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HYBRID IMAGE FUSION

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Abstract - *Image fusion is defined as combining useful information from multiple images to a single image. The resulting image will be more informative and accurate. Image fusion not only just combines images but also constructs images such that the information produced is understandable from human and machine perception. The satellites capture images by the high resolution camera and by the help of concepts of remote sensing. Remote sensing is the process of gathering the information of an object without making a physical contact with the object. This paper uses the hybrid fusion technique which is composed of both spatial and frequency domains. This paper is based on the concept of satellite image fusion as an application of hybrid fusion technique.*

Key Words: **Remote Sensing, Multisensor, Spatial and Frequency fusion, Wavelet transform, Fourier transform.**

1. INTRODUCTION

Image fusion combines multisensor data to produce a fused image with high spatial, spectral, and radiometric resolutions. Image fusion is the most beneficial technology in remote sensing for utilizing multisensor, multispectral earth observation satellites at varying resolutions. Spatial resolution is critical for delineating objects in a remote sensing picture. The characteristics of a high spatial resolution image with multispectral information are easier to comprehend than a single high resolution Pan image. The single output image is more informative and accurate than any of the single source image and it consists of all necessary information

Image restoration: Image fusion can be used to restore an image from more than one degraded images with uncommon areas of degradation.

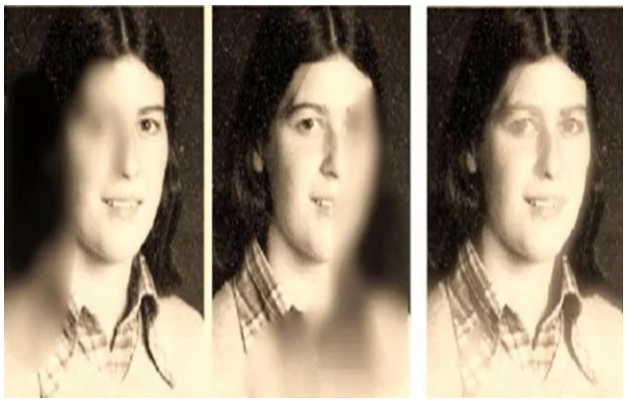

Fig -1: Image Restoration

Image mixing: Two or more images can be fused to create a new image which carrier more information.

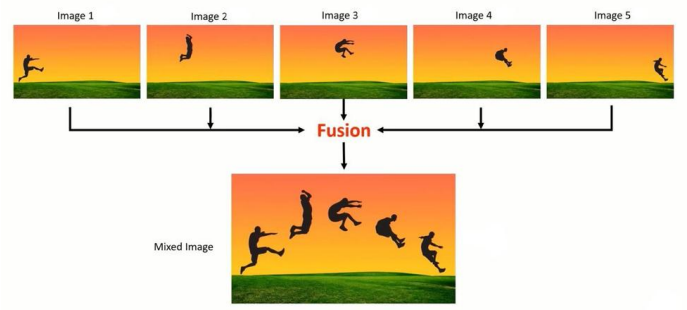

Fig -2: Image Mixing

Image fusion can help in restoration of degraded images and mixing images. By using the hybrid fusion technique, the image quality will be super enhanced in terms of both spatial and frequency domains. Image fusion is used in various fields like computer vision, remote sensing and medical imaging.

Image fusion can be broadly classified into two types: Spatial domain fusion and Transform (Frequency) domain fusion. In spatial domain the operations are done directly on pixels of the image to get the desired image whereas in the Transform domain the operations are done on Fourier transform of the image followed by Inverse Fourier transform to get the resultant image.

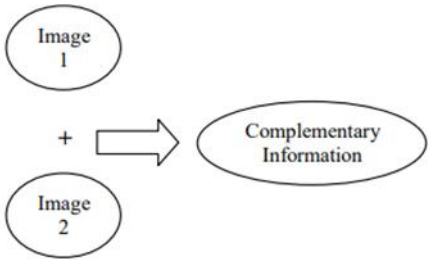

Fig -3: Fusion

1.1 Spatial Image fusion

Averaging, Select Maximum / Minimum, and Principal Component Analysis (PCA) are examples of simple image fusion methods. These methods are classified as spatial domain methods. The major drawback of spatial domain approaches is that it produces spatial distortion in fused images and during the further process spectral distortion causes negative impact on image causing classification problems.

1.2 IMAGE FUSION TECHNIQUES (SPATIALDOMAIN)

1.2.1 Simple Average

It is a fusion technique that uses pixel averaging to fuse an image. This approach focuses on all parts of the image and works best if the images are captured with the same sort of photographs sensor. It will provide good results if they have a high brightness and contrast. This technique is used in hybrid image fusion for the enhancement of the image.

$$F(a,b) = \{X(a,b) + Y(a,b)\}/2$$

1.2.2 Minimum Technique

It selects the lowest intensity value of the pixels from images and produces fused images. This technique is used in satellite image fusion used in oceanography reflectometry.

$$F(a,b) = \sum_{a=1}^{M} \sum_{b=2}^{N} minX(a,b)Y(a,b)$$

1.2.3 Maximum Technique

It selects the pixel values of high intensity from images to produce fused images. The high intensity pixel is used to detect the grasslands from the satellite.

$$F(a,b) = \sum_{a=1}^{M} \sum_{b=2}^{N} maxX(a,b)Y(a,b)$$

1.2.4 Max-Min Technique

It selects the averaging values of the pixels smallest and largest from the entire source images and produces the resultant merged image.

$$F(a,b) = \{\sum_{a=1}^{M} \sum_{b=2}^{N} maxX(a,b)Y(a,b) + \sum_{a=1}^{M} \sum_{b=2}^{N} minX(a,b)Y(a,b)\}/2$$

2. Frequency Image fusion

In frequency image fusion the Fourier transform of the pixel is taken and the value of the pixel is achieved by taking the inverse Fourier transform.

2.1 Wavelet Transform

Wavelets can be defined as the wave-like oscillations generated according to the frequency of the pixel values. This transform completely depends on the wavelets of an image. An image after the wavelet transform application is divided into four wavelet coefficients, vertical coefficient and the diagonal coefficient. This procedure keeps on happening until the desired image is achieved.

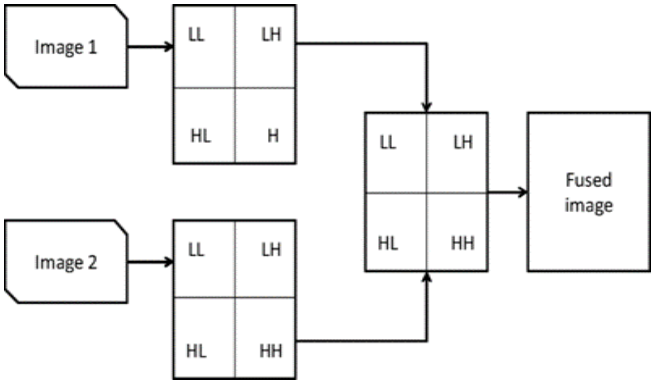

Fig- 4: Image dividing into wavelet coefficients

Both the images are decomposed into wavelet coefficients using Discrete Wavelet Transform. Only single level discrete wavelet decomposition of 4 matrices of coefficients.

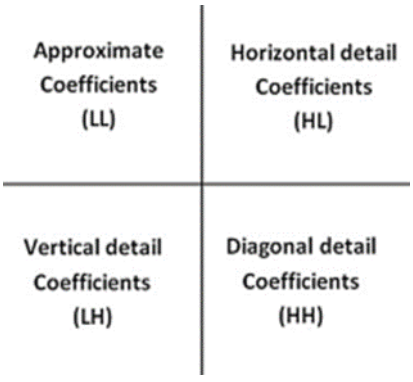

Fig -5: Four Wavelet Coefficients

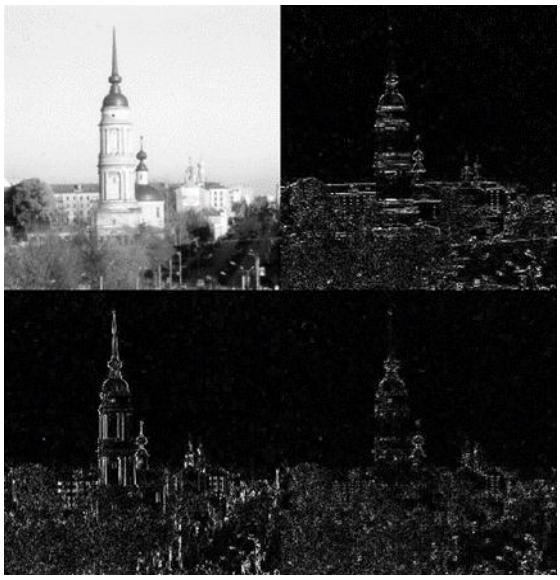

Fig -6: Wavelet Coefficients of an image

The given above images are the outputs of the wavelet transform .The first image is the approximation image or the original image ,the second image is the horizontal component ,the third is the vertical and the fourth is the diagonal component respectively. Fusing all the wavelet coefficients to get the fused wavelets followed by the inverse discrete wavelet transform results in the fused image.

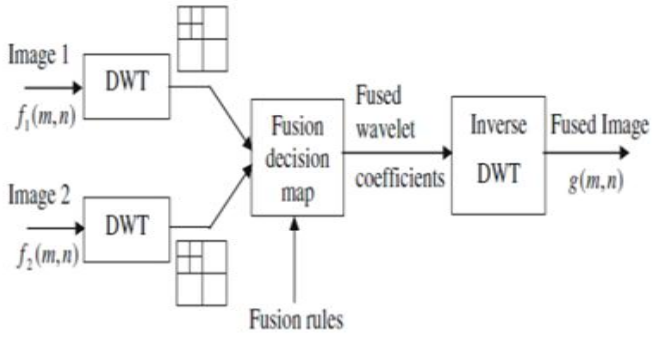

Fig -7: Fusion Process

The wavelet coefficients of the two images can be fused using different combinations of mathematical operations.

Fusion is performed in two ways

1. fusion1 for approx. coefficient

2. fusion2 for detailed coefficient

LL=fusion1 (LL1, LL2)

HL=fusion2 (HL1, HL2)

LH=fusion2 (LH1, LH2)

HH=fusion2 (HH1, HH2)

Fusion1 and fusion2 are the mathematical operations such as mean, max and min.

Therefore total 9 combinations of mathematical operations on approximation coefficients and detailed coefficients are possible such as

MeanMean, MeanMax, MeanMin, MaxMean, MaxMax, MaxMin, MinMean, MinMax, MinMin

Fusion1 (Approx. Coeff.)	Fusion2(Detailed Coeff.)
Mean	Mean
Mean	Max
Mean	Min
Max	Mean
Max	Max
Max	Min
Min	Mean
Min	Max
Min	Min

Table -1: Mathematical operations

Based on the data acquisition of a user and by observing the efficiency of the algorithm, a suitable method can be chosen for the appropriate result.

Fig -8: MaxMax

Fig -9: MinMax

Fig -10: MeanMax

3. Hybrid Image Fusion

Nowadays satellite communication is being advanced at a higher level using the concept of remote sensing, where the information of the image is acquired without the physical contact of the object. In the hybrid fusion technique spatial and frequency domains are combined for the enhancement of the image.

3.1 Working of Hybrid Image Fusion

The hybrid image fusion uses the concept of both spatial and frequency domain. The algorithm processes two images and fuses both in spatial domain and frequency domain and takes the sum of products of results of fusion of the first image and the second image with the given value alpha and beta respectively.

The algorithm multiplies 0.5 to the fusion values (fusion1 and fusion2) and takes the sum of it to get the final hybrid fusion value

The algorithm takes the sum of products of fusion1 and fusion2 with 0.5 to get the final fusion value.

The algorithm takes the sum half of fusion1 and fusion2 to get the final value of fusion to get the final fusion value.

fusion = alpha * fusion1+ beta * fusion2

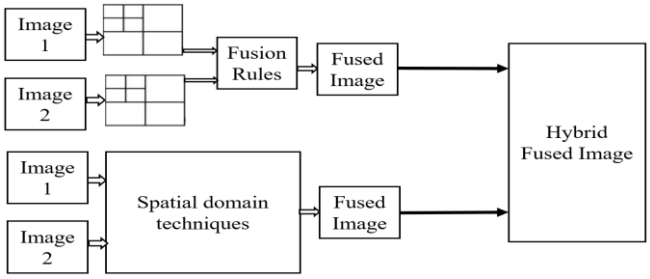

Fig -11: Block diagram Hybrid Image Fusion

Fig -12: Fused Output

4. CONCLUSION

By using this method of the Hybrid image fusion we can achieve the better quality image by the combination of both spatial and the frequency domain. The resulted image can be used as application for the military and the experimental purpose.

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