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Image Fusion Based on Non sub sampled Shear let Transform

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Abstract: ***In current days, an image fusion is a powerful method and developing field in the area of image processing. The image fusion is the process of combining two or more images into a single image then the resulting image will appear more informative than any of the input images. It is the process of assimilation of numerous input images into a new single fused image with highly informative than the input image. There are various image fusion transform techniques are proposed. Out of that techniques a Non-subsampled shearlet transform includes shift invariant property, highly directionality, feasible and more efficient information as compared to previous techniques such as wavelet transform(WT), DWT, LWT, MWT, CWT, Curvelet transform, Counterlet transform, and Nonsubsampled Counterlet transform(NSCT). This NSST technique is carried out by adjusting the levels with filter banks. Downsampling is used to reconstruct. NSST decomposition provides a simple hierarchical framework for image fusion with different geographical resolution.***

Keywords: ***Image fusion, NSCT, NSST, Quality parameters.***

I. INTRODUCTION

The word image fusion means associating all the particulars from various images and their inclusion into fused image. The resultant fused image consists of all required information, more explanatory and exact information than the input image. The objective of image fusion is to get more appropriate and understandable data from a single image and also to reduce the complexity to get data. Applications where image fusion used are remote sensing, satellite imaging, medical field etc.

Image fusion is mainly used in medical field, this paper deal the various medical images.

In the medical field still there are so many cases which were not clearly diagnosed by CT scan, PET scan, SPECT scan, MRI scan. Because there is a little information is extracted by the doctors because of the low resolution of the images. To overcome the low resolution of images NSST image fusion algorithm was implemented.

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II. VARIOUS IMAGE FUSION TECHNIQUES

There are various techniques to implement the Image fusion. The techniques are Wavelet Transform, Curvelet Transform, Contourlet Transform, and Nonsubsampled Contourlet Transform (NSCT).

In Wavelet Transform, Wavelet allows decomposition of complex information into fundamental forms which are speech music images and patterns with high precision at various positions. There are different types in wavelet transform. They are Stationary Wavelet Transform, Discrete Wavelet Transform (DWT), Lifted Wavelet Transform (LWT), Morlet Wavelet Transform (MWT), Complex Wavelet Transform (CWT), Dual Tree Complex Wavelet Transform (DT-CWT). The advantages are, they provide a simultaneous localization in both time and frequency domain, It is mathematically very fast. But the disadvantages are does not provide shift invariance, poor directionality and does not capture edges properly. To overcome these drawbacks we go for Curvelet Transform.

In Curvelet Transform, Wrapping based on fast curvelet transform and fast Fourier transform are not equally spaced. It can be used for both continuous and digital domain. The advantages are high directivity, representing curves like edges efficiently, reduce noise effects and it represents edges better than wavelet. But the disadvantages are shift variance and it is not associated with multi-resolution analysis. To overcome these drawbacks we go for contourlet transform.

In Contourlet Transform, The advantages are Multi-resolution, discrete domain implementation, multidirectional, reduces the redundancy. But the disadvantages are Shift variant, it leads to Pseudo Gibbs phenomenon, frequency selectivity and temporal stability are poor. To overcome these drawbacks we go for Nonsubsampled Contourlet Transform (NSCT).

In NSCT, The advantages are Shift Invariance in decomposition process, and effective Infrared and Visible Image Fusion scheme. But the main disadvantage is, NSCT algorithm has more complexity of time complexity and takes more time to decompose which highly decreases the fusion efficiency.

To avoid these drawbacks in all the various techniques we go for the Shearlet Transform. The Shearlet Transform is best technique compared to all the other various techniques which are implementing in Image Fusion.

III. SHEARLET TRANSFORM

Contourlet transform has been explored for image fusion. Contourlet transform is better than both, wavelet and curvelet transforms. The only problem with contourlet transform is its shift variance nature. In nonsubsampled contourlet transform shift invariance is obtained by downsampling and upsampling operations from the decomposition and reconstruction steps. But, this increases computational cost of nonsubsampled contourlet transform. These problems of contourlet transform have motivated us to use shearlet transform for image fusion. Shearlet transform has a rich mathematical structure and based on multiresolution analysis. In shearlet transform there is no restriction on the number of directions.

Initially, shearlet transform has been used for denoising, sparse image representation and edge detection. In recent years, it has also been used for image fusion.

IV. NON SUBSAMPLED SHEARLET TRANSFORM

Shearlet Transform is a powerful tool for Multiscale Geometric Analysis (MGA) having rich mathematical structure. It is well localized and has fastest reduce in spatial domain and satisfies the parabolic scaling law. It is highly directional sensitive. But, it is not shift invariant due to which pseudo Gibbs phenomenon and other inefficiencies occur in the fusion results. Therefore to avoid these deficiencies a shift invariant of Shearlet Transform (ST) named as Nonsubsampled Shearlet Transform (NSST) is developed. The main advantage of NSST is the shift invariant, which is able to capture 2-D geometrical structure more effective which compared to traditional multi-scale transform. Compared to NSCT, the computational complexity of NSST is lower. Hence the NSST is the best technique in image fusion field.

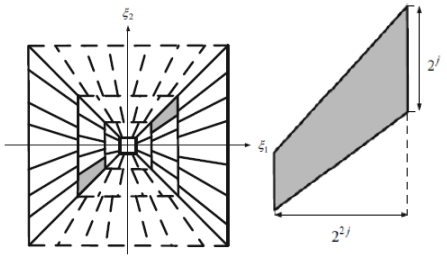


Figure 1: The Structure of the frequency partition by NSST

In Nonsubsampled Contourlet Transform (NSCT), the multi focus images are decomposed. The sum modified laplacian transform is used for the fusion of low frequency sub band coefficients and the log-Gabor energy is used for the fusion of high frequency sub band coefficients. The inverse NSCT is used to reconstruct the image with fused coefficients. The disadvantages of NSCT, high time complexity to decompose and decrease the fusion efficiency.

In Nonsubsampled Shearlet Transform (NSST), low pass sub-band and high pass sub-band coefficients are obtained by the decomposition of inputs (images) into many sub bands of different directions and scales. Finally, the inverse NSST is used for producing the final fused output image.

A.Proposed Algorithm

In the NSST, the proposed image fusion method consists of the following steps:

- Firstly, the source images are decomposed into low pass and high pass coefficients.
- By using the fusion rules, fuse the low pass and high pass coefficients.
- Reconstruct the fused image by performing inverse NSST technique.

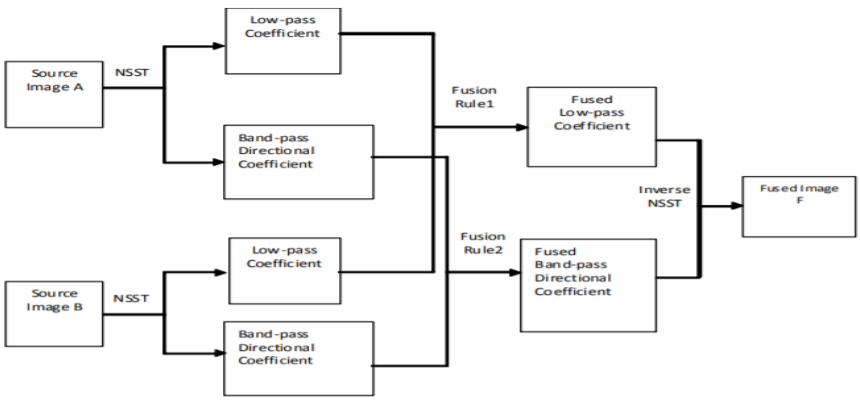


Figure 2: Block diagram of the NSST proposed technique

V. IMAGE QUALITY ASSESSMENT PARAMETERS

A. PSNR:

Peak Signal to Noise Ratio is the ratio of maximum power and the noise.

The equation of PSNR is,

$$PSNR = 20\log\frac{255\sqrt{3MN}}{\sqrt{\sum_{x=1}^{M}\sum_{y=1}^{N}\left(B'(x,y)-B(x,y)\right)^2}}$$

Where, B is the perfect image
B' is assuming the fused image
x is row index
y is column index
M, N indicates number of rows and number of columns

B. Entropy:

To estimate the quality of the image, this concept is behind in entropy. The information increases and the fusion performance are improved after fusing.

The equation of Entropy is given by,

$$E = -\sum_{y=0}^{L-1} P_y log_2 P_y$$

Where, L is sum of gray levels

P is gray level of the individual probability distribution.

C. MSE:

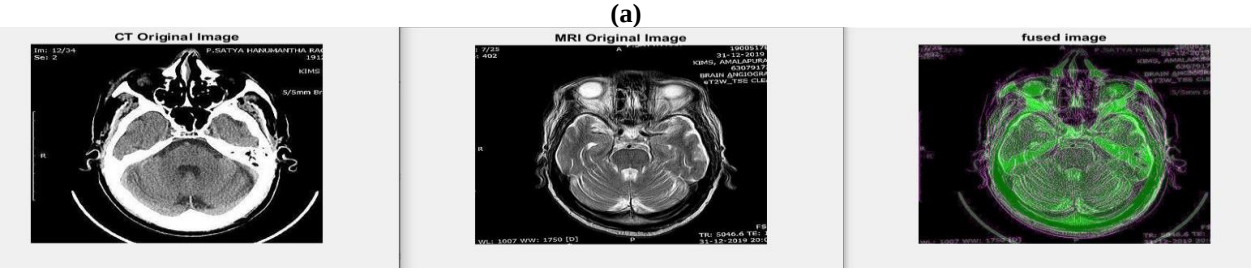
Mean Square Error measures the quality index of an image. The large value of MSE is said that the image is poor.
The equation of MSE is given by,

$$MSE = \frac{1}{mn}\sum_{x=1}^{m}\sum_{y=1}^{n}\left(A_{xy} - B_{xy}\right)^2$$

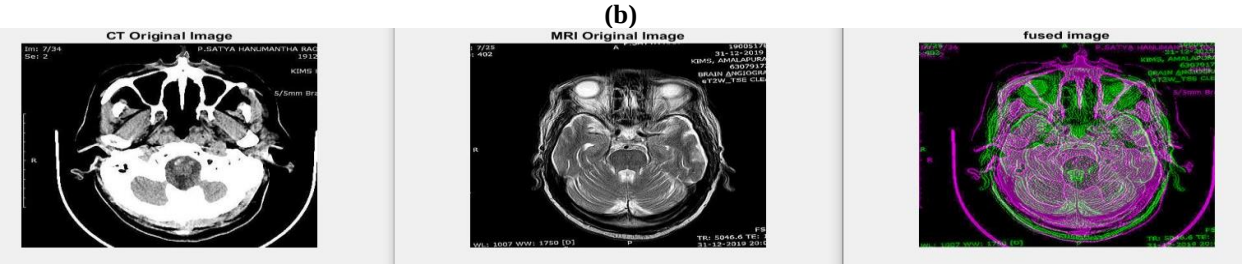
Where, A is the perfect image
B is fused image to be accessed
x is row index
y is column index
M, N indicates number of rows and number of columns

VI. EXPERIMENTAL RESULTS

(a)



(b)



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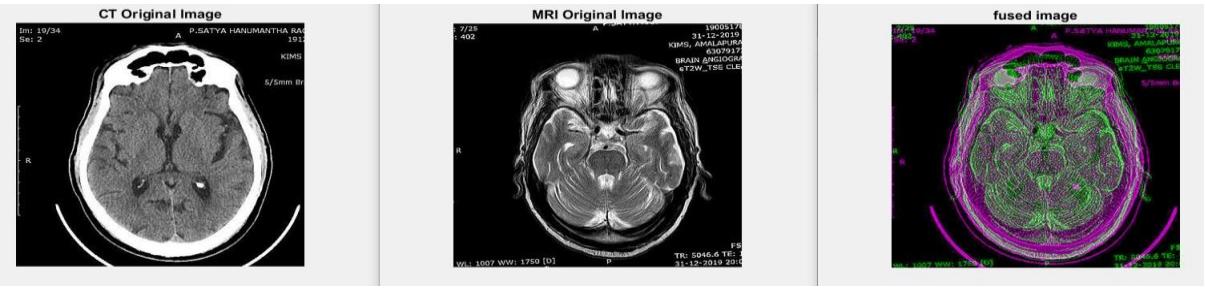

VII. CONCLUSIONS

The NSST algorithm used for image fusion is better as compared to the previous techniques. The NSST has many advantages. This technique avoids Gibbs phenomenon and shift invariance. It achieves shift invariance without increasing redundancy. This algorithm is effective, feasible and efficient for image fusion. It is rich mathematical structure. High directionality, Multiscale. It is localization and anisotropy. Finally conclude that, the NSST technique is better than the previous techniques like wavelet transform(WT), DWT, LWT, MWT, CWT, Curvelet transform, Counterlet transform, and Nonsubsampled Counterlet transform (NSCT).

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