtering procedure. This method includes two pyramid level transformations: initial formation of gaussian pyramid structure, form laplacian pyramid from gaussian pyramids. Like DWT based fusion this method also uses different operators to combine different pyramid levels and finally uses an inverse laplacian pyramid transform to reconstruct the fused output. The algorithm used for this method is not much effective as conventional methods but the main advantage is it can detect shadows in image.

Li, Shutao and Kwok, JT-Y and Tsang, Ivor W and Wang, Yaonan[6] proposed fusing images with di erent focuses using support vector machines. Image fusion using Support Vector Machine (SVM) is another method for image fusion which is based on both wavelets and machine learning approach. It uses both SVM and discrete wavelet frame transforms (DWFT) for fusion purpose. DWFT decomposes and extract feature coefficients. An enhancement in DWT based technique is DWFT. The major difference of DWFT from DWT is that it provides a translation invariant image processing and representation pattern. The basic steps in image fusion process using discrete wavelet frame transforms and SVM is shown in Fig 4.

A SVM is trained for finding the best image pixels that suit for processing. Using DWFT and SVM model some complex wavelet coefficients is generated. This SVM based method incorporates the advantages of both wavelet decomposition and SVM. Different methods such as chose maximum, weighted average method are available for combining the DWFT coefficients. Based on activity levels at each pixel in decomposed levels, SVM performs supervised or unsupervised learning. The major advantages of this method is the use of better DWFT instead of simple wavelets and an effective SVM based approach is used instead of simple coefficient combining scheme. Like simple wavelet based methods the reconstruction process is done by applying an inverse wavelet transform on images.

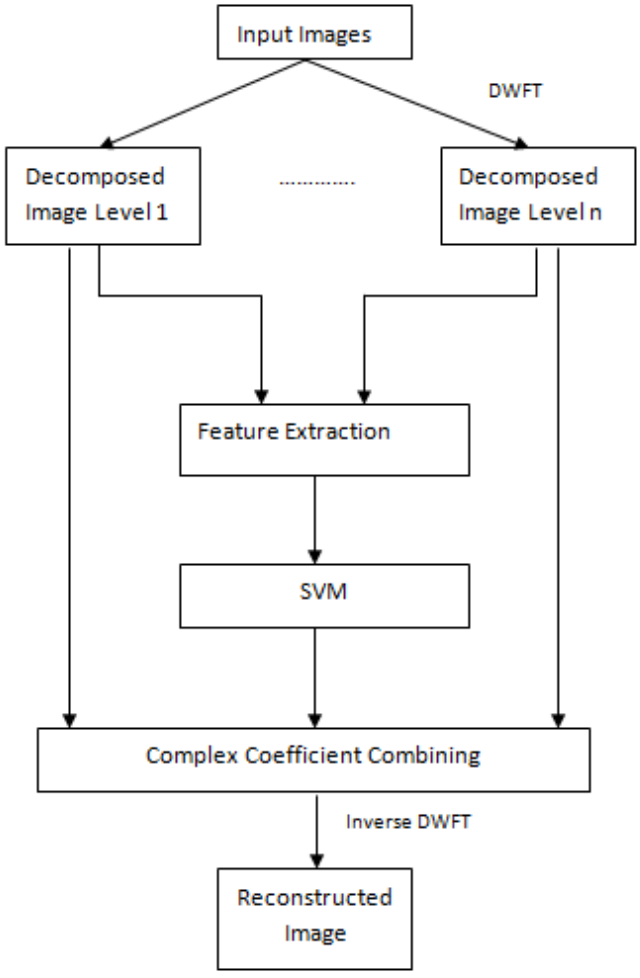

Fig 4: SVM Based Image Fusion Basic steps

Liang, Junli and He, Yang and Liu, Ding and Zeng, Xianju, [7] proposes an Image fusion using higher order singular value

decomposition. HOSVD is another data driven image fusion scheme. The key difference of HOSVD from other fusion methods is it decomposes the input image into different tensors instead of lower and higher sub bands in wavelet decomposition. Image is initially divided into different slices for feature extraction. This type of decomposition is highly effective in high dimensional data and in matrix based operations. Initially image is divided into slices and absolute values of pixel energy values are taken. Coefficient combining scheme used in this method is a special sigmoid function. A shrinking factor controls this sigmoid function. This sigmoid function acts as chose maximum scheme or averaging or smoothing functions based on shrinking parameter. Using any one of these sigmoid functions final fused image is generated. This variable sigmoid function makes this method effective for fusion of multiple images.

Li, Shutao and Kang, Xudong and Hu, Jianwen [8] proposes an Image fusion with guided filtering. Image fusion with guided filter is a filtering based technique and is capable to produce much better results. The important difference of this method from all other methods discusses above is that it uses a two scale decomposition scheme. A serial combination of average, laplacian, gaussian and guided filter is used in this method. A simple average filter is used for perform the two scale image decomposition. The coefficient combining scheme used in this method is weighted average. A weight map is created for each source image and is filtered using guided filter. Guided filter [9] is an efficient edge preserving filter. Since this method uses this guided filter it can well preserve edge information. The key advantage of guided filter is it takes a guidance image to control over all filtering process.

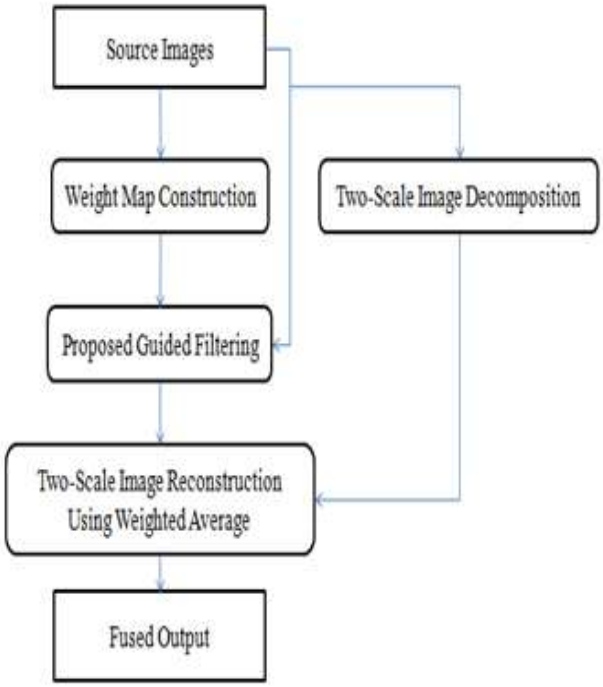

Fig 5: Guided Filtering Based Image Fusion

Local edge-preserving multi scale decomposition for high dynamic range image tone mapping [10] proposes a novel edge preserving filter called Local Edge Preserving Filter (LEP). Like guided image filter LEP filter also uses local linear model to generate fused output. LEP filter produces better results than guided image filter since it uses adaptive linear coefficients in the local linear model. The linear coefficients vary with respect to each window taken for processing. Gradient of image is taken for computing the linear coefficients. This makes LEP filter more adaptive than guided filter. The fusion procedure in [8] can produce better results by replacing the guided filter with LEP filter.

OBSERVATION AND ANALYSIS

The decomposition schemes, tool used for decomposition and fusion strategy used in methods discusses in literature are shown below in table 1. All common methods are using multi scale decomposition. The effectiveness of final output mainly depends on this decomposition scheme and fusion strategy used.

Table 1: Comparison of different image fusion methods

Method	**Based on**	**Decomposition Scheme**	**Fusion Strategy**
DWT	Wavelet	Multi scale	Different Fusion Rules
Laplacian	Pyramid	Multi scale	Different Fusion Rules
SVM	Wavelet	Multi scale	Complex Coefficient Combining
HOSVD	Image Segmentation	Image patches	Sigmoid Function
Guided Filter	Filtering	Two scale	Weighted Average

ACKNOWLEDGMENT

An endeavor over a long period may be successful only with advice and guidance of many well wishers. I take this opportunity to express my gratitude to all who encouraged me to complete this work. I would like to express my deep sense of gratitude to my respected Principal for his inspiration and for creating an atmosphere in the college to do the work. I would like to thank Head of the department, Computer Science and Engineering.

CONCLUSION

Different image fusion methods have been discussed in literature. Among these methods, multi-scale image fusion and data-driven image fusion are very prosperous methods. They fixate on different data representations, e.g., multi-scale coefficients or data driven decomposition coefficients and different image fusion rules to guide the fusion of coefficients. The major advantage of these methods is that they can well preserve the details of different source images. Comparatively better image fusion method among DWT, Laplacian, SVM, HOSVD and Guided filtering is Guided filter based technique. Filter based fusion solves multi-scale decomposition problem, color distortion problem, problems associated with brightness of fused output etc. But the problem with guided filter is it requires more running time. Local Edge Preserving Filter (LEP) [10] is another computationally effective edge preserving filter. LEP also provides better image filtering result than guided filter. The guided filtering based fusion method can be enhanced by using LEP filter for image fusion instead of using guided filter for fusion.

REFERENCES:

[1] "Study of different image fusion algorithm," International Journal of Emerging Technology and Advanced Engineering, vol. 3, no. 5, pp. 288–291, 2013.
[2] D. Yalamanda and V. P. Bhushan, "Medical image fusion based on improved wavelet transform."
[3] K. Rani and R. Sharma, "Study of image fusion using discrete wavelet and multiwavelet transform."
[4] V. Naidu and J. Raol, "Pixel-level image fusion using wavelets and principal component analysis," Defence Science Journal, vol. 58, no. 3, pp. 338–352, 2008.
[5] Wang, Wencheng and Chang, Faliang, "A multi-focus image fusion method based on Laplacian pyramid," Journal of Computers, 2011.
[6] Li, Shutao and Kwok, JT-Y and Tsang, Ivor W and Wang, Yaonan, "Fusing images with different focuses using support vector machines," Neural Networks, IEEE Transactions on. IEEE, 2004, pp. 1555–1561
[7] Liang, Junli and He, Yang and Liu, Ding and Zeng, Xianju, "Image fusion using higher order singular value decomposition," Image Processing, IEEE Transactions on, vol. 31, no. 12, pp. 2898–2909, 2012 2013.
[8] Li, Shutao and Kang, Xudong and Hu, Jianwen, "Image fusion with guided filtering,"IEEE transactions on image processing: a publication of the IEEE Signal Processing Society, IEEE, vol. 27, no. 2, pp.2864–2875, 2013.
[9] K. He, J. Sun, and X. Tang, "Guided image filtering," in Computer Vision–ECCV 2010. Springer, 2010, pp. 1–14.
[10] Gu, W. Li, M. Zhu, and M. Wang, "Local edge-preserving multiscale decomposition for high dynamic range image tone mapping," Image Processing, IEEE Transactions on, vol. 22, no. 1, pp. 70–79, 2013