Panchromatic and Multispectral Image Fusion by Combining IHS Transform and Haar Wavelet

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Abstract

The technique of integrate complimentary details from two or more input images is known as image fusion. The fusion image is more informational and will be complete more than any of the original input images. This paper Illustrates implementation and evaluation of fusion techniques used on the Satellite images a high-resolution Panchromatic (Pan) and Multispectral (MS). A new algorithm is proposed to fuse a Pan and MS of the low-resolution images based on combining IHS and Haar wavelet transform.Firstly, this paper clarifies the classical fusion by using IHS transform and Haar wavelet transform individually. Secondly proposition new strategy of combining the two methods. Performance of the proposed method is evaluated with the help of assessment parameter such as Mean Square Error and Peak Signal to Noise Ratio. Experiment results shows that the proposed algorithm has higher performance than the classical fusion by IHS transform.

Keywords: Image Fusion, IHS transform, Haar wavelet

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Introduction

In our time , remote sensing image is developed to high (spatial, spectral and time) resolution [1].

The technical method that integrates the spatial details of spectral information of low-resolution MS and Pan with the high-resolution to produce the new high-resolution multispectral image is known as Image fusion. In fusion , Enhanced spatial details of the Pan images and maintain the spectral information of the MS images at the same time was the most important point [2]. The techniques of image fusion is performing at three different categories depend on the stage at which fusion takes place, it is (pixel, feature and decision) level of impersonation [3].

Pixel level is the lowest level of image fusion, referring to the merging of measured physical parameters .Its combination mechanism is directly on the pixels obtained at the different sensors through several algorithms under hard registration conditions.

Feature level fusion working on features extract from the source images which is intermediate level of image fusion where the features correspond to characteristics extracted from the initial images depend on their environment, on the other hand the high-level fusion Decision-level, its results providing by the basis for command and controlling decision make [4] .Recent years, there are many research works on methods of image fusion , IHS image fusion technique is wide used in remote sensing fusion because it can improving the textural characteristics and enhancing spatial details of the fusing image but still exist serious spectral distortion. We can overcome this problem by improving IHS through integration with other techniques such as wavelet.

Image fusion algorithms

There are many fusion methods for image which can be divided into:

1.Spatial domain.

2.Transform domain.

In spatial domain like (Principal Component Analysis (PCA), Maximum, Minimum, Averaging and IHS) it deals directly with pixels of input images. In transform domain transfer the image in to frequency domain first by applying one of the transform methods like DCT, DWT**...** [5].

The pixel-level algorithms are described below

Simple average method

It is the straight forward technique it can be achieved by adding the value of the pixel of each image then divided the sum by 2 to obtaining the average. The corresponding pixel of the output image is assigned by the average value.

Maximum selection method

This method is simple and fusion could be achieved by taken the pixel with the Maximum intensity from each input image, the resultant pixel is used to obtain a fused image. Comparing to average method highly focused output image obtained.

Minimum selection method

In Minimum method, the fused image is achieved by selecting the pixel with the Minimum intensity from each input image. The resultant pixel is used to obtain a fused image. with dark shades images a good fusion image is generating by using this method[6].

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Principal component analysis

The PCA involves a mathematical procedure generating variables called principal components by transforming a number of correlated variables into a number of uncorrelated variables. PCA create an uncorrelated feature space instead of the original multispectral which can be used for further analysis. PCA is applied to the multispectral bands and the inter correlated MS bands transform converts into a set of new uncorrelated components [7].

Fusion using IHS transform

For remote sensing the most common image fusion technique is IHS (Intensity-Hue-Saturation). This technique converts an RGB color image space to the IHS color space. The I (intensity) band is replaced by the panchromatic image, histogram matching the multispectral and the panchromatic image before image fusing.[8]. The channels in the multispectral image need not actually correspond to the red, green, and blue bands of visible light, but the reliance on the IHS transform does mean that this method suffers from the notable limitation that the multispectral image must consist of exactly three bands.

The general principle is that the intensity component captures much more of the "fine detail" of the image than the other components, so this data fusion method works by replacing the intensity component of the resized and transformed multispectral image with the values of the panchromatic image, which is actuallymeasured at the higher spatial resolution, and then reversing the transform back to the variable space of the multispectral bands as in Fig(1) [9].

Fusion using wavelet transform

In Wavelet Transforms Haar is one of the simplest ways. Wavelet family or basis form together by a sequence of rescaled "square-shaped" functions. Similarity of Fourier analysis is to the Wavelet analysis in that it allows a target function over an interval to be represented in terms of an orthonormal function basis. Haar sequence is now known as the first organized wavelet basis.

The mother function of haar wavelet ψ(t) can be describe as[10]

$$\psi(t) = \begin{cases} 1 & 0 \leq t \geq 1/2 \\ -1 & \frac{1}{2} \leq t \geq 1 \\ 0 & otherwise \end{cases} \quad ---------(1)$$

Its scaling function ϕ(t) can be described as

$$\phi(t) = \begin{cases} 1 & 0 \leq t < 1 \\ 0 & otherwise \end{cases} \quad ------(2)$$

In the tradition wavelet-based image fusion the performance done by decomposing the two input images separately into (approximate, detailed) coefficients then MS image high detailed coefficients are replaced with of the pan image coefficient. Fusion multi-spectral image obtained by transforming the new wavelet coefficients of the multi-spectral image with the inverse pan wavelet transform as in Fig(2)[11].

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The Proposed Hybrid Method

A single method for image fusion may not efficient always may it lack in one point or other. Therefore used for developing a method by hybrid of Haar wavelet and IHS transform to get better results.

The algorithm is shown in following steps:

Step 1: Input the Panchromatic image (PAN) and Multi spectral image (MS)
Step 2: Transformed the (MS) image to IHS components
Step 3: Matching histogram of (PAN) image to I component of (MS) to get new (I)
Step 4: Transform the I,H ,S to RGB
Step 5: Apply the Haar wavelet to both (PAN) and the RGB image.
Step 6: Compute the fusion rule three time
Step7: Apply the inverse Haar wavelet to obtain the final fused image.

The proposed hybrid methods block diagram shown in Fig (3)

Experimental Result and Discussions

In this section we discussed the result after applying the hybrid of IHS and haar wavelet for two images MS and Pan and these images and fusion image are shown in Fig For comparison the proposed (IHS-haar wavelet) algorithm compared with classical IHS fusion MSE & PSNR by computing MSE first in order to compute the PSNR using the following equations[12]:-

$$MSE = \frac{1}{N}\sum_{j-0}^{N}(I_W - I)^2 \quad -------- (3)$$

$$PSNR(dB) = 10\log_{10}\frac{(255)^2}{MSE} \quad ------(4)$$

PSNR and MSE for the IHS fusion and the proposed algorithm for each bands in MS image is shown in Table (1).

Conclusion

We have introduced an image fusion method for MS and pan images. The proposed method is a combine IHS transform and Haar wavelet transform traditional image fusion techniques have limitation therefore our way is the only hybrid systems. The proposed algorithm compared with classical IHS transform for fusion using the term PSNR and MSE.

Finally the visual results show that the proposed algorithm can achieve better performance relative to classical IHS fusion image for all three bands for MS image.

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Table (1) PSNR, MSE for IHS and the IHS-Haar wavelet algorithm

Method	Band 1		Band 2		Band 3	
	PSNR	MSE	PSNR	MSE	PSNR	MSE
IHS	16.630	5.695e+03	20.975	2.0941e+03	19.943	2.655e+03
IHS-haarwt	16.908	5.341e+03	22.886	1.349e+03	21.208	1.989e+03

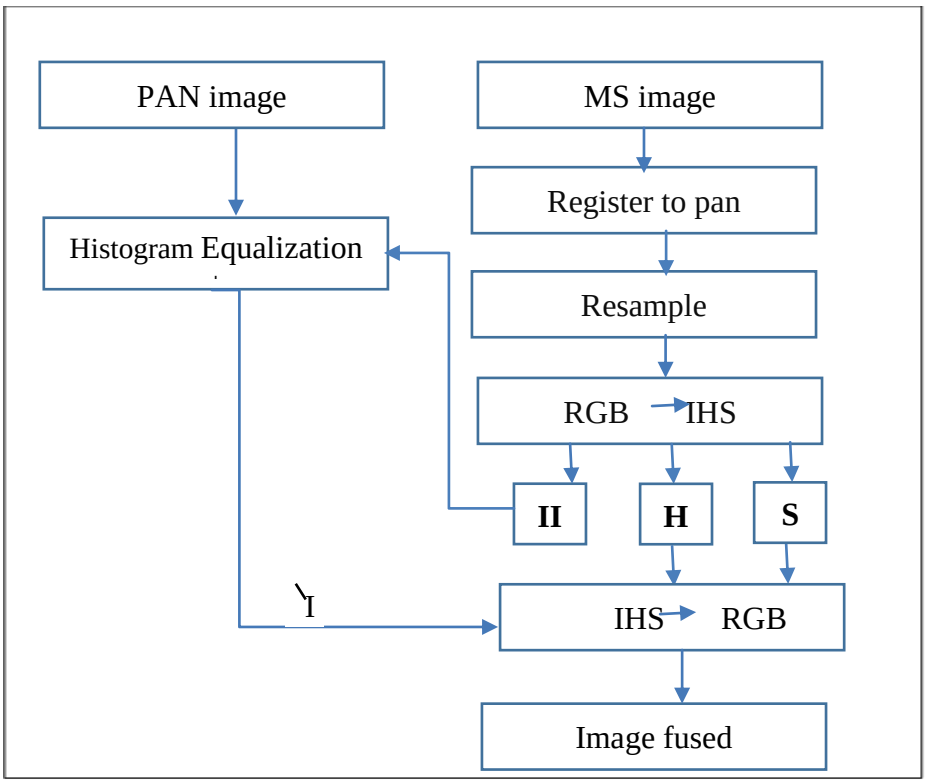

Figure: (1) scheme of IHS image fusion

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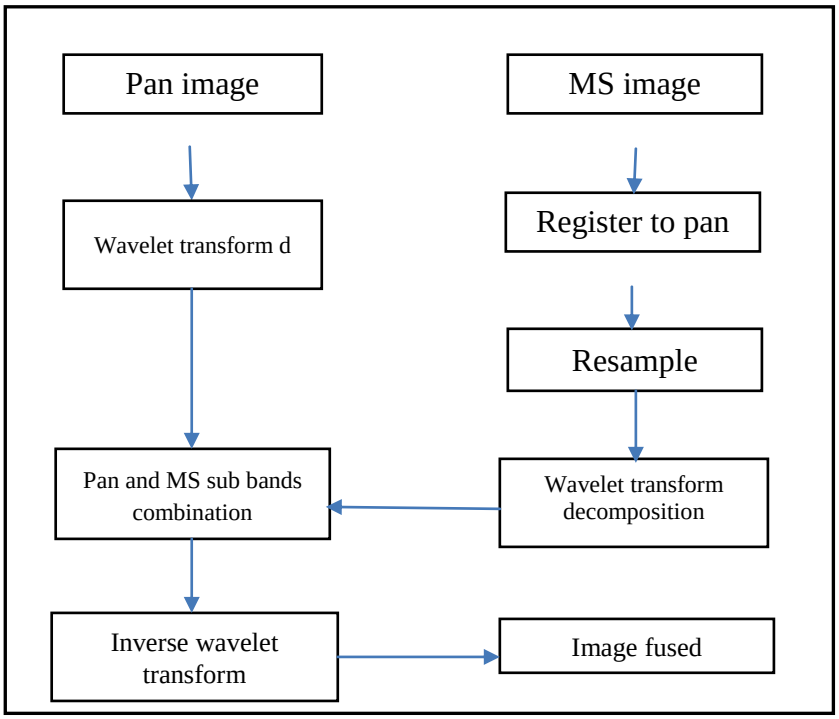

Figure (2): image fusion Wavelet Scheme

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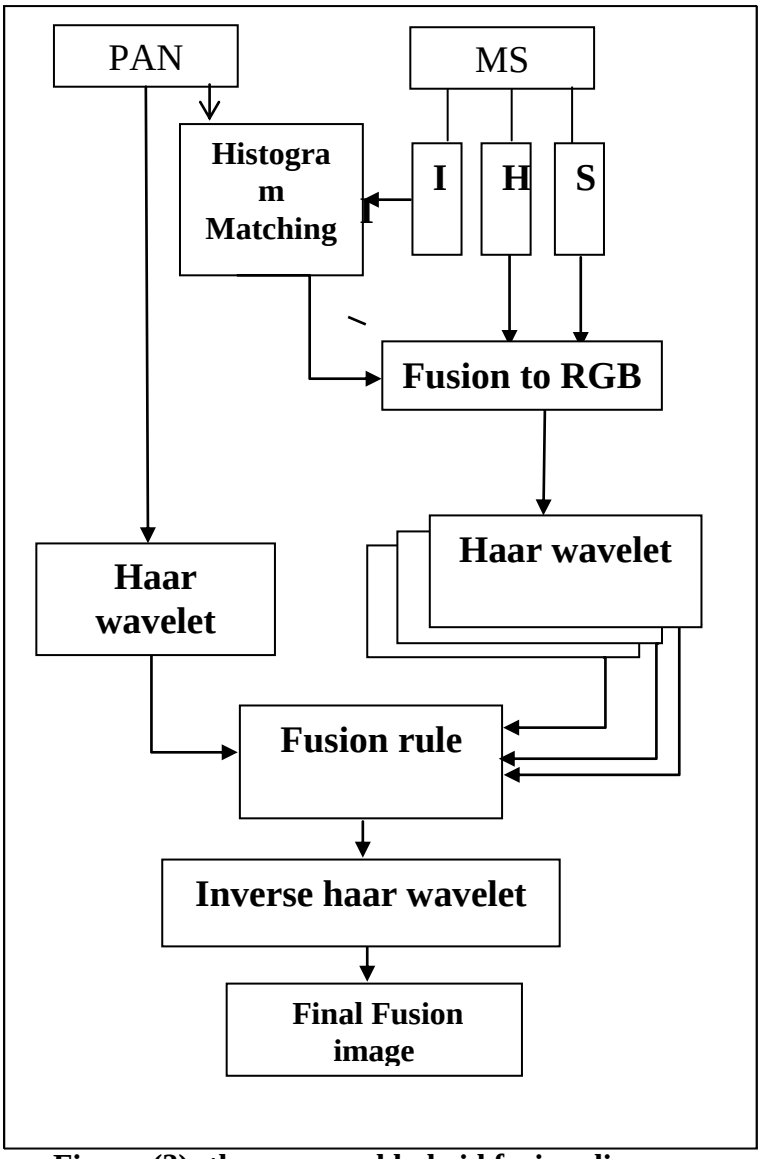

Figure (3): the proposed hybrid fusion diagram

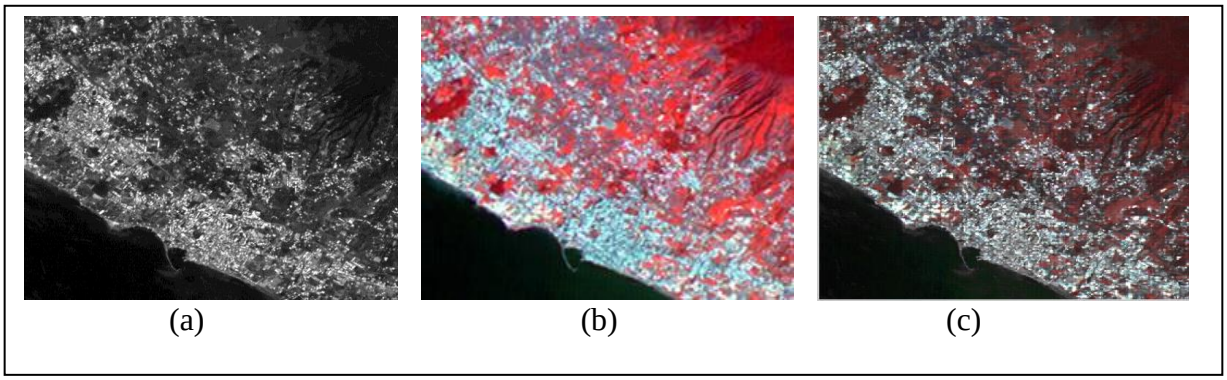

Figure (4): (a) Panchromatic PAN image, (b) Multispectral MS image (c) fused color image using IHS and haar wavelet.

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