Multi Model Image Registration and Fusion using Fast Discrete Contourlet Transform

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ABSTRACT: This paper proposes Transform Domain Fusion Rule (TDFR) via high pass modulation using Local Magnitude Ratio (LMR) in Fast Discrete Contour let Transform (FDCT) domain. Contour let transform method uses low resolution multispectral image and Cartosat-1 Panchromatic (PAN) of spatial resolution 2.5m is used as high resolution panchromatic image. This both images are up sampled in order to resize the image and registered using mutual information to parameterize and solve the correspondence problem in feature-based registration. This fusion rule generates as high resolution multispectral image at 2.5m spatial resolution with the help of Inverse Fast Discrete Contour let Transform increases the contrast of an image and thus gives sharper visual appearance. Different techniques are compared with this method such as Wavelet, Principal component analysis (PCA) and Curve let also tabulated.

Keywords—Fast Discrete Contour let Transform (FDCT), Local Magnitude Ratio (LMR), Panchromatic (PAN), Principal Component Analysis (PCA),Transform Domain Fusion Rule (TDFR).

I INTRODUCTION

The image should focus everywhere to obtain more information, instead of focusing on just one object. Remote sensing image fusion aims at integrating the information conveyed by data, acquired with different spatial and spectral resolutions, for purposes of photo analysis, feature extraction, modeling, and classification.Special domain term refers to more no of pixels combined for composing an image and transform domain enhances the image computing 2-dimensional unitary transform of image [1, 2]. Principal Component Analysis (PCA) fusion will enhance the special quality but represents uniformity features due to dense non zero entries [3].Whereas contourlet Image fusion methods based on injecting high frequency components taken from the panchromatic image into resampled versions of the multispectral data have demonstrated a superior capability of translating the spectral information of the coarse scale multispectral data to the finer scale of the panchromatic image with minimal introduction of spectral distortions.

Image fusion requires the definition of a model establishing how the missing high pass information to be injected into the re-sampled multispectral bands is extracted from the panchromatic image. Firstly, we are considering two input images one low resolution multispectral image i.e. reference image and another one panchromatic image i.e. target image must be pre-processed, the pre-processed images are subjected to Fast Discrete ContourletTransform (FDCT), which converts the time domain into frequency domain images, these frequency domain values are then fuse together by applying Transform Domain Fusion Rule, then Inverse Fast Discrete Contourlet Transform (IFDCT) reconverts the frequency domain values in to time domain values. By all these methodologies we can achieve multi model image registration and fusion using Fast Discrete Contourlet Transforms (FDCT).

Especially image acquired by satellites is helpful in tracking of earth resources; geological mapping; forecast of agricultural crops, metropolitan growth, and climate; flood and free control; and several environmental applications. Image broadcast and storage applications happen in broadcast television, teleconferencing, broadcast of facsimile images for office computerization communication through computer networks, closed-circuit television based safety monitoring systems, and in armed forces communications.

I. RELATED WORK

Chen Chen et.al [4] has proposed thatimages of low resolution multispectral image and high resolution panchromatic imagecan be simultaneously fused with in the geographical area based on fast discrete curvelet transform. Earlier spectral information of the multispectral images where preserved by virtue of the dynamic gradient sparsity property. The linear computational complexity in the size of the output image in each iteration is solved by the efficient algorithm. High-quality products are obtained from coarsely registered real-world IKONOS data sets from four satellite images. Experimentation based results have shown appropriate improvements in Entropy, Peak signal to noise ratio (PSNR) and Root Mean Square Error (RMSE). C.V.Rao et.al [5]has proposed satellite image fusion based on fast discrete curvelet transform, which retains both special and spectral qualities of source image.This curvelet transform overcomes the drawbacks of convention 2-dimensional discrete wavelet transform. Each multispectral band is compared to the high resolutionpanchromatic image for special quality evaluation and resampled multi spectral bands of Linear Imaging Self Scanner (LISS-4) sensor image and corresponding bands in the fused image are compared for spectral quality evaluation.

II. Problem Statement

High resolution satellite imagery provides researchers with information sources necessary for use in many change detection applications. However, problems occur when applying conventional traditional image processing methods to process and analyze these high resolution images. A common problem of existing techniques is the color distortion that occurs in the resulting fused images. For high resolution images, such as IKONOS and QuickBird, the wavelength of the panchromatic image is much broader than that of the multispectral bands. This discrepancy between the wavelengths causes considerable color distortion to occur when fusing high resolution panchromatic and multispectral images. To solve the color distortion problem, methods based on wavelet have been introduced and have demonstrated superior performance. However, when applying wavelet based methods, spatial distortions, typically ringing or aliasing effects, and originating shifts or blur of contours and textures may occur.Wavelet basis is isotropic and takes lot of co-efficient to account for edges [8-10]. These problems- which can be as pronounced as color distortion mentioned above - are emphasized by misregistration between a panchromatic image and its multispectral counterparts, especially if the wavelet is not shift-invariant.

III. Proposed System

Fig.1 shows the block diagram of proposed system, the inputs low resolution multispectral image and high resolution panchromatic image are up-sampled. Here low resolution multispectral images are RGB color image and high resolution PAN image are grey scale image. The up-sampled color bands and the panchromatic band are aligned to reduce artifacts due to Mis-registration. There are different methods used in image registration that enhances the visual appearance of an image [6, 7].The R, G, B color bands are up-sampled to the same resolution as the panchromatic band. Panchromatic band is then directly substituted to Fast Discrete Contourlet Transform which provides a flexible multi-resolution, local and directional expansion of images. The multi resolution images are registered using mutual information which is used to have identical geometry and size in feature-based registration. The obtained registered image is merged using Transform Domain Fusion Rule. Inverse Fast Discrete Contourlet Transform increases the visual appearance so that images are more clearly depicted. Finally images are fused to obtain high resolution multi-spectral image.

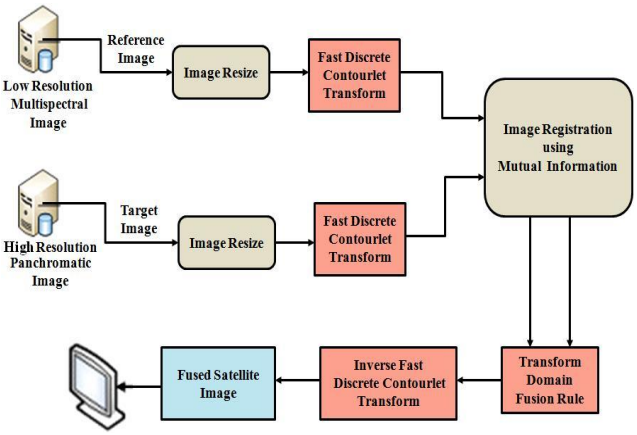


Fig.1 Block Diagram of Proposed Work

4.1 Fast Discrete Contourlet Transform (FDCT)

When compare to other existing transforms theFast Discrete Contourlet Transform (FDCT) are simpler, faster, and very less redundant, with the same complexity of rapid inversion algorithms the Fast Discrete Contourlet Transform (FDCT) are invertible. Coutourlet is a method of two-dimensional image representation. There are two-layer filters in contourlet transform they are, Laplacian pyramid transform is used to realize multi-scale decomposition and multi direction decomposition can be implemented by directional filter bank.Laplacian pyramid technique is used for data compression and in directional filter bank, frequencies can be coded to finer resolution after the decomposition.The two filters of the countourlet transform are used for image decomposition and yield a smoother sparse representation of the original image [11-13].Contourlet transform can realize multi-resolution and multi-direction decomposition flexibly and grasp essential character of image.The important characteristics of contourlet transform are directionality, multi-resolution, localization, anisotropy and critical sampling [14,15].Contourlet transform presented by digital conversion of discrete domain first, and then extended to continuous domain and analysis are done on the basis of properties when it is compared with curvelettransform.The curvelet de-noising scheme is very effective because the energy of the signal is captured within few energy transform values but Contourlet transform accuracy is more accurate compared to curvelet [16].

To present the simulation, contourlet are more convenient. Fast Discrete Contourlet Transform (FDCT) provides variable frequency components locally for synthesis and analysis of digital image in multi-resolution analysis. The main aim to use Fast Discrete Contourlet Transform is to provide a flexible multi-resolution, local and directional expansion of images. Decomposition sampled signals of fast and structured curvelet gives the anisotropy scaling relation for curves by applying contourlet transforms. As an output, the proposed contourlet transform provides an incompact representation for two-dimensional piecewise smooth signals that compares images. The link between the developed filter

banks and the continuous-space constructions is set up precisely in a newly defined directional multiresolution analysis. Finally, we show some numerical experiments demonstrating the potential of the new transform in several image processing tasks.

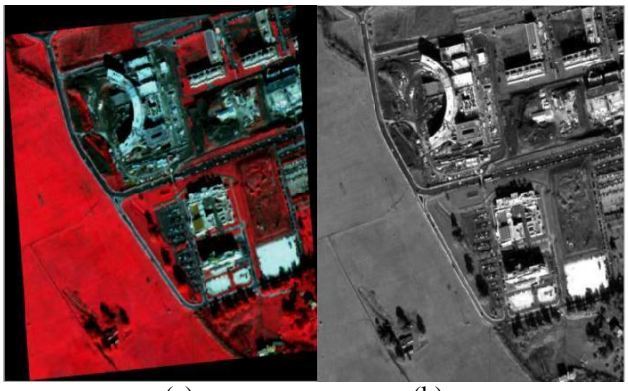
Fast Discrete Contourlet Transform (FDCT) is multi-scale geometric transform, which is a multi-scale pyramid with many directions and positions at each length scale. Fast Discrete Contourlet Transform (FDCT) has main direction associated with 2-dimensional anisotropic extension to classical wavelet transform. Fast Discrete Contourlet Transform (FDCT) can be translated and dilated analogous to wavelet. Whereas curvelet are based on multiscale ridgelets that separates images into disjoint scales with the help of bandpass filtering [17-20]. The frequency content of the Contourlet is controlled by the dilated scale index; direction can be changed through a rotation along with indexed position. This rotation is indexed by an angular index. Contourlet satisfy anisotropic scaling relation, which is generally referred as parabolic scaling.

Fast Discrete Contourlet Transform (FDCT) is applied to a rotated and un-sampled high-resolution grid. At Contourlet domain the high resolution grid is decomposed at three levels. The locations must be determined in each sub-band in order to interpolate the missing pixels. In Contourlet domain missing pixels corresponds to missing coefficients of each sub-band. The missing coefficients are interpolated at finest scale. Inverse Contourlet transform reconstructs the original high-resolution grid.

4.2 Transform Domain Fusion Rule

In transform domain fusion rule firstly, both low resolution multispectral image and panchromatic images are pre-processed and both images must be at identical geometry and of same sizes, then extract band wise the multispectral data in Green, Red and near infra-red bands, after getting multispectral data, apply Fast Discrete Contourlet Transform (FDCT) to both low resolution multispectral image and panchromatic image. Input images are decomposed into four levels in multiple directions. At lower frequencies multispectral image and the fused image fusion rule 2 is explained and applied. Fusion rule 1 is defined for the multidirectional multi resolution Contourlet co-efficient at higher frequencies based on high pass modulation. A set of Contourlet planes are constructed for the fused image and Inverse Fast Discrete Contourlet Transform (IFDCT) is applied to reconvert resolute frequencies in to time domain values. Combination of three resultant fused bands provide multispectral fused image.

IV. Experimental Result



(a) (b)

Fig.2 Input Images

(a) Low Resolution Multispectral Image (Reference Image)
(b) High Resolution Panchromatic Image (Target Image)

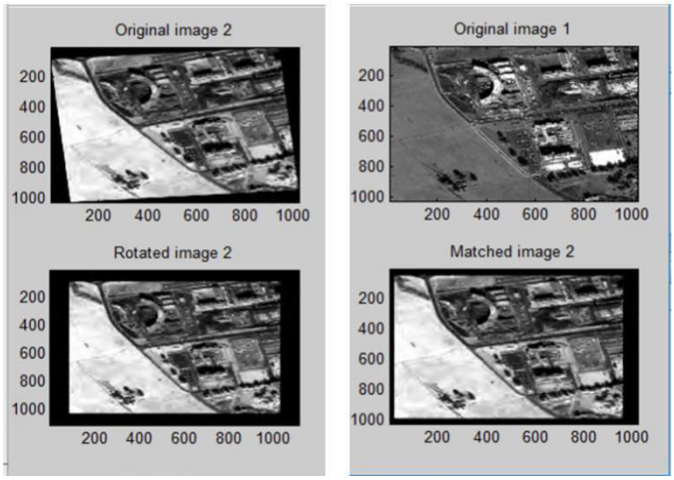


Fig.3 Level 1 Resizing of an Image into RGB plane

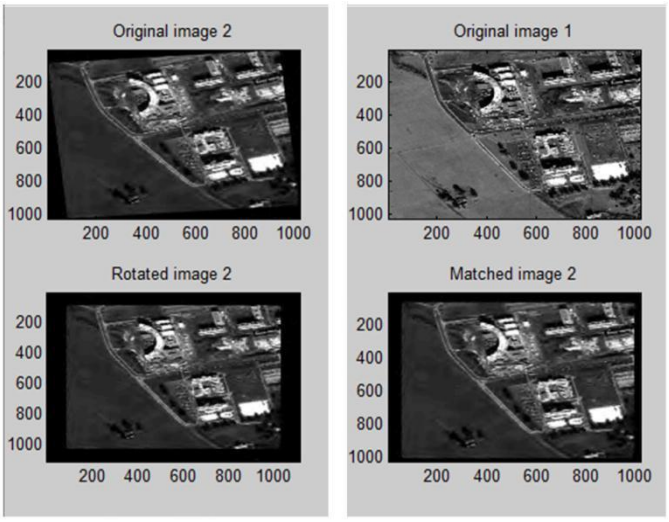


Fig.4 Level 2 Resizing of an Image into RGB plane

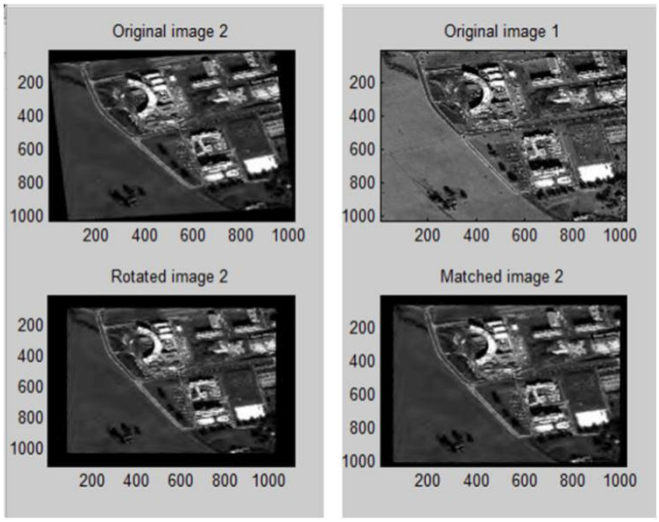


Fig.5 Level 3 Resizing of an Image into RGB plane

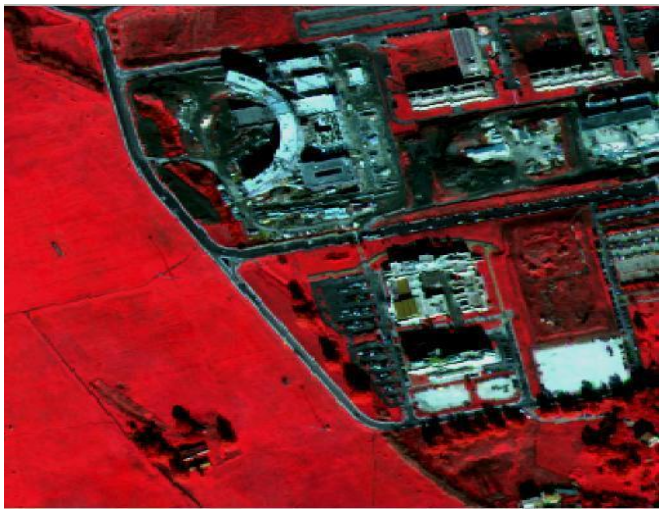


Fig.6 Registered Image of Reference and Target Image

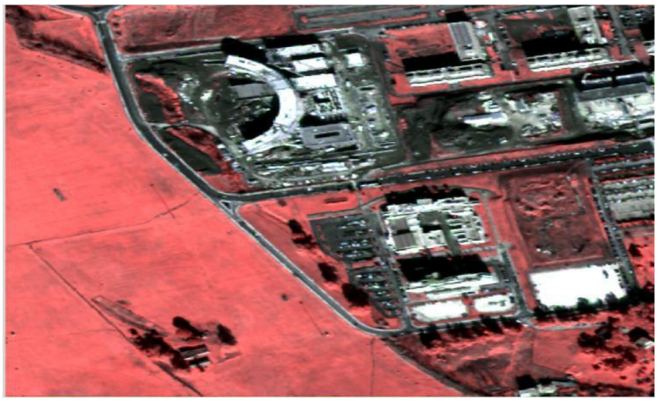


Fig.7 Finally Fused Image of High Resolution Multispectral Image.

V. PERFORMANCE EVALUTION

Table 1.Parameters value comparison of various methods

METHOD	PARAMETERS			
	RMSE	PSNR	ENTROPY	STANDARD DEVIATION
PCA	24.1	20.7	2.8944	47.5389
Wavelet	4.5	36.1	5.1801	53.4367
SIRF	4.1	47.5	6.2147	59.9738
Contourlet	3.5	49.3	7.6261	62.9543

VI. COMPARISON PLOT

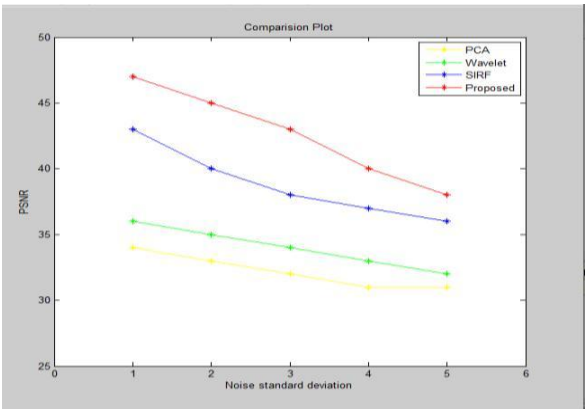


Fig.8 The PSNR values of PCA,Wavelet,SIRF and contourlet with different level of noise.

VII. CONCLUSION

High resolution satellite imagery provides researchers with information sources necessary for use in many change detection applications. However, problems occur when applying conventional traditional image processing methods to process and analyze these high resolution images. A common problem of existing techniques is the color distortion that occurs in the resulting fused images. For high resolution images, such as IKONOS and QuickBird, the wavelength of the panchromatic image is much broader than that of the multispectral bands. This discrepancy between the wavelengths causes considerable color distortion to occur when fusing high resolution panchromatic and multispectral images. To solve the color distortion problem, methods based on wavelet have been introduced and have demonstrated superior performance. From this proposed system, input low resolution multispectral image and PAN image resized and registered using mutual information before fusing the images, after image registration image is fused using fast discrete Contourlet transform and inverse transform domain based fusion rule is used to fuse the images.

REFERENCES

[1] —**Ima**ge Enhancement using a Combined Approach of

Spatial and Transformation Domain **Techniques‖,**SnehalO.Mundhada, Prof. V. K. Shandilya,International Journal of Emerging Research in Management &Technology, Dec 2012.

[2] **—Comparativeă Studyă ofă Imageă Fusionă Techn**iques **basedă onă Spatialăandă Transformă Domain‖,ă Swetaă K.ă** Shah, Prof. D.U. Shah, International Journal of Innovative Research in Science, Engineering and Technology, Vol 3, Issue 3, March 2014.

[3] **—Fastă andă Efficientă Medicală Imageă Compressionă** Using Contourlet Transform (FEMI-**CCT)‖,ăSandeepă** Kumar, NitinGoel, Vedpal Singh, AmitChaudhary, NirmalSirohi, Gurbaj Singh,Open Journal of Computer Sciences,Vol 1, May 2013.

[4] **—SIRF:ăSimultaneousăSatelliteăImageăRegistrationăandă FusionăinăaăUnifiedăFramework‖,ChenăCh**en, Yeqing Li, Wei Liu, and Junzhou Huang, IEEE Transactions on Image Processing, Vol. 24, No. 11, November 2015.

[5] **—SatelliteăImageăFusionăusingăFastăDiscreteăCurveletă Transforms‖,ă C.V.Rao,ă J.MalleswaraRao,ă A.Senthilă** Kumar, D.S.Jain, V.K.Dadhwal, National Remote Sensing Centre, Indian Space Research Organization, Hyderabad-500037, India, IEEE 2014.

[6] **—Imageă Registrationă Techniques:ă Ană overview‖,ă** Medha V. Wyawahare, Dr. Pradeep M. Patil, and Hemant K. Abhyankar,International Journal of Signal Processing, Image Processing and Pattern Recognition, Vol. 2, No.3, September 2009.

[7] —Image Registration and Wavelet Based Hybrid **ImageăFusion‖,ăMrs.Disha** S Bhosle Mrs. Kanchan S Gorde, IOSR Journal of VLSI and Signal Processing (IOSR-JVSP) Volume 4, Issue 2, and Ver. I (Mar-Apr. 2014).

[8] **—Imageă Fusionă basedă onă Waveletă andă Curveletă** Transform using ANFIS Algorithm", NavneetKaur and MadhuBahl, International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 3, Issue 9, September 2014.

[9] **—Aă Newă Imageă Fusionă Methodă basedăonăIntegrationă** of Wavelet and Fast Discrete Curvelet Transform", Anjali A. Pure, Neelesh Gupta and MehaShrivastava, Vol 69, Issue 18, May 2013.

[10] **—Aă Novelă Architectureă foră Waveletă basedă Imageă Fusion‖,ă Su**smithaVekkot, PanchamShukla, International Journal of Computer, Electrical, Automation, Control and Information Engineering Vol 3, No 9, 2009.

[11] —An improved contourlet transform technique for **imageă watermarking‖,ă Y.Anusha,ă K.Veeraswamy,** International Journal of Research in Computer andCommunication Technology, Vol 2, Issue 11, November- 2013.

[12] —Gray Scale Image Fusion using Modified Contourlet **Transform‖,Gurdeepă Singh,ă Naveenă** Goyal,International Journal of Advanced Research in Computer Science and Software Engineering,Volume 3, Issue 9, September 2013.

[13] **—ImageăFusionăUsingăImprovedăContourletăTransformă Technique‖,ă Nupură Singh,ă PinkyTanwar,ă** International Journal of Recent Technology and Engineering (IJRTE), Vol 1, Issue 2, June 2012.

[14] —Fast and Efficient Medical Image Compression Using Contourlet Transform (FEMI-**CCT)‖,ăSandeepă** Kumar, NitinGoel, Vedpal Singh, AmitChaudhary, NirmalSirohi, Gurbaj Singh,Open Journal of Computer Sciences,Vol 1, May 2013

[15] **—Fuzzyă Basedă Imageă Compressionă** on ROI using Optimized Directional Contourlet **Transform‖,M.Tamilarasiă** ,ă Dr.V.Palanisamy,International Journal of Recent Trends in Engineering, Vol 2, No. 5, November 2009.

[16] **—Imageă Denoisingă usingă Curveletă Transform‖,ă** AmandeepKaurBains, PrabhneetSandhu, International Journal of Current Engineering and Technology, Vol.5, No.1, Feb 2015.

[17] **—Remoteă Sensingă Satelliteă Imageă Fusionă Usingă Fastă** Curvelet Transforms",Namratha H. N, Raghu M. T, International Journal of Science and Research (IJSR), Vol 4 Issue 4, April 2015.

[18] **—Imageă Compressionă Algorithmă Usingă aă Fastă Curveletă Transform‖,ă Walaaă M.ă Abd-**Elhafiez, International Journal of Computer Science and Telecommunications, Vol 3, Issue 4, April 2012.

[19] **—Ană Imageă Fusionă usingă Waveletă andă Curveletă** T**ransforms‖,ă** Smt.G. Mamatha, L.Gayatri, Andhra Pradesh, India, Global Journal of Advanced Engineering Technologies, Vol1, Issue-2, 2012.

[20] **—Spatială Imagesă Featureă Extractionă Basedă onă** Bayesian Nonlocal Means Filter and Improved **Contourletă Transform‖**, Pengcheng Han, Junping Du,Hindawi Publishing Corporation, Journal of Applied Mathematics, Volume 2012.