

# A Review on Multi-Scale and Multi-Resolution Transform Based Multi-Focus Image Fusion

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## ABSTRACT

The strategy of mixing two images or in excess of two images which produces result as the composite mixed image. The got combined image is the updated form of unique images since it has all the Focus data. The present applications makes more than two image combination to accelerate their handling unfocused part in their separate fields. Late constant applications which require image combination are remote detecting applications, medicinal applications, reconnaissance application and photography applications. In the photography field, the imaging procedure contains taking a few shots with various centred districts and to coordinate similar images to create holding nothing back center image is very noisy. In this manner, to incorporate the multi-canter image combination calculations into purchaser gadgets to catch excellent mixed image progressively applications is required. The general arrangement of image combination systems are Non-change area or spatial space and Transform area or recurrence area. The previous procedure works straightforwardly on the pixels of the image though the last system utilizes combination technique where numerous combinations decides are connected on that changed images to deliver wanted corrected image. In Non Transform area combination, the image's striking highlights are not plainly noticeable. The mix of different image combination techniques in Non-change space beats combination execution measurements. In this a mixture mix of Wavelet and Ripplet changes is decided for combination technique. A strategy that consolidates both the highlights that is Multi-resolution and Multi-scaling. Wavelet change is speedier created multi-goals examination combination strategy and Multi-scaling change is equipped for speaking to images at various scales and diverse bearings.

## 1. Introduction

The technique of blending two images or more than two images which produces outcome as the composite fused image. The obtained fused image is the upgraded version of original images because it has all the salient information. The present applications makes majority usage of this fused image to speed up their processing tasks in their respective fields. Recent real-time applications which require image fusion are remote sensing applications, medical applications, surveillance application and photography applications [13]. The following figures show how image fusion can be applied to several areas.



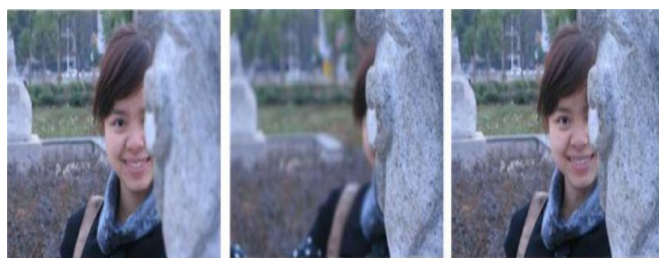
1) Back side blurred Image 2) front side blurred image



Fig 1: Example of Fused Image

In Fig1, each image (1) (2) has back side blurred part and front side blurred part respectively due to bad focus. Image (3) is the result of combining the three other images using image fusion technology. This example could be used in a commercial advertisement photo shot.

The constraint of the optical lens is that it will focus only on the object that is visible in its focal length. Multi focus image fusion produces the composite image having all the objects or every scene is in-focus that enhances the visual perception. Fig 1.2 shows the example of Multi focus image fusion. In image (1) and (2) the scene captured is back-focused and fore-focused. Hence, in manual image capturing process, the salient information of the scene is lost. By applying the Multi focus image fusion technique, we get the fused image shown in image (3)



1) Back-focused Image 2) Fore-focused Image 3) Fused Image

Fig 1.1: Multi-focus Image Fusion.

## 2. Related Work

In [1] Y. Yang, M. Yang, S. Huang, M. Ding, and J. Sun describes A multi-focus image fusion method based on robust sparse representation (RSR) and An adaptive pulse-coupled neural network (PCNN) is presented. Each source image is first decomposed with RSR to obtain a sparse coefficients matrix and a residuals matrix. Second, the spatial frequency of the Residuals matrix is calculated as the motivation for PCNN neurons, and a salience map of the source image is proposed as an adaptive linking strength for the PCNN. To validate the method on a Sensor network testbed. Limited for particular application such as 'traffic' and 'battlefield' images.

In [2] Yang Dongsheng, H. Shaohai, L. Xiaole, S. Yuchao describes, a fusion framework based on block-matching and 3D (BM3D) multi-scale transform. The algorithm first divides the image into different blocks and groups these 2D image blocks into 3D arrays by their similarity. Then it uses a 3D transform which consists of a 2D multi-scale and a 1D transform to transfer the arrays into transform coefficients, and then the obtained low- and high- coefficients are fused by different fusion rules. The final fused image is obtained from a series of fused 3D image block groups after the inverse transform by using an aggregation process.

In [3] P. Lin, Y. Yang, S. Tong, Shuying Huang, Y. Fang presents a fast discrete Curvelet transform (FDCT) based technique for multi-focus image fusion to address two problems: texture selection in FDCT domain and block effect in spatial-based fusion. First, we present a frequency based model by performing FDCT on the input images. Considering the human visual system (HVS) characteristics, a union of pulse coupled neural network (PCNN) and sum-modified laplacian (SML) algorithms are proposed to extract the detailed information of frequencies.

In [4] Milad Abdollahzadeh, T. Malekzadeh, H. Seyedarabi, Image fusion methods based on discrete cosine transform (DCT) are less complex and time saving in DCT based standards of image and video which makes them more suitable for VSN applications. In this paper an efficient algorithm to fusion of multi-focus images in DCT domain is proposed. Sum of modified laplacian (SML) of corresponding blocks of source images are used as contrast criterion and blocks with larger value of SML are absorbed to output images. The experimental results on several images show the improvement of proposed algorithm in terms of both subjective and objective quality of fused image relative to other DCT based techniques.

In [5] X. Zheng, Z. Zhang, X. Luo, Xiao-Jun Wu, It describes a novel multi-focus image fusion method is proposed in quaternion wavelet transform domain. To obtain the dependency in different high frequency subbands, a quaternion wavelet contextual hidden Markov model (Q-CHMM) is established for modeling quaternion wavelet coefficients. And for better image representations, several features are proposed by analyzing the transform coefficients, phases of coefficients and the statistical attribution of coefficients. Different from the traditional fusion methods basing on a single feature, a comprehensive feature is

constructed by using quaternion matrix to fuse the high frequency subbands. Experimental results demonstrate that the proposed method possess good fusion performance.

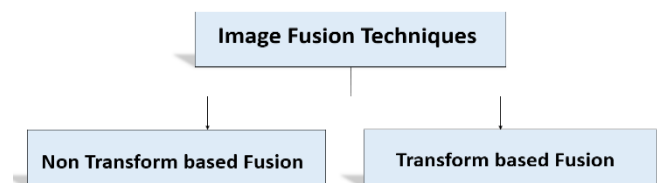
In [6] Mehdy Dousty, S. Daneshvar, Roberto C. Sotero, the discrete Hartley transform (DHT) is used for this purpose. The main advantages of DHT are that it transforms real inputs into real outputs (as opposed to complex outputs as in the Discrete Fourier transform) and of being its own inverse. Our results demonstrate that the image obtained using the proposed method is multi-focused, with sharp edges for the different objects forming the image.

In [7] Aishwarya N, Abirami S, Amutha R, a novel fusion algorithm based on Discrete Wavelet Transform (DWT) and Sparse Representation (SR) is proposed. Initially, DWT is applied to extract the low frequency components and high frequency components of source images. High frequency components are merged using SR based fusion approach and low frequency components are combined using variance as activity level measurement. Finally, inverse DWT is performed on the fused coefficients to get the fused image.

Experimental results demonstrate the effectiveness of proposed method in terms of visual perception and quantitative analysis.

## 3. Methodology

Figure 1. Image



### Fusion Techniques

#### A. Non transform based fusion techniques:

The well-known existing Spatial Domain Image Fusion methods are listed below:

- Simple average[]
- Select maximum[]
- Principal Component analysis(PCA)[]
- Intensity Hue Saturation(IHS)[]

#### B. Transform based fusion techniques:

In transform domain, image is first transformed into frequency domain and decomposed primarily based on transform Coefficients. Then the fusion approach is implemented and the decision map is acquired. Lastly, the Inverse transformation at the decision map produce is the fused image. Some famous examples of Transform Domain Image Fusion techniques are Discrete Wavelet Transform, Curvelet Transform, Contourlet Transform, and Discrete Ripplet Transform.

#### i. Discrete Wavelet Transform (DWT)

Discrete Wavelet transform offers directional information in decomposition stages and includes particular information at distinct resolutions [18]. The fusion procedure based on

wavelet transform can be described as follows:

1. The images to be fused must be registered to assure the corresponding pixels area lined.
2. These images are decomposed into wavelet transformed images respectively, based on wavelet transformation. The transformed images include one low frequency portion (low-low band) and three high frequency portions (low-high bands, high-low bands, and high-high bands).
3. The transform coefficients of different portions or bands are performed with some fusion rules.
4. The fused image is constructed by performing an inverse wavelet transform based on the combined transform coefficients from step 3.

**ii. Discrete Curvelet Transform**

The curvelet transform is a totally newest signal analyzing technique with has the precise capability. It's so far identified as a milestone on image processing and Curvelet transform is extra precise to cope up with the curves than wavelet transform. Different applications.

In the Wavelet technique, many wavelet coefficients are required to account edges that is to say singularities alongside lines or curves had to account edges. In Curvelet technique much less coefficients are required to account edges.

**iii. Contourlet Transform (CT)**

Contourlet transform is an actual dimensional image

illustration proposed by Minh N. Do and Martin Vetterli in 2002. Contourlet transform is done by means of two steps: Laplacian pyramid decomposition (LP) and directional filter banks (DFB) filtering. First of all, decompose the original image into one low-pass sub-picture and one band-pass sub-picture via LP decomposition. The band-pass sub-picture is the difference image among the original image and the low-pass prediction image. Then decompose the band pass sub-picture into numerous direction sub-bands via the directional filter banks. Repeat above procedure to the low-pass sub-band that will gain multi-resolution and multi-directional decomposition of the picture. Contourlet transform now not only has multi-scale and time frequency local characteristics, however has directional features that could correctly capture the image edges into unique scales and distinct frequency sub-bands.

**iv. Discrete Ripplet Transform (DRT)**

The traditional transforms like Fourier transforms and Wave transforms suffer from discontinuities consisting of edges and contours in pictures. To cope up with this hassle, Jun Xu et al. Proposed a novel Multi Geometric-Analysis (MGA) called Ripplet Transform (RT). The RT is a higher dimensional generalization of the Curvelet transform (CVT), capable of representing images or 2d signals at different scales and different directions. Visible and quantitative evaluation states that the Ripplet transform technique gives good fusion results as compared to fusion scheme based on Contourlet transform (CNT).

**4. Comparative Study**

**Table I. Comparative Analysis of Recent Transform Domain Techniques**

Image Fusion Method	Merits	Demerit
Discrete Wavelet Transform[]	The DWT fusion method has least spectral distortion. It also provides better PSNR than pixel based approach. Multi-resolution, localization and critical sampling is provided by wavelet [16].	<b>Do not provide directionality (Multi-scaling)</b> and anisotropy so does not produce good result while capturing edges.
Curvelet Transform	In Curvelet approach less coefficients are needed to account edges [24]. Multi-Scaling is provided by Curvelet.	CVT is just a special case of RT with $c = 1$ and $d = 2$ [15].
Contourlet Transform	Multi-scaling, directionality, Multi-resolution, localization are provided by Contourlet [16].	Visual and quantitative analysis shows that the Ripplet Transform technique performs better compared to fusion scheme based on Contourlet Transform (CNT) [15].
Discrete Ripplet Transform	Multi-scaling, directionality, localization are provided by Ripplet.	<b>It does not provide Multi-Resolution.</b>

**Table II. Comparison Between existing v/s proposed Method**

parameter	Existing method[1]	proposed methpod
domain	transform	transform
multi-resolution	dct-pcnn	dwt
multi-scalng	-	drt
method	without image blocking	image block
type	gray	rgb

**5. Conclusion**

Several methods are available for Multi-focus Image Fusion. All the spatial domain based methods have side effects like reducing the contrast of the entire image. But these are

much useful and simpler in case of high contrast and bright images. The disadvantage of spatial domain approaches is that they produce spatial distortion in the fused image. Spatial distortion can be very well handled by frequency domain

approaches on image fusion. Limitation of DWT is that it does not provide directionality and anisotropy so it is not suitable for Multi-focus Image Fusion. Limitation of DWT can be overcome using DRT Transform. Here Multi-focus Image Fusion is implemented using DWT, DRT, combined DWT and DRT and

combined DWT and DRT integrated with image blocking method. In future we will implement Image fusion technique which can deal with Colour and gray with more no of input images. Further we will try to evaluate implement Hybrid Multi-focus fusion technique based on parameters.

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