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Multispectral Satellite Image Enhancement Based On Pan Sharpening Under NSCT

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ABSTRACT- Pan sharpening based Non-subsampled contourlet transformation for satellite panchromatic and multi spectral images. It involves two different approaches that are, NSCT with different levels of decomposition and NSCT with up sampling based pixel level fusion. NSCT is very efficient in representing the directional information and capturing intrinsic geometrical structures of the objects. It has characteristics of high resolution, shift-invariance, and high directionality. An integration of high spatial resolution extracted from PAN images into the high spectral resolution of MS images generates both high spatial and spectral resolution pan sharpened image. Here, a given number of decomposition levels are used for multispectral images while a higher number of decomposition levels are used for Pan Images relatively to the ratio of the Pan Pixel size to the MS pixel size. This preserves both spectral and spatial qualities while decreasing computation time. By applying upsampling after NSCT, structures and detail information of the MS images are more likely to be preserved. Hence, pan-sharpening is done by fusing it with detail information provided by the Pan image at the same fine level. The system simulated result shows that used method provides better resolution in these images rather than prior approaches and it also measured the performance parameters such as correlation, PSNR, SSIM and standard deviation.

KEYWORDS: Pan and Ms Image, Preprocessing, Non-subsampled contourlet transformation, Feature extraction, Fusion, Parameter analysis.

I. INTRODUCTION

Image fusion integrates the multisensor data to create a fused image containing high spatial, spectral and radiometric resolutions. In remote sensing, image fusion is most valuable technique for utilization of multisensor, multispectral at various resolutions of earth observation satellites [10]. Spatial resolution plays a vital role to delineate the objects in the remote sensing image. It is easy to interpret the features with high spatial resolution [20] image with multispectral information than the single high resolution Pan image. Image fusion enhance the spatial, spectral and radiometric [11] resolutions of images. There are several satellite image fusion techniques but spatial and spectral details retention simultaneously is a trade-off. F.Nencini et al. [5] proposed a fusion method based on inter band structure model (IBSM) in first generation curvelet transform domain. The method uses Quick-bird and Ikonos multispectral and Pan images. The experimental results shows that, the method slightly better than the Atrous Wavelet Transform (ATWT) and outperform Grams-Schmidt spectral sharpening method. Ying Li et al. [6] proposed a Fast Discrete Curvelet Transform (FDCT) based remote sensing image fusion. The method uses Synthetic Aperture Radar(SAR) and Thematic Mapper(TM) images for fusion. This work concluded that FDCT based fusion method retain good spatial details and simultaneously preserve the rich spectral content compared with Discrete Wavelet Transform (DWT)and Intensity-Hue-saturation (IHS) ArashGolibag et al. [7] focuses on region based image fusion using linear dependency decision rule based on Wronskian determinant.

II. LITERATURE SURVEY

In the literature many pan sharpening methods have been proposed for combining PAN with MS image, see [3, 5] for a detailed review. Among them, methods such as Intensity-Hue-Saturation (IHS) and Principal Component Substitution(PCS) provide superior visual high-resolution multispectral images but ignore the requirement of high quality synthesis of spectral information. More recently, an underlying multi-resolution analysis employing the discrete wavelet

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transform has been used in image fusion. It was found that multi-sensor image fusion is a trade-off between the spectral information from an MS sensor and the spatial information from a PAN sensor. With the wavelet transform fusion methods, it is easy to control this trade-off. Properties, such as multiresolution, localization, critical sampling, and limited directionality have made the wavelet transform a popular choice for feature extraction, image denoising, and pan sharpening. However, wavelets fail to capture the smoothness along the contours. The contourlet transform, an alternative multiresolution approach, provides an efficient directional representation and also efficient in capturing intrinsic geometrical structures of the natural image along the smooth contours. Remote sensing images have presence of natural and man-made objects, e.g., rivers, roads, coastal areas, buildings, etc. which indicate higher geometrical content. Thus, the transformation staking in consideration the geometric structure along with other properties of wavelet transformation will be more useful for pan sharpening.

III. PROPOSED METHOD

The proposed system involves Non subsampled Contourlet transform, Pixel level fusion, Texture filter for pan sharpanening of remote sensing images. Preprocessing is done by filtering. Then we had applied NSCT transform for both MS and PAN image, extract the texture and fuse the subbands, finally we get sharpened image. Also we had done parameter analysis for both techniques.

METHODOLOGIES

- Different Level NSCT
- Gabor Based Fusion
- Lanczos Based Upsampling
- Pixel Level Fusion
- Parametric Evaluation

A. PROPOSED METHOD BLOCK DIAGRAM:

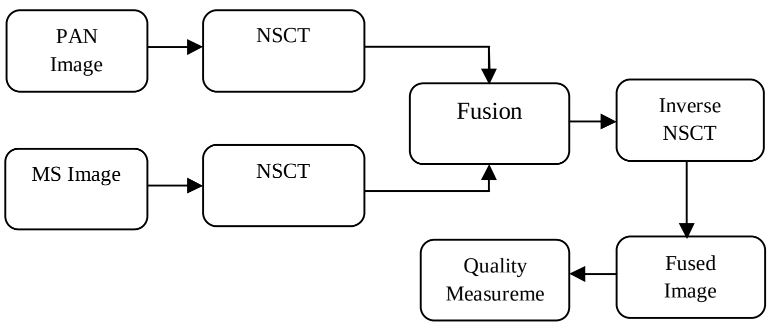

Fig.1 Block diagram of proposed method

1. PREPROCESSING

In Preprocessing of the proposed system the following steps namely Gray scale conversion, Noise removal is involved. In computing, a gray scale digital image is an image in which the value of each pixel is a single sample, it carries only intensity information. Images of this sort, also known as black-and-white, are composed exclusively of shades of gray, varying from black at the weakest intensity to white at the strongest. Gray scale images are distinct from one-bit bi-tonal black-and-white images, which in the context of computer imaging are images with only the two colors, black, and Gray scale images have many shades of gray in between.

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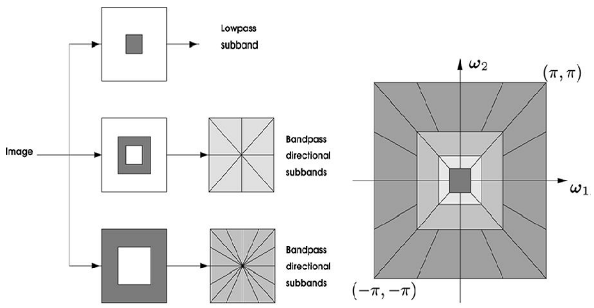
$$gray(i,j) = \{0.29 * rgb(:,:,1) + 0.59 * rgb(:,:,2) + 0.11 * rgb(:,:,3)\}; \quad (1)$$

Generally we are using median filter to suppress the noise. The procedures are

(i) Arranging matrix pixel value in the form of ascending order.
(ii) Find the median value of that matrix.
(iii) Replace that value into that noisy pixel location.

2.NON SUBSAMPLED CONTOURLET TRANSFORM (NSCT)

NSCT is a shift-invariant version of CT and has some excellent properties including multilevel and multidirection properties. NSCT provides a better representation of the contours. CTemploys the Laplacian pyramid for multiscale decomposition and the DFB for directional decomposition. To reduce the frequency aliasing of CT and to reach the shift invariance, NSCT eliminates the downsamplers and the upsamplers during the decomposition and the reconstruction of the image; it is built upon the non-subsampled pyramid filter banks (NSPFBs) and the non-subsampled DFBs (NSDFBs), as illustrated in Fig. 1. NSPFB, employed by NSCT, is a 2-D two channel non-subsampled filter bank (NFB). To achieve the multiscale decomposition, conceptually similar to the 1-D non-subsampled wavelet transform computed with the “à trous algorithm,” the filters for the next stage are obtained by upsampling the filters of the previous stage with the sampling matrix. NSDFB, employed by NSCT, is a shift-invariant version of the critically sampled DFB in CT. DFB is constructed by combining critically sampled two-channel fan filter banks and resampling operations, which results in a tree-structured filter bank that splits the 2-D frequency plane into directional wedges. NSDFB is constructed by eliminating the downsamplers and upsamplers in DFB and as a result, NSDFB is also a two-channel NFB. To achieve multi direction decomposition, NSDFB is iteratively used. NSCT is obtained by combining NSPFB and NSDFB, as shown in Fig. 1.



(a) (b)

Fig 2. Non subsampled contourlet transform. (a) NSFB structure that implements the NSCT. (b) Idealized frequency partitioning obtained with the proposed structure.

3. GABOR BASED FUSION

A tunable band pass filter Similar to a STFT or windowed Fourier transform Satisfies the lower-most bound of the time-spectrum resolution (uncertainty principle) It’s a multi-scale, multi-resolution filter Has selectivity for orientation, spectral bandwidth and spatial extent. Has response similar to that of the Human visual cortex (first few layers of brain cells) used in many applications – texture segmentation; preserve edge losses, face and fingerprint recognition. Computational cost often high, due to the necessity of using a large bank of filters in most applications. Edge extraction using 2-D Gabor filters smears the edge information The magnitude of the 1-D Gabor filter output is used as a feature to detect boundaries for texture-like images Advantage of 1-D processing: Feature extraction and edge extraction are applied along orthogonal directions. The Gaussian function (1-D) of the Gabor filter will not affect the edge information in the orthogonal direction The edge evidence obtained from a set of Gabor filters are combined using a constraint satisfaction neural network to obtain the final output.

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4. LANCZOS UPSAMPLING

Lanczos upsampling or Lanczos filter is a mathematical formula used to smoothly interpolate the value of a digital signal between its samples. It maps each sample of the given signal to a translated and scaled copy of the Lanczos kernel, which is a sinc function windowed by the central hump of a dilated sinc function. The sum of these translated and scaled kernels is then evaluated at the desired points.

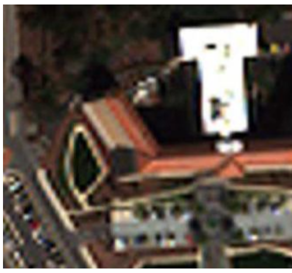
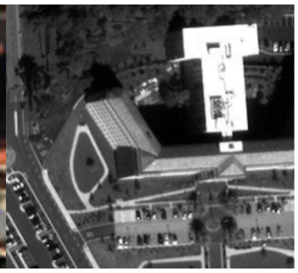

Fig:3 Multi Spectral image Fig:4 PAN image

The complex Gabor in space domain, here is the formula of a complex Gabor function in space domain

$$g(x, y) = s(x, y)\ wr(x, y) \quad (2)$$

where s(x; y) is a complex sinusoidal, known as the carrier, and wr(x; y) is a 2-DGaussian-shaped function, known as the envelop. The complex sinusoidal is denotes as follows,

$$s(x, y) = \exp\ (j\ (2*pi(u0\ x + v0\ y) + P)) \quad (3)$$

where (u0, v0) and P denotes the spatial frequency and the phase of the sinusoidal respectively.

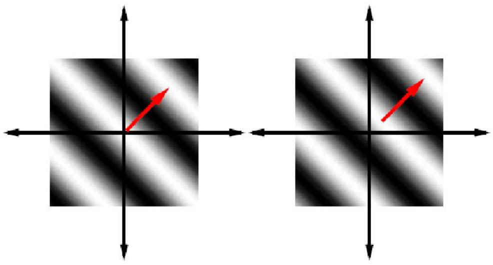

Fig 5: Phase diagram for spatial frequency

High-frequency coefficients always contain edge and texture features. A salience measure as a combination of region energy of NSCT coefficients and correlation of the cousin coefficients, is proposed for the first time. We define region energy by computing the sum of the coefficients' square in the local window. Suppose C_l^k (x y) is the high-frequency CT coefficients, whose location is (x,y) in the subband of k-th direction at l-th decomposition scale. The region energy is defined as follows:

$$E_l^k(x, y) = \sum_{m,n\epsilon S_{M\times N}} \left(C_l^k(x + m, y + n)\right)^2 \quad (4)$$

where $S_{M\times N}$ denotes the regional window and its size is M × N (typically 3×3).Region energy, rather than single pixel value, will be more reasonable to extract features of source images by utilizing neighbors' information.

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5.PARAMETER ANALYSIS:

Peak –signal-to noise ratio and Mean square error:

To establish an objective criterion for digital image quality, a parameter named PSNR (Peak Signal to Noise Ratio) is defined in equation 3.8 as follows:

$$PSNR = 10*\log10\ (255*255/MSE) \quad (5)$$

*Correlation Coefficient:*It gives similarity in the small structures between the original and reconstructed images. Higher value of correlation means that more information is preserved. Coefficient correlation in the space domain is defined by:

$$Correlation = sum\ (sum\ (B.*A))/Sqrt\ (sum\ (sum\ (B.*A))*sum\ (sum\ (A.*A))) \quad (6)$$

Where, B is difference between fused image and its overall mean value. A is difference between source image and its overall mean value.

6. RESULTS AND DISCUSSION

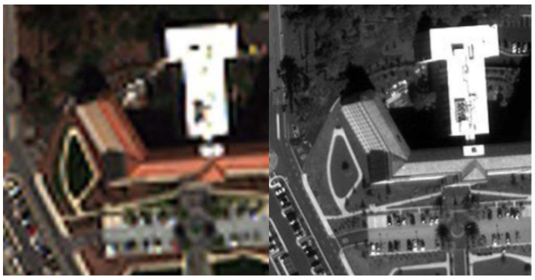

Fig 6: Test images (Multispectral image and the PAN image)

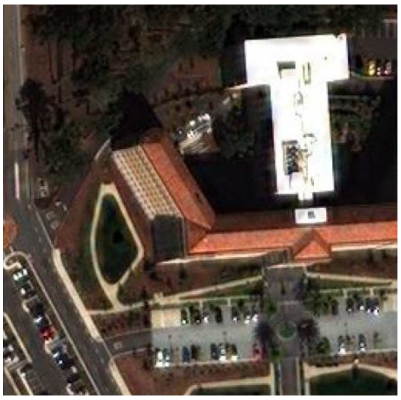

Fig 7: Fused Image (MS and PAN)

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V. CONCLUSION

In this survey paper various methods of Image fusion has been studied and compared for the period of more than two decades .This is used to focus on the future of developments of sat image processing in image surveillance. In our paper we had fuse PAN and MS images for pan-sharpening methods based on the non-subsampled contourlet transform (NSCT) and gabor based texture fusion.In this paper, various steps in pan sharpening progress,i) The Preprocessing Technique ii) NSCT based transformation, up sampling, gabor based texture fusion and their performance have been studied and compared.

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