# A Review on various Transform Techniques for Image Fusion

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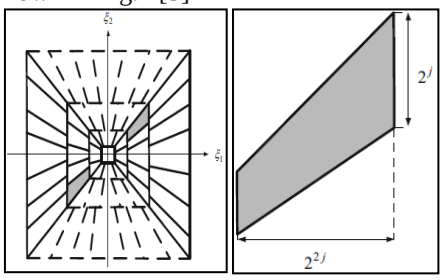
*Abstract*— Now a days an image fusion is a emerging field and powerful technology in the area of image processing. The process of integrating multiple input images into a new single composite image with more informative than any of input image. There are different image fusion transform techniques proposed by many researchers. Out of that transform techniques a non-subsampled shearlet transform adds the property of shift-invariant, capture more directional information and represent the directions of edges more accurately as compared to other transform techniques such as discrete wavelet transform and non-subsampled contourlet transform (NSCT) techniques.

***Key words:*** Image Fusion, Discrete Wavelet Transform (DWT), Non-subsampled Shearlet Transform (NSST), Peak Signal to Noise Ratio (PSNR)

## I. INTRODUCTION

The NSST is the shift-invariant version of shearlet transform, which can capture 2-D geometrical structure much more effectively than those traditional multi-scale transforms. When the NSST is introduced into the image fusion field, more information for fusion can be obtained and the impacts of miss-registration on the fused results can also be reduced effectively. Moreover, the computational complexity of NSST is lower than that of the NSCT. Therefore, the NSST is suitable for image fusion [3].

The frequency support of shearlet is a pair of trapezoidal region which is symmetric relatively for the origin along the direction of the slope s in different scales and the size of which is $2^{2j} \times 2^{j}$, and the frequency partition of NSST is shown in Fig.1 [3]




(a) (b)

Fig. 1: the structure of the frequency partition by NSST (a) The tiling of the frequency plane (b) the frequency support of shearlet

An illustration of this frequency tiling is shown in Fig.1. Shearlet are well localized and exhibit highly directional sensitivity, and the number of orientations doubles at each finer scale. The key idea of Shearlet transform is to filter signal in pseudo polar grid by one dimensional bandpass filter banks. It is more important that frequency-domain implementation of Shearlet transform [3].Whose filtering is done in frequency domain directly without critical sampling operation, so the distortion in directional filtering is avoided and the translation-invariance is ensured. This transform can adaptively capture the geometrical characteristic of multidimensional data and is more efficient in representing images containing edges. So, In more details, Non-subsampled Shearlet transform (NSST) with translation-invariant is designed to improve effectiveness algorithm [2].

## II. LITERATURE REVIEW

In the last few years, there are different image fusion algorithms proposed by many researchers.

A.Amira, A.Bouridane, P.Milligan and M.Roula [2001] [22] has shown that fast Walsh-Hadamard transforms. These transforms are important in many signal-processing applications including speech compression, filtering and coding. Two novel architectures for the fast Hadamard transforms using both a systolic architecture and distributed arithmetic techniques are presented.

Bouden Toufik and Nibouche Mokhtar [2002][21] has explained "The Wavelet Transform for Image Processing Applications" adoption of some wavelet-based schemes to add features inherent to the transform, such as time-scale localization and multi resolution capabilities.

Hai-Hui Wang, Jian Zhang, Wei Wang [2005] [20] has discussed a Steerable Pyramid Transform for the purpose of human visual perception and the compute-processing tasks It has several advantages in comparison with other pyramid transform in image fusion. In this fusion technique the image fusion is performed at the pixel level; a feature-based fusion rule is used to combine original sub-images and to form a pyramid for the fused image. When images are merged in sub-space, different frequency ranges are processed differently. It can merge information from original images adequately and improve abilities of information analysis and feature.

Xiong-Mei Zhang, Jun-Shan Li, Zhao-Xiang Yi, Wei Yang [2007][18] has shown that an adaptive image fusion algorithm based on the Contourlet transform, which realizes automatic parameter adjustment and gets rid of the bad effect caused by artificial factors. The algorithm incorporates the quality metric of structural similarity (SSIM) into the Contourlet fusion framework. The SSIM value is calculated to assess the fused image quality, and then it is fed back to the fusion algorithm to achieve a better fusion by directing parameters (level of decomposition and flag of decomposition direction) adjustment. Based on the cross entropy, the local cross entropy (LCE) is constructed and used to determine an optimal choice of information source for the fused coefficients at each scale and direction

Longxu Jin, Guoging Li [2008][17] has shown that a discrete cosine transform for multi-focus image fusion algorithm.DCT is an efficient algorithm to fuse multi-focus images or videos using discrete cosine transform (DCT) based standards in WVSN. The spatial frequencies of the corresponding blocks from source images are calculated as the contrast criteria, and the blocks with the larger spatial frequencies compose the DCT presentation of the output image. Experiments on plenty of pairs of multi-focus images

coded in Joint Photographic Experts Group (JPEG) standard are conducted to evaluate the fusion performance. The results show that our fusion method improves the quality of the output image visually and outperforms the previous DCT based techniques and the state-of-art methods in terms of the objective evaluation.

Tianjiao Zeng, Renyi Hu, Yaodong He, and Yunqi Wang [16] have discussed a Laplacian Pyramid Transform analysis and comparison of different algorithms; Laplacian pyramid transform focused on pixel level as our fusion methodology. Mobile computing is used, as the whole process is done on the mobile device without uploading to the cloud. The result of our project realizes the enhancement of reality, improves resolution and intelligibility.

Ligia Chiorean, Mircea-Florin Vaida [2009] [15] has presented a discrete wavelet transform, so the imge fusion process allows combination of salient feature of these images. The dedicated application considers Java technology for using its facilities as a future development, regarding a remote access mechanism.

Fitri Amia, Syiah Kuala, Banda Aceh[2009] [14] improve perceptual quality of a robust Discrete Cosine Transform (DCT) domain watermarking scheme, a wavelet based image fusion has proposed instead of spatial masking techniques The robust watermarking is, achieved by inserting watermark sequences in the low frequency DCT coefficients of a host image. Then, the host and the watermarked image are decomposed using a two-level Discrete Wavelets transform (DWT). The image fusion is done by means of replacing the approximate and detail coefficients of the watermarked image with the new coefficients that obtained by applying a certain rule.

Qiang Zhang, Bao-long Guo [2009] [13] has discussed the Multifocus image fusion using the non-subsampled contourlet transform. It significantly outperforms the traditional discrete wavelet transform-based and the discrete wavelet frame transform-based image fusion methods in terms of both visual quality and objective evaluation, especially when the source images are not perfectly registered.

Gurpreet Singh, Gagangeet Singh Aujla [2013] [12] has presented the proposed technique Modified Haar Wavelet Transform is an enhanced version of Haar Wavelet Transform which can reduce the calculation work and is able to improve the contrast of the image. The main achievement of MHWT is sparse representation and fast transformation. In MHWT at each level, we need to store only half of the original data due to which it becomes more efficient.

Vadher Jagruti [2014] [9] has presented an Implementation of discrete wavelet transform based image fusion, So image fusion can be used to get improved image resolution. There are many methods for image fusion, from which wavelet transform based image fusion has advantage over other spatial domain methods in terms of spatial and spectral resolution. Hence discrete wavelet transform (DWT) technique is used for multi Resolution fusion. Multi Resolution fusion uses wavelet transform at multi scale for the representation of the source images.

Siji Quan, Weiping Qian, Junhai Guo [2014] [8] has shown that the Visible and infrared image fusion based on Curvelet transform. Curvelet transform decompose images to different resolutions, and standard fusion rules are built to integrate information from both images. This algorithm is carried out on a set of standard image set, and is compared to a traditional method. It proves that this fusion algorithm based on Curvelet transform is effective enough to accomplish visible and infrared image fusion.

Vijay Kumar Banga [2014] [7] has shown that the discrete cosine transforms (DCT) based methods of image fusion are more suitable and time-saving in real-time systems using DCT based standards of still image or video. DCT based image fusion produced results but with lesser clarity, less PSNR value and more Mean square error. It is a new algorithm whose overall objective is to improve the results by combining DCT with adaptive histogram equalization.

Om Prakash, Arvind Kumar, Ashish Khare [2014] [6] has presented a pyramid transform proposed a pixel-level image fusion scheme using multi-resolution steerable pyramid wavelet transform. Wavelet coefficients at different decomposition levels are fused using absolute maximum fusion rule. Two important properties shift invariance and self-reversibility of steerable pyramid wavelet transform are advantageous for image fusion because they are capable to preserve edge information and hence reducing the distortion in the fused image.

Harmandeep Kaur, Jyoti Rani [2015] [5] has discussed the Image fusion on digital images using Laplacian pyramid with DWT. In this system there is discrete wavelet worked on higher level of spatial resolution with frequency coefficient bands, decomposed the source images with the fusion rule in to high and low levels of coefficient bands. By using enhanced laplacian pyramid technique, mapped the local binarized pixels of images within the region which is pixel by pixel fusion. The final step performed is an inverse DWT with the new band coefficients to construct the fused image. The Laplacian provides the enhanced results of fused images with more accuracy in PSNR and Entropy

N.S. Labhade , Ashwini Y. Chopade, Shubhangi S. Dhumal, Shraddha S. Urunkar [2015] [4] has discussed a Pyramid Transform techniques the pyramid structure can be described as a collection of images at various scales which collectively gives the original image. Pyramid Transform is used to represent the pyramid structure. Another type of Pyramid that is Laplacian Pyramid implements a pattern-selective method for fusing images. In this approach the image is constructed at feature level and not at pixel level. For this the basic concept is to perform pyramid decomposition on each image. After that all these decompositions are integrated and a composite representation is formed. The represented image is reconstructed finally by performing inverse pyramid transform to get fused image.

Yong Yang, Song Tong, Shuying Huang and Pan Lin [2015] [2] has shown that Multifocus Image Fusion Based on non-subsampled contourlet transform (NSCT) and Focused Area Detection. First, the source multifocus images are decomposed using the non-subsampled contourlet transform (NSCT). The low-frequency sub-band coefficients are fused by the sum-modified-Laplacian-based local visual contrast, whereas the high-frequency sub-band coefficients are fused by the local Log-Gabor energy. The initial fused image is subsequently reconstructed based on the inverse NSCT with the fused coefficients. Second, after analyzing the similarity between the previous fused image and the source images, the initial focus area detection map is obtained; this

is used for achieving the decision map obtained by employing a mathematical morphology post processing technique. Finally, based on the decision map, the final fused image is obtained by selecting the pixels in the focus areas and retaining the pixels in the focus region boundary as their corresponding pixels in the initial fused image.

Xingbin Liu, Wenbo Mei, Huiqian Du, Jiadi Bei [2015] [3] has shown that the non-subsampled shearlet transform algorithm for image fusion. In that algorithm the source images are decomposed into several subbands of different scales and directions by NSST and the low frequency sub-band and bandpass sub-band coefficients are obtained. Secondly, for the low frequency sub-band coefficients, the singular value decomposition method in the gradient domain is used to estimate the local structure information of image, and an adaptive 'weighted averaging' fusion rule based on the sigmoid function and the extracted features. And finally, the fused image is obtained by performing the inverse NSST on the combined coefficients. Hence the NSST has higher computational efficiency and stronger selectivity of anisotropic direction.

## III. Conclusions

After going to various literature reviews in regards of transform techniques for image fusion. It has been understood that DCT based image fusion produced results with lesser clarity, less PSNR value and more mean square error. so to improve the results by using laplacian pyramid with DWT. laplacian pyramid with DWT provides the enhanced results of fused images with more accuracy in PSNR and entropy. But DWT can capture only limited directional information, and cannot represent the directions of edges accurately. So non-subsampled shearlet transform (NSST) is found to be best algorithm for image fusion.

Hence NSST has stronger selectivity of anisotropic direction, higher computational efficiency, and provides additional information about the geometry of the set of singularities such as edges and other discontinuities compared to NSCT. Therefore, NSST is more applicable in various applications of image fusion. And further it can be implemented on hardware platform in optimized manner.

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