

# A Survey on Multiresolution Based Image Fusion Techniques

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## Abstract

Image fusion is the process of combining relevant information from two or more images into a single fused image. This technique improves and increases the quality of relevant applications with the help of mutual data. Some of the most widely used real-world applications in the field are agriculture, robotics and informatics, aeronautical, military, medical, pedestrian detection, etc. This paper produces a survey of different research articles which are using various multiresolution algorithms, approaches and also provides a survey of different image fusion techniques used for different applications includes the traditional pyramid based approaches to recent multiresolution based methods. The performance of these techniques depends on the methods used to determine the traditional multiresolution approaches to get a fused image.

**Keywords:** Image Fusion, Gaussian Pyramid, Laplacian Pyramid, Wavelet, Curvelet, Contourlet and Non-subsampled Contourlet.

## INTRODUCTION

Image fusion is a process of multiple images of same scene form single fused image. The objective of image fusion is to combine complementary as well as redundant information from multiple images. Initially fusion would take place in pixel mode. In that, direct pixel values of the source images are added this produces a final fused image. This kind of fusion is called pixel level fusion. In IR image, warm objects can be highlighted but cold objects cannot be visible properly which is just opposite to visual image displays. Thus, by merging both visual and IR, the result image gets cold as well as warm objects in it. This technique had been used in many army, navy and air force application. While using pixel level fusion, the object's shape gets changed due to information redundancy in the fused image [1]. The transform domain fusion methods are also known as Multi-scale fusion [4] methods. Plenty of research had been carried out using Fourier transform and wavelet transforms Though Fourier transform was used in many research works, it leads to fail in preserving edges during the process of different operations. Wavelet based fusion [3] approach provide excellent edge preserving in different direction. To overcome this problems, the other transformations include curvelet and contourlet are being used by now a day's research scholars. Fusion taken place by curvelet and contourlet transformations [7] gives excellent Object preserving in the fused images. Because, the further actions like segmentation, feature identification and

detection would be much important for different applications using fusion. This paper produces a survey of different research articles which are using various algorithms and approaches. Section II presents a review of literature works. Section III represents a brief reviews of contourlet are being used by now a day's research scholars. Fusion taken place by curvelet and contourlet transformations [7] gives excellent Object preserving in the fused images. Because, the further actions like segmentation, feature identification and detection would be much important for different applications using fusion. This paper produces a survey of different research articles which are using various algorithms and approaches. Section II presents a review of literature works. Section III represents a brief reviews of multiresolution based image fusion approaches and Section IV presents performance metrics on different multiresolution based image fusion techniques. The traditional multiresolution approaches like Pyramid, Wavelet, Curvelet, Contourlet and Non-subsampled Contourlet.

## RELATED WORKS

In this image fusion enhance the information apparent in the images as well as to increase the reliability of the interpretation by integrating disparate images. This leads to more clear data [6] and increased visualises in application fields like medical imaging, foggy images, etc. This paper discuss different techniques of pixel level image fusion enhance the images.

A fusion algorithm to fuse two different images of the same scene by applying Laplacian Pyramid technique over the selected image to convert them into different levels. To use the fusion rule [8], they developed weight value using fuzzy approach in order to calculate weight values using the principle component analysis (PCA) technique.

A contrast enhancement gray images based on Fast Discrete Curvelet Transform via Wrapping (FDCT-Wrap). The transforms tolerates a table of curvelet measurements indexed by a scale factors [1], an orientation, and a spatial locality. The FDCT-Warp coefficients can be modified in order to enhance contrast in an image. There are several techniques used in enhance images according to the image type. A technique that is used to enhance a certain type of images may not give the best results for another type. This is as an outcome of the different quality standard for each image. We propose an efficient method to enhance low contrast in gray image.

Image Fusion states multiple images of the same scene are taken as input images and included in order to retrieve the best fused image which is more informative and comprehensive than any of the input images. There are few methods of image fusion technique such as principal component analysis (PCA), Discrete Wavelet transforms (DWT), curvelet transform [5] which contracts with image pixels to reduce multidimensional data sets to lower dimensions for analysis and discrete Wavelet (DWT) transform are the transform domain methods to integrate the input images and extract required information.

The image fusion is the combination of NSCT as well as edge weakening guided image filter. This algorithm could not maintain the depth of multi-focus picture but also contain artefacts well by combining advantage of NSCT as well as EWGIF. The fusion measures for combining low subband as well as bandpass subband coefficients, that is the other part of the nonsubsampling contourlet transform after that it decomposed through employing converse NSCT method [9] for fusing low as well as bandpass coefficient bands contained

by pictures in which outputs of various fusion rules depend a dissimilarity measure of source pictures. The recital evaluation with the support of EWGIF to maximize IE, SD, AG, spatial frequency. Root mean squares cross entropy, Fusion Factor and Contrast Gain within final fused image.

A fusion-based NSCT (Nonsubsampled Contourlet Transform) and multi-scale saliency maps for detecting transformed areas by using multispectral images is presented in this paper. In order to remove most of the noise, saliency maps of each sub bands and each scales are obtained by processing only the low-frequency sub-band coefficients of the decomposed image. In this paper, an unsupervised approach with Nonsubsampled Contourlet Transform and multi-scale saliency maps change detection method is multispectral images [3]. By decomposing the initial difference image set into several scales, maximum of the noise could be removed. Then a frequency-tuned saliency detection method is introduced to obtain the saliency maps in which the changed and unchanged area is clearly discrepant.

**Table I.** Comparisons on Multiresolution Based Image Fusion Techniques

S.No	Author	Year	Method	Merits	Demerits
1	Chamman sahu et al.,	2014	Pyramidal method for Image Fusion	Improve the quality of an image and enhance the maximum information from degraded image.	A fusion outcome that would show some color details.
2	Barkha Panda	2016	Wavelet and Curvelet Transform	Develop the image Quality	Curvelet transform is done on Grayscale Images.
3	Abdullah M.Hammouche et al.,	2017	Fast Discrete Curvelet Transform.	Develop Enhancement Contrast in an Image.	A Complex Steps Which Include the Ridgelet Transform.
4	Along zang	2017	A novel inter-scale and inter-band fusion method.	The spectral information and remove noise in multispectral image change detection.	Multitemporal images is applied to get an initial difference image.
5	Gulshanpreet et al.,	2017	Principle Component Analysis (PCA).	Develop weight values using fuzzy approach.	Medical images from fused image.
6	Harmanpreet kaur et al.,	2017	Edge-Weakening Guided Image Filter.	Multiple Picture using NSCT as well as Edge weakening Guided Image Filter.	Low frequency subband coefficient are fused through visual salient features (VSF).

## MULTIRESOLUTION BASED IMAGE FUSION TECHNIQUES

The multi-resolution transformations have been recognized as a very useful method to analyze the information content of images for the purpose of image fusion. In this study some image fusion techniques using wavelet, curvelet, contourlet transform domain. The purpose of fusion is to extract the important information from each of the given source images and are fused together to form a resultant image whose quality is superior to any of the input images.

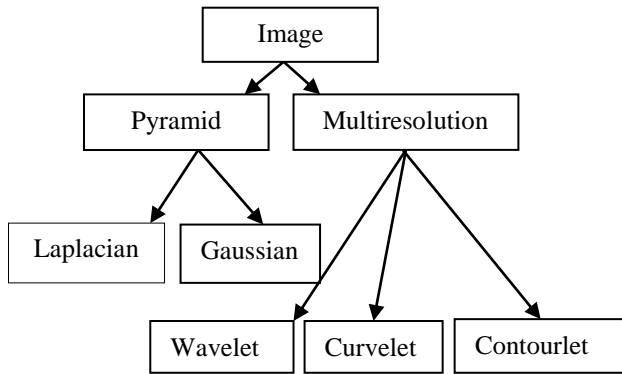


Figure 1. Image fusion techniques

Enhanced Vision System (EVS) is more popular in the context of fusion of visual and IR image fusion. It can be a combination of two infrared sensor for date acquisition. In [2], aimed to tackle the present implementation by a combination of single FLIR sensor with a CCD camera their work. The Laplacian pyramid based work had been implemented in MATLAB.

The wavelet transform has become a very useful tool for image fusion. A different way of medical images and developed a fusion algorithm to fuse them. The source images for the fusion can be included for three steps of operation including image pre-processing, image registration and finally image fusion. Since image pre-processing is a course of noise reduction, this paper suggest a wavelet denoising method. Image registration is a premise of multiimage fusion and multimodality image analysis [10].

In image fusion is the process in which we combine two or more images are some features of images to from a single image which is free from a single image which is free from distortion [20] and does not loses it information. In this paper to develop a Curvelet and Contourlet transformation for better fused images. The combination of the features of both Curvelet and Contourlet make this method generalized for using it for almost all types of medical images. It makes a improved quality of fusion process.

In this transform, the Multiscale analysis and the multi-direction analysis are separated in a serial way. A novel image fusion algorithm based on the Nonsubsample Contourlet transform, specially, according to the imaging principle of the defocused optical system, the characteristics of the human

visual system and the perfect property of the NSCT. The selection principles of the low pass Subband coefficients and the band pass directional Subband coefficients are discussed in detail. The low pass Subband coefficients to improve the fused image quality, a clarity measure should be defined to determine which pixels or regions of source images. [12]. Image fusion is to integrate complementary and redundant information from multiple images to create a composite which contains a better description of the scene than any of the individual source images.

An image fusion method based on NSCT and focused area detection [21]. The image fusion framework for multi-focus images, which relies on the NSCT domain and focused area detection. In the process of initial fused image that is obtained based on NSCT that provides low and high frequency to provide a better performance than the current fusion methods whatever the source images are clean or noisy. The experimental is conducted on several groups of multi-focus images. The NSCT algorithm is time-consuming and of high complexity.

## PERFORMANCE MEASURES

Performance measures are used to measure the possible benefits of fusion and also used to compare results obtained with different multiresolution algorithms. To check evaluation performance of fusion process, qualitative and quantitative measures can be used. Quantitatively it is measured by visual analysis statistical analysis. Qualitative assessment can be evaluated using reference and non-reference based metrics. Reference based metrics includes mean square error, peak signal to noise ratio. Non-reference based metrics includes mutual information, structural similarity index, spatial frequency and quality index.

$$RMSE = \sqrt{\frac{1}{(M * N) \sum_{i=1}^M \sum_{j=1}^N ((R(i, j) - F(i, j))^2)} \quad \rightarrow 1$$

$$PSNR = 10 \log_{10} \frac{L^2}{(RMSE)^2} (dB) \quad \rightarrow 2$$

Mutual information is defined in equation 3 as

$$MI_{RF} = \sum_{i=1}^M \sum_{j=1}^N p_{RF}(i, j) 10 \log_2 \left( \frac{p_{RF}(i, j)}{p_F(j) * p_R(i)} \right) \quad \rightarrow 3$$

Where  $p_{RF}$  is the normalized joint gray level histogram of images F and R having size M\*N,  $p_F$  and  $p_R$  are the normalized marginal histograms of the two images, L is number of gray levels and F (i, j) and R (i, j) are the pixel values of the fused and the reference image.

## CONCLUSION

Image fusion increases the information contents in fused image. The input images for image fusion may be from different sensors. Image fusion techniques have been widely used to various applications such as remote sensing, computer vision, medical imaging, object recognition, etc. This paper gives multiresolution based image fusion techniques. Various issues have been found on the basis of the study of the reviewed papers. Further improvement can be done by hybrid techniques using both spatial and frequency domain methods can be used to obtain better results. In this paper, a complete overview for multiresolution based image fusion with its types and variants are discussed.

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