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Pan-Sharpening Based Satellite Multispectral Image Enhancement under NSC-Transform

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Abstract: The project presents that pan sharpening used for satellite panchromatic and multi spectral images based Non-subsamples contourlet transformation. It contains two different approaches that are, NSCT with different levels of decomposition and NSCT with up-sampling based fusion of pixel level. NSCT is very well-organized in representing the information of directional and capturing intrinsic geometrical structures of the objects. A combination of spatial resolution (high) extracted from PAN images into the spectral resolution (high) of MS images gives both high spatial and spectral resolution pan sharpened image. This displays both spatial and spectral qualities while falling computation time. By applying up sampling after NSCT, structures and more information of the MS images are extra likely to be preserved. Hence, pan-sharpening is done by merging it with detail information offered every Pan image at the same fine level. The system simulated result represents that used method provides better resolution in this image and it also measured the performance parameters for example correlation, PSNR, SSIM and standard deviation.

Keywords: Image Enhancement, Non-sub sampled Contourlet Transform, Pan-sharpening Technique.

I. INTRODUCTION

Now, enormous quantities of images of satellite are obtainable from various earth surveillance platforms, such as SPOT, Land sat 7, IKONOS, Quick Bird and Orb View. Moreover, now of the rising during satellite sensors, the gaining frequency of the same scene is constantly increasing. Remote sensing image is recorded in digital form and then treated by computers to create image products useful for a broad range of applications.
The quality of images provided that by earth surveillance satellites a system are straight connected to their spatial and spectral resolutions. Due to physical and technological limitation, satellite sensors cannot provide images with both high spatial and high spectral resolutions; the spectral and spatial resolutions include inverse relationship.

During remote sensing imaging system, spatial resolution is communicated as the areas of the ground captured by one pixel and remain the reproduction of details within the scene. When the size of the pixel is decreased, extra scene facts are preserved in the digital representation. The spatial resolution anticipates the IFOV. The initiate of high-resolution satellites used for remote sensing has produced a need for the development of efficient and accurate image fusion methods. These satellites are usually capable of producing two different types of images: a low resolution multispectral image and a high resolution panchromatic image. The combination of the multispectral and panchromatic images, or pan-sharpening, provides a solution to this by merging the clear geometric features of the panchromatic image and the color information of the MS image [14]. Pan sharpening can consequently be defined as a pixel level merging method common raise the spatial resolution of the MS image. Pan sharpening techniques increase the spatial resolution while simultaneously maintaining the spectral information in the MS image, giving the better of the two worlds: high spectral resolution and high spatial resolution. Several applications of pan sharpening include improving geometric correction, civilizing sure features invisible in any of the single data on your own, changing detection using temporal data sets and enhancing classification.

1.1 Multispectral Image

A multispectral image is an image that contains more than one spectral band. It is made by a sensor which is able of motion light reflected from the earth into discrete spectral bands. A color image is a very easy example of a multispectral image that encloses three bands. In this situation, the bands correspond to the R, G and B wavelength bands of the electromagnetic spectrum.

1.2 Panchromatic Image

Panchromatic sensors have of a single band detector sensitive to radiation within a large spectral range covering visible again IR wavelengths. When the wavelength range lies inside the visible range, then the ensuing image will constitute a black and white photograph taken from space. The colour of the targets is not available.

In contrast to the multispectral image, a panchromatic image contains single wide band of reflectance data. The data is generally representative of a range of bands and wavelengths, such as visible or thermal infrared, specifically; it combines many colours so it is "pan" chromatic. A panchromatic image of the visible bands is more or less a combination of red, green and blue data into a single measure of reflectance. Recent multispectral scanners also normally include some radiation at slightly longer wavelengths than red light, called "near infrared" radiation.

Panchromatic images can generally be collected with higher spatial resolution than a multispectral image because the broad spectral range permits smaller detectors to be used while maintaining a high signal to noise ratio.

II. NON-SUB SAMPLED CONTOURLET TRANSFORM

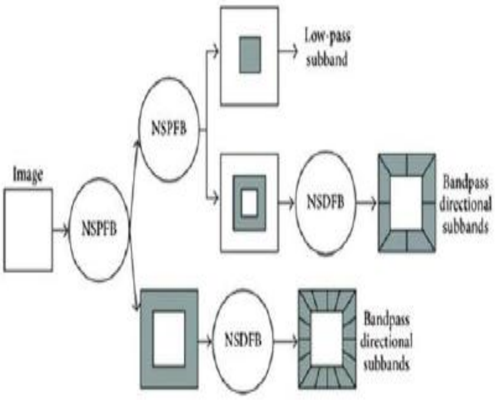

Fig.1 NSCT decomposition flow structure

It is very efficient in representing the directional information and capturing the intrinsic geometrical structures of the objects. It has the characteristics of high resolution, shift invariance, perfect reconstruction, sharp frequency response, easy implementation, linear phase filter and high directionality. It built upon the non-sub sampled pyramid filter banks (NSPFBs) and the non- sub sampled directional filter banks (NSDFBs), It eliminates the down samplers and the up samplers during the decomposition and the reconstruction of the image both the up sampling and down sampling are lie in the laplacian pyramid and directional filter banks, NSP structure to retain the multiscale property then directional filter bank for directionality and it provides the better contour edges.

Contourlet transforms finding the laplacian pyramid for multiscale decomposition and the DFB for directional decomposition. Shift invariant properties reducing the frequency aliasing of CT.

NSCT decomposition is to compute the multiscale and different direction components of the discrete image, it involve two stage such as NSPFB and NSDFB to extract the texture and contours and the detailed coefficients. NSPFB decompose the image into low and high frequency subband at each decomposition level and it produces n 1 sub images if the decomposition level is n. NSDFB extracts the detailed coefficients from the direct decomposition of high frequency sub and obtained from the non-sub sampled pyramid and it generates _m' power of two sub images if the number of stages be _m'. NSCT is obtained by combining NSPFB and NSDFB as shown in Fig.1.

III. QUALITY INDICSES

1. Correlation Coefficient: It gives similarity in the small structures between the original and reconstructed images. High value of correlation means that extra information is preserved.

$$CC = \frac{\sigma_{xy}}{\sigma_x \sigma_y}$$

Where, σ_{xy} the covariance of x and y.
2. Relative Bias (BIAS) - It is the variation between the mean of the original image and that of the merged one separated by the mean of the original image.

3. Relative variance (VAR) - It is the variation between the variance of the original image and that of the merged one divided by the variance of the original image, results reached up to best level.

4. Standard Deviation (SD) - It is the variation image in relation with the mean of the original image.
5. Structural Similarity Index (SSIM) –It calculate the similarity between two images.

6. Relative average spectral error (RASE) – it is used to characterize the average performance of the pan-sharpening method in spectral band.

$$RASE = \frac{100}{M}\sqrt{\frac{1}{N\sum_{i=1}^{N} RMSE^2(Bi)}}$$

In the formula for RASE, M is the mean radiance of the N spectral bands (Bi) of the original MS bands.

7. Peak –signal-to noise ratio and Mean square error: To establish an objective criterion for digital image quality, a parameter called PSNR (Peak Signal to Noise Ratio) is defined as follows:

$$PSNR = 10 \log \frac{255^2}{MSE}$$

Where, MSE is mean square error.
8. Mean square error [9] is calculated for 2n-1 pixels of residual blocks X.

$$MSE = \frac{1}{M \times N} \sum_{i=1}^{M \times N} (Si - Ci)^2$$

Where, Si and Ci represent pixels values of input image and decompressed image respectively.

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IV. PROPOSED METHOD FOR PAN-SHARPENING USING NSCT

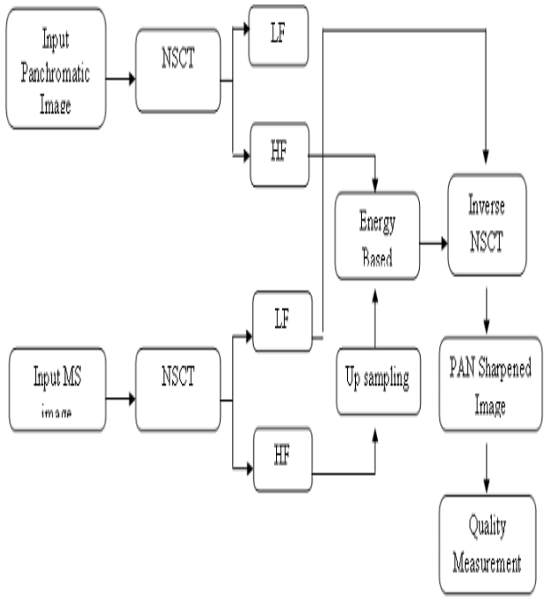


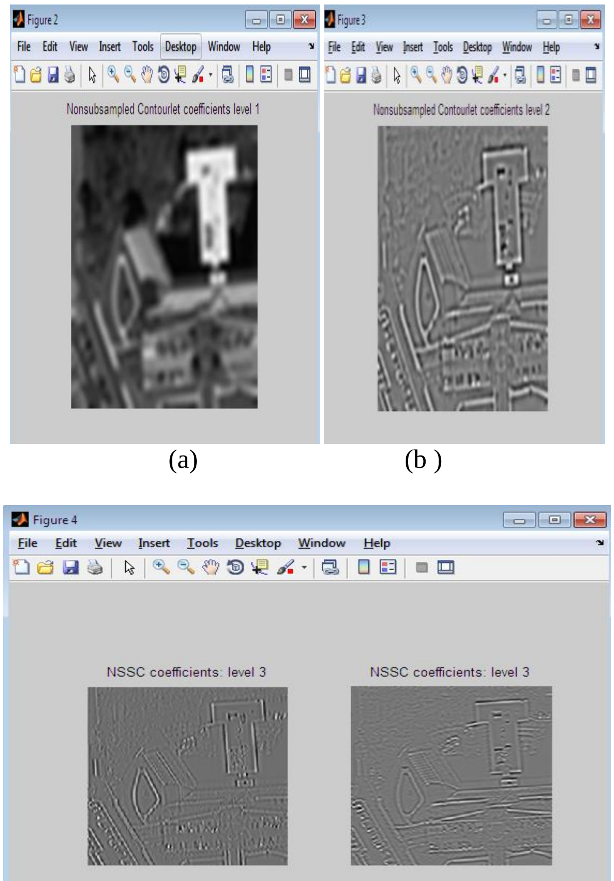
Fig.2 Proposed Method

In this block diagram, flow of the work is given into one after one, initially input images(PAN and MS) are taken, as input images(PAN and MS) has noise we must pre-process, the given input image for reducing noise and to enhance the contrast. Pre-processing has been completed by using Median filter, then enhancing images (PAN and MS) by NSC transform. The NSCT is a fully shift-invariant, multi-scale, and multi-direction expansion that has better directional frequency localization and a quick implementation. The output of NSCT contains low again high frequency which conceivable fused through energy base fusion method and also used up-sampling for getting a higher-resolution version of the image. The fused image produced will be high in quality; it shows every object from both images very accurately and it can also provide extra detailed information about the picture. Pan-sharpened image will get using inverse NSC transform. And finally measure the performance parameters for example cross correlation (CC), relative bias (BIAS), relative variance (VAR), sd (SD), peak signal to noise ratio (PSNR), root mean square error (RMSE), structural similarity (SSIM) and relative average spectral error (RASE) etc. directions.

V. EXPERIMENTAL RESULTS

In this section, the proposed method has been evaluated and the quality metric shows the performance metrics of pan-sharpened image. Fig.3 shows input images (PAN image and MS image).Fig.4 shows different decomposition levels of PAN and MS image.Fig.5 shows Pan-sharpened image which is having high spatial and high spectral resolutions. Fig.6 shows the performance metrics of pan-sharpened image.

Fig.3 PAN image and MS image



(a) (b)

(c)

Fig.4 (a), (b), (c) shows different decomposition levels of PAN and MS images.

Fig.5 Pan-sharpened image

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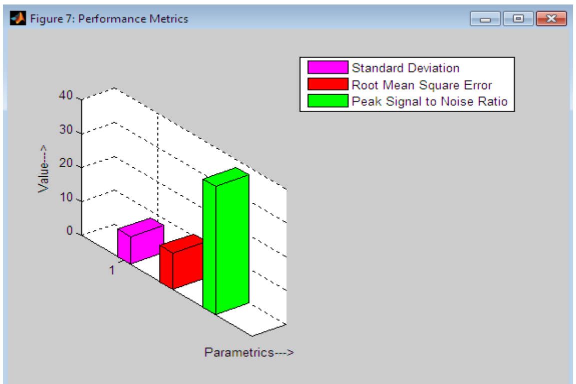

Fig.6 Performance Metrics

VI. CONCLUSION

Proposed method of enhancement of image based on pan-sharpening using NSCT is achieved. Here, spatial details of pan chromatic image are merged effectively with multi spectral image based on Non-sub sampled contourlet transform and pixel level fusion. NSCT was helped to characterize an image with better contour edges in different directions.

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