An Efficient Approach with Contourlet and Curvelet Transformation for Image Fusion

Rohit Dubey
Student (Department of Information security),
Chandigarh Engineering College, Landran,India

Manish Mahajan
Associate Professor(Department of IT)
Chandigarh Engineering College, Landran , India

Abstract : Image fusion is the process in which we combine two or more images or some features of images to form a single image which is free from distortion and does not loses its information. Images which are taken from different angles sometimes needs to be fused together to form a single image which has all the detail information to create accurate description of the image. Its application lie for medical imaging, satellite images, general photography etc. Nowadays, medical image fusion plays a vital role for diagnosis. There are number of issues related to image fusion that needs to resolved. None of single method can work as generalized for image fusion. In the current paper we are going to hybrid two methods: contourlet transformation and curvelet transformation for better fused images.

KEYWORDS : Image Fusion, contourlet transformation, curvelet transformation

I. INTRODUCTION

Image fusion is a technique in which different images are fused together to form a single image which contains the detailed information of the images. The primary requirement of a good image fusion technique is that the fused image should be free from distortion and there should not be any lose of information [1]. The image formed after fusion should describe the image more accurately than the source image and is more easily understandable to human visual [7]. The resultant image has characteristics of spatial and spectral resolution. In medical images, images of same part can be taken from different sources like MRI, X-rays or CT scans etc and with the help of image fusion we can provide a single image of these images which has all the vital information from the source images and removing irrelevant data.

A. General Image fusion process

Feature Extraction: During image fusion feature extraction is the first step; in this step features or objects are detected either manually or automatically. The process can be accomplished using different frequency domains.

Feature matching: The next step is feature matching, in this step features are matched and reference image is established. The matching algorithm used should be robust and efficient.

Transform model estimation: This is the third step in which, estimation is made about the mapping functions that are used to align the sensed image with the reference image.

Image re-sampling and transformation: Finally, the choice of the appropriate type of resembling technique depends upon the trade- off between the demanded accuracy of the interpolation and the computational complexity.

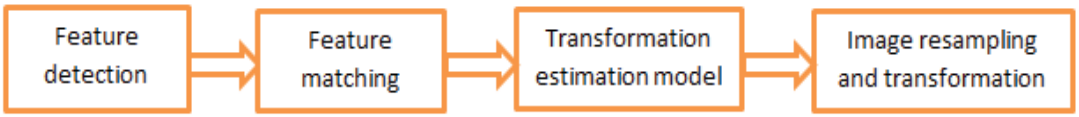


fig. 1. General image fusion process

B. Techniques

Many image fusion techniques have been proposed in the literature. Basically, these are categorized into [2]: pixel level image fusion, feature level and symbol level image fusion. No image fusion technique can be said to very effective every one of them is said to have some flaws. The two image fusion techniques which are used in this paper are contourlet and curvelet based image fusion.

II. Contourlet Transformation

There are various limitations of using separable extension transforms such as Fourier and wavelet as they are not very good in getting the geometry of image edges [4].A true two- dimensional visual information that is important to transform that can capture the intrinsic geometrical structure. The main challenge in the pursuit of geometry in images comes from the discrete nature of the data.

STEP-1 Feature Point Extraction

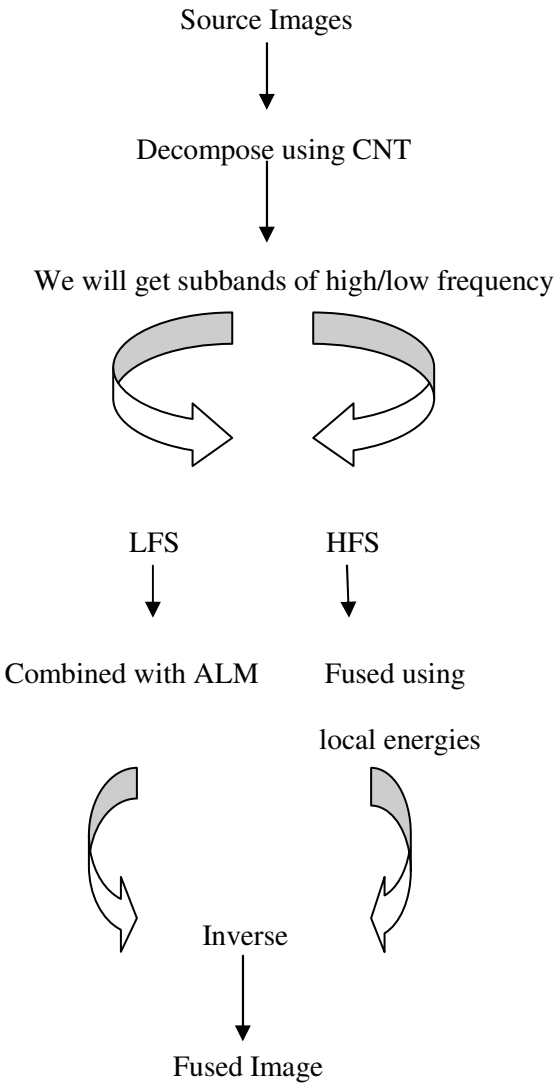
In image fusion feature points become locations which can be used to determine whether two images have matching points and also to estimate the transformation parameters required to fuse the two images. Here after decomposing the images we get subbands of two types of frequencies high frequency and low frequency.

STEP-2 Combing frequencies

After the first step of decomposing the image next we combine different frequencies. Low level frequencies are combined using Activity level measurement ALM and high level frequencies are combined using local energies

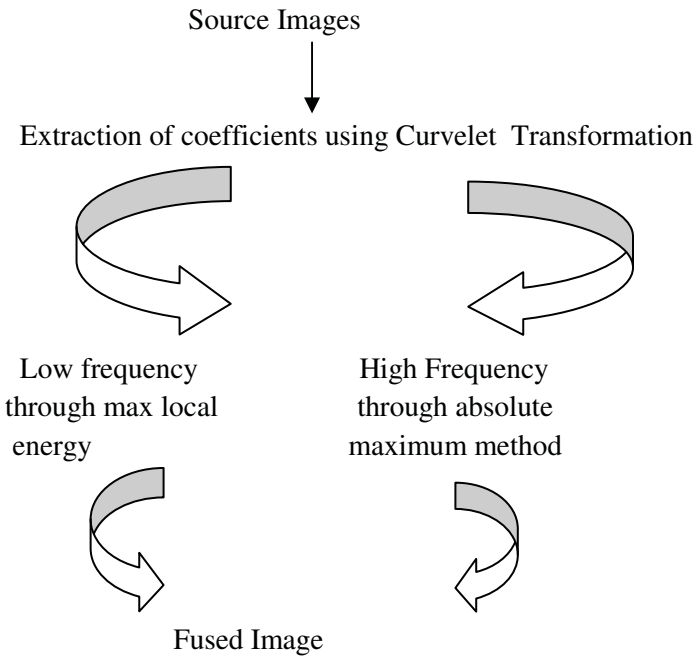
STEP-3 Inverse of images

After combining both the images inverse of the image is taken to fuse the image together



III. CURVELET TRANSFORMATION

Most of the image fusion techniques are not able to deal with the problem of smoothing of curves of the image [5]. Curvelet transformation is extension of wavelet transformation and has become very popular in recent time. It is a multi focus image fusion method which basically was made to deal with the problem of smoothing of curves. This transformation is basically used for those images which has bounded curves where when we zoom in the sharp edges appear to be straight curvelet transformation make use of this property. As shown in the following diagram the basic working structure of curvelet transformation is shown where the coefficient of images are extracted using curvelet transformation , low frequency coefficient are extracted using maximum local energy where as high frequency coefficient are extracted using absolute maximum method . After the extracted the low coefficient and high coefficients of both the images are matched and the images are fused together forming absolute curved images having smoothing of curves

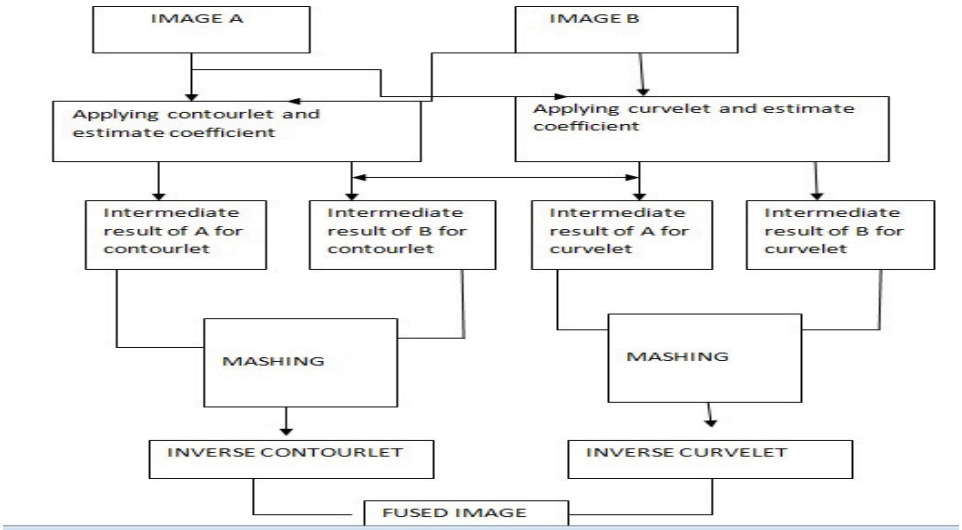


IV PROPOSED WORK

We have proposed the hybrid of Contourlet and Curvelet transformation for image fusion. Both have their own features and limitation. As Contourlet is very fast but it finds difficulty in image having curves and in smoothing of curves. Whereas Curvelet work well for images having curves [8]. On the other hand contourlet is very fast and is very accurate. So we have combined the features of Contourlet with the curvelet transformation.

The proposed algorithm is as follows:

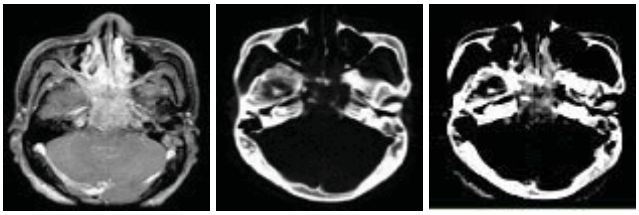
1 Firstly on both the source images contourlet and curvelet transformations will be applied and their coefficients will be calculated.
2 Intermediate results of both the images for contourlet and curvelet will be calculated and the images will be mashed together as shown.
3 Inverse contourlet and inverse curvelet will be done
4 In the end both images will be Fused together



V. EXPERIMENTAL RESULTS

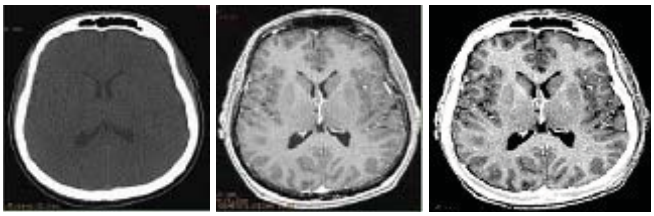
The performance of the proposed technique is calculated using three examples of images. Various parameters are used to calculate the end results such as entropy, standard deviation, quality index, maximum difference and structural content. These all parameters help define the image quality and the distortion level in the image as The geometric error can be quantified by standard deviation of errors for all point pairs, after excluding the pairs of false correspondence

Example 1



Source image 1 source image 2 Fused Image

Example 2



Source image 3 source image 4 Fused image

Example 3

Source image 5 Source image 6 Fused image

Result using proposed technique i.e. image fusion using hybrid of contourlet and curvelet transformation.

Image Set	Quality Index	Entropy	SD	Max Diff	Structural Content
Ex 1	83.52	14.67	76.78	124.95	2.1995
Ex 2	117.093	20.1854	75.43	125.95	1.554
Ex 3	79.8228	0.6918	40.60	94.55	1.9612

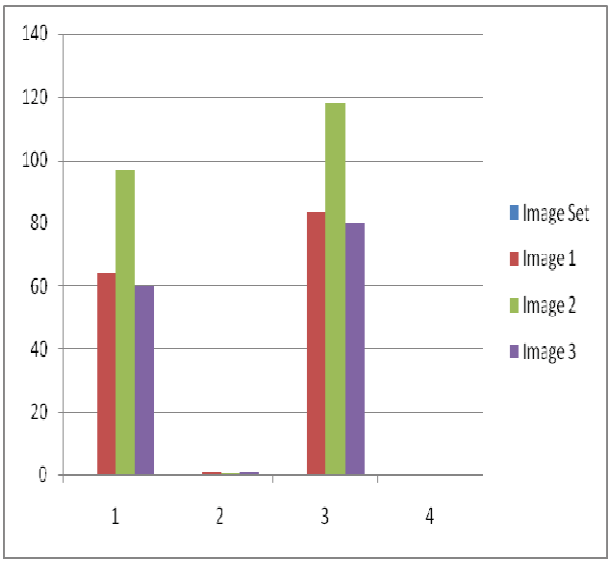
Results using contourlet transformation

Image Set	Quality Index	Entropy	SD	Max Diff	Structural Content
Ex 1	63.80	0.86	76.68	127.5	1.573
Ex 2	96.65	0.0031	75.36	128.5	0.8385
Ex 3	59.82	0.12	40.84	104.5	1.215

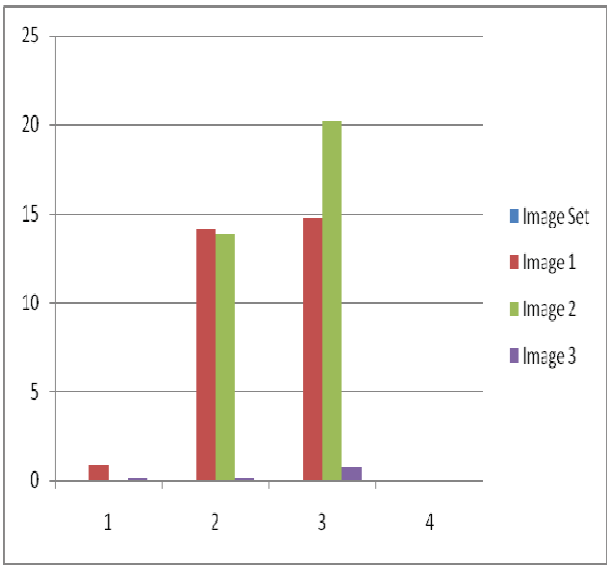
Result using curvelet transformation

Image Set	Quality index	Entropy	SD	Mx Diff	Structural Content
Ex 1	0.94	14.053	91.33	153	1.55
Ex 2	0.42	13.81	87.45	147	0.7732

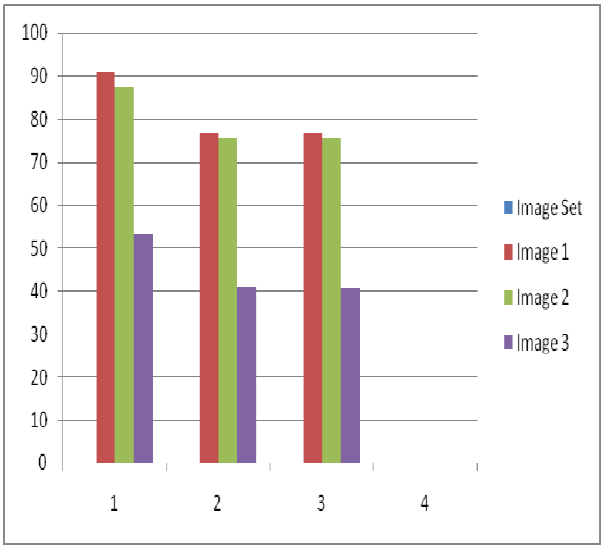
Ex 3	0.8456	0.1727	53.08	119	1.17



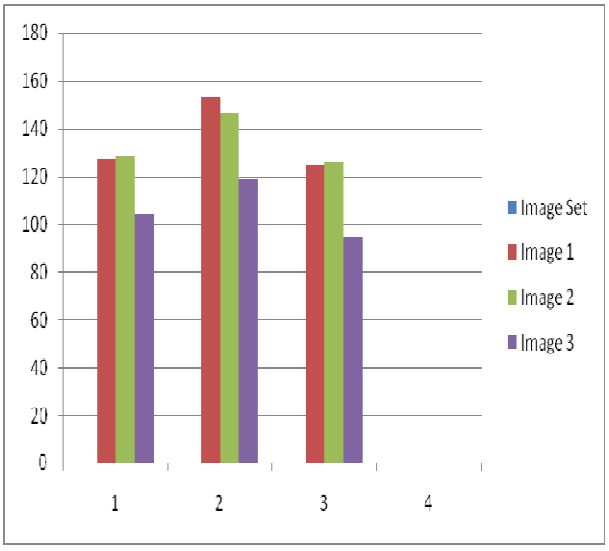
Graph showing values of quality Index



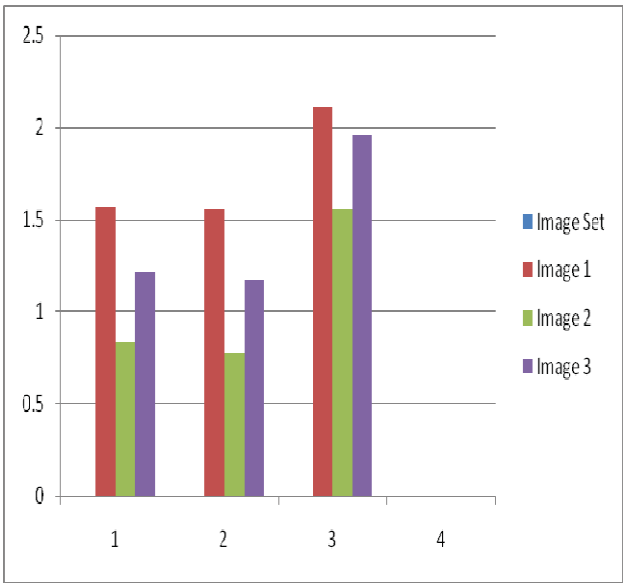
Graph showing Values of Entropy



Graph showing Values of standard deviation



Graph showing values of maximum difference



Graph showing values of Structural Content

VI. CONCLUSION

An efficient approach with Contourlet and Curvelet for image fusion has been presented. The combination of the features of both contourlet and curvelet makes this technique generalized for using it for almost all types of images especially for complex(medical) images.
The proposed technique has some important features

1. It makes quality better.
2. It makes the fusion process fast.
3. More resistant to distortion

In future other methods can be hybrid such as fuzzy logics and results can be verified.

REFERENCES

[1] Mitianoudis. N. and T. Stathaki, "Pixel-based and region-based image fusion schemes using ICA bases," *IEEE Transactions on Geoscience and Remote Sensing,* vol. 8, no. 2, pp. 131–142, 2007.
[2] F. Maes, D. Vandermeulen, and P. Suetens, "Medical image registration using mutual information," *Proceedings of the IEEE*, vol. 91, no. 10, pp. 1699–1721, 2003.
[3] Y.-M. Zhu and S. M. Cochoff, "An object-oriented framework for medical image registration, fusion, and visualization," *Computer Methods and Programs in Biomedicine*, vol. 82, no. 3, pp. 258–267, 2006.
[4] V. S. Petrovic and C. S. Xydeas, "Gradient-based multi resolution image fusion," *IEEE Transactions on Image Processing*, vol. 13, no. 2, pp. 228–237, 2004.
[5] Heng Ma , Chuanying Jia, and Shuang Liu, **"**Multisource Image Fusion Based on Wavelet Transform", *International Journal of Information Technology*, Vol. 11, No. 7, pp.81-91,2005.
[6] W. Z. Shi, C. Q. Zhu, Y. Tian, and J. Nichol, "Wavelet-based image fusion and quality assessment", *International Journal of Applied Earth Observation and Geoinformation*, vol. 6, pp.241-251, 2005
[7] S. T. Shivappa, B. D. Rao, and M. M. Trivedi, "An iterative decoding algorithm for fusion of multimodal information," *EURASIP Journal on Advances in Signal Processing*, vol. 57,no.11, pp.241-251, 2008.
[8] R. Redondo, F. Sroubek, S. Fischer, and G. Cristobal, "Multifocus image fusion using the log-Gabor transform and a Multisize Windows technique," *Information Fusion*, vol. 10, no. 2, pp. 163–171, 2009.
[9] S. Li and B. Yang, "Multifocus image fusion using region segmentation and spatial frequency," *Image and Vision Computing*, vol. 26, no. 7, pp. 971–979, 2008.

[10] P. S. Pradhan, R. L. King, N. H. Younan, and D. W. Holcomb, "Estimation of the number of decomposition levels for a wavelet-based multiresolution multisensor image fusion," *IEEE Transactions on Geoscience and Remote Sensing*, vol. 44, no. 12, pp. 3674–3686, 2006.
[11] S. Li, J. T. Kwok, and Y. Wang, "Multifocus image fusion using artificial neural networks," *Pattern Recognition Letters*, vol. 23, no. 8, pp. 985–997, 2002.
[12] Miao Qiguang, and Wang Baoshul, "A Novel Image Fusion Method Using Contourlet Transform" *IEEE trans. geosci. remote sens.*, vol. 43, no. 6, pp. 1391-1402, June 2005.
[13] Subed Das, Malay kumar kundu "Fusion of multimodality medical images using combined activity level measurement and contourlet algorithm" IEEE Conference Publications, 2011
[14] Sabri Banu, "Medical Image Fusion by the analysis of Pixel Level Multi-sensor Using Discrete Wavelet Transform", 20th International Conference Publications, 2011
[15] Krishnamoorthy and sonam, "Implementation and Comparative Study of Image Fusion Algorithms", International Journel of computer Application 10.5120/1357-1832
[16] Wang e, "Design and Implementation of Image Fusion System", International Conference on Computer application and system modelling, 2010
[17] Hu el te, "A New Type of Multi-focus Image Fusion Method Based on Curvelet Transforms", IEEE Conference on electrical and control engineering, 2010
[18] Hui et al, "Discussion and Analyze on Image Fusion Technology" Second international conference machine vision 2009.
[19] Zhang-Shu Xiao, Chong-Xun Zheng, "Medical Image Fusion Based on An Improved Wavelet Coefficient Contrast", Global Communications Conference,2012