

## Implementation & comparative study of different fusion techniques (WAVELET, IHS, PCA)

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**Abstract:** In the image fusion scheme represented in this paper, we compare three different image fusion techniques, which are: - Wavelet transform, IHS & PCA. Here we apply the input images & corresponding fused image is obtained, with different RGB values for different techniques.

In this wavelet transform of different images are appropriately combined by taking inverse wavelet transform of fused wavelet coefficients. Max. area selection rule & consistency verification step are used for feature selection.

The Intensity-Hue-Saturation transformation, a method mainly used for merging multi-resolution and multispectral data and for contrast stretching applications, has never been applied. In this study, a method is presented by which transforming the RGB values of a three-channel composite to IHS values.

Each wavelet also has a unique image decompression & reconstruction characteristics that lead to different fusion results, However if a wavelet transform & a traditional transform such as PCA transform are integrated for a better fusion results may be achieved.

### I Introduction

Fusion (also called synthesis) is the process of combining two or more distinct entities into a new whole. Image fusion is the process of combining relevant information from two or more images into a single image. The resulting image will be more informative than any of the input images.

“Data fusion is a formal framework in which are expressed means and tools for the alliance of data originating from different sources. It aims at obtaining information of greater quality; the exact definition of ‘greater quality’ will depend upon the application” [1].

As the introduction of pyramid transform in mid-80, some new approaches began to emerge. People found that it would be better to perform the fusion in the transform domain. Pyramid transform appears to be very useful for this purpose. The basic idea is to construct the pyramid transform of the fused image from the pyramid transforms of the source images, and then the fused image is obtained by taking inverse pyramid transform. Here are some major advantages of pyramid transform: It can provide information on the sharp contrast changes, and human visual system is especially sensitive to these sharp contrast changes. It can provide both spatial and frequency domain localization [2].

The purpose of this paper is to demonstrate an image enhancement technique for easy, rapid & effective mapping of investigating areas, separating the needed spectral information into one new component.

### II Objective

As we all know there are so many techniques of image fusion are developed in now a days. Here we study three techniques of image fusion which are: - Wavelet, IHS & PCA.

Here we study these techniques and also done comparative study of these techniques so that we find which one among these is better than other.

In this study we take the RGB vales of each different technique one by one. By studying the Red, Green & Blue components values of new fused image formed, we make table and compare these techniques on the new fused image RGB values.

Here we take two source images, on which we apply these three image fusion techniques. After getting the new fused image from two source images through fusion techniques, we take RGB values and study them for results.

### III Image Fusion Schemes

#### 3.1 Wavelet Transform

A multi-resolution decomposition of an image in a bi orthogonal basis and results in non-redundant image representation. This basis is called wavelets.

First the images are transformed to the wavelet domain with the function `wfusing()`, where the number of scales, the wavelet filter and the edge handling are specified. Then, a decision mask is built in the same way as it was explained in the Laplacian fusion implementation. The next step is carried out by constructing the fused transformed image with this decision mask. Finally, the fused image is obtained by applying an inverse wavelet transform.

### 3.1.1 Implemented Fusion Rules

Three previously developed fusion rule schemes were implemented using discrete wavelet transform based image fusion:

- **Maximum selection (MS) scheme:** This simple scheme just picks the coefficient in each sub band with the largest magnitude.
- **Weighted average (WA) scheme:** This scheme developed by Burt and Kolczynski uses a normalized correlation between the two images' sub bands over a small local area. The resultant coefficient for reconstruction is calculated from this measure via a weighted average of the two images' coefficients;
- **Window based verification (WBV) scheme:** This scheme developed by Li et al. creates a binary decision map to choose between each pair of coefficients using a majority filter.

### 3.1.2 Command & syntax used

#### **Wfusing**

**Purpose** - Used for fusion of two images.

**Syntax:-**

`wfusing(X1,X2,WNAME,LEVEL,AFUSMETH,DFUSMETH,FLAGPLOT)`

The principle of image fusion using wavelets is to merge the wavelet decompositions of the two original images using fusion methods applied to approximations coefficients and details coefficients.

`wfusing(X1,X2,WNAME,LEVEL,AFUSMETH,DFUSMETH)`

It returns the fused image `XFUS` obtained by fusion of the two original images `X1` and `X2`. Each fusion method, defined by `AFUSMETH` and `DFUSMETH`, merges in a specific way detailed below, the decompositions of `X1` and `X2`, at level `LEVEL` and using wavelet `WNAME`. `AFUSMETH` and `DFUSMETH` define the fusion method for approximations and details, respectively.

### 3.2 IHS Transform

The IHS technique is a standard procedure in image fusion, with the major limitation that only three bands are involved [3]. Originally, it was based on the RGB true color space. It offers the advantage that the separate channels outline certain color properties, namely intensity (I), hue (H), and saturation (S). This specific color space is often chosen because the visual cognitive system of human beings tends to treat these three components as roughly orthogonal perceptual axes. However, in remote sensing, arbitrary bands are usually assigned to the RGB channels to produce false color composites for display purposes only.

#### 3.2.1 Four steps used in IHS

1. Transform the red, green, and blue (RGB) channels (corresponding to three multispectral bands) to IHS components.
2. Match the histogram of the panchromatic image with the intensity component.
3. Replace the intensity component with the stretched panchromatic image; and
4. Inverse-transform IHS channels to RGB channels. The resultant color composite will then have a higher spatial resolution in terms of topographic texture information.

#### 3.2.2 Command & syntax used in IHS

`hist` – histogram plot. A histogram shows the distribution of data values.

**Syntax:-**

`n = hist(Y)`

`n = hist(Y,x)`

`n = hist(Y,nbins)`

`[n,xout] = hist(...)`

`hist(...)`

`hist(axes_handle,...)`

A histogram shows the distribution of data values.

`n = hist(Y)` bins the elements in vector `Y` into 10 equally spaced containers and returns the number of elements in each container as a row vector. If `Y` is an `m-by-p` matrix, `hist` treats the columns of `Y` as vectors and returns a 10-by-`p` matrix `n`. Each column of `n` contains the results for the corresponding column of `Y`. No elements of `Y` can be complex or of type integer.

### 3.2.3 Features of IHS Transformation

1. It does not require radiometric corrections or radiometric enhancements.
2. It does not require the assessment of training areas.
3. It produces a new data set in which the burned areas are well discriminated.
4. Confusion between burned areas and other land-cover land-use categories, such as shadows, urban areas, and water bodies is eliminated

### 3.3 Principal Component Analysis (PCA)

The first principal component image contains the information that is common to all the bands used as input to PCA, while the spectral information that is unique to any of the bands is mapped to the other components. Then, similar to the IHS method, the first principal component (PC1) is replaced by the HRPI, which is first stretched to have the same mean and variance as PC1. As a last step, the HRMIs are determined by performing the inverse PCA transform[4].

In data sets with many variables, groups of variables often move together. One reason for this is that more than one variable might be measuring the same driving principle governing the behavior of the system. In many systems there are only a few such driving forces. But an abundance of instrumentation enables you to measure dozens of system variables. When this happens, you can take advantage of this redundancy of information. You can simplify the problem by replacing a group of variables with a single new variable.

Principal component analysis is a quantitatively rigorous method for achieving this simplification. The method generates a new set of variables, called principal components. Each principal component is a linear combination of the original variables. All the principal components are orthogonal to each other, so there is no redundant information. The principal components as a whole form an orthogonal basis for the space of the data. There are an infinite number of ways to construct an orthogonal basis for several columns of data.

#### 2.3.1. Command & syntax used in PCA

**Pcacov**- Principal component analysis on covariance matrix.

#### Syntax:-

```
COEFF = pcacov(V)
```

```
[COEFF,latent] = pcacov(V)
```

```
[COEFF,latent,explained] = pcacov(V)
```

#### Description:-

`COEFF = pcacov(V)` performs principal components analysis on the `p-by-p` covariance matrix `V` and returns the principal component coefficients, also known as loadings. `COEFF` is a `p-by-p` matrix, with each column containing coefficients for one principal component. The columns are in order of decreasing component variance.

**pcacov** does not standardize `V` to have unit variances. To perform principal components analysis on standardized variables, use the correlation matrix  $R = V ./ (SD * SD')$ , where  $SD = \text{sqrt}(\text{diag}(V))$ , in place of `V`. To perform principal components analysis directly on the data matrix, use `princomp`.

`[COEFF,latent] = pcacov(V)` returns `latent`, a vector containing the principal component variances, that is, the eigenvalues of `V`.

`[COEFF,latent,explained] = pcacov(V)` returns `explained`, a vector containing the percentage of the total variance explained by each principal component.

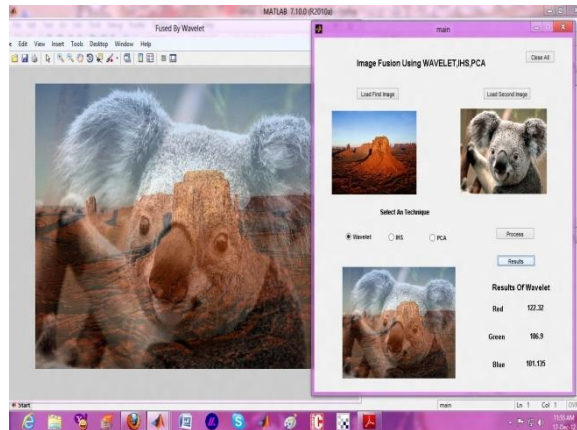
In PCA image fusion technique we used the concept of eigen values & eigen vectors.

Here we took the properties of each layer i.e. RGB layer one by one by using eigen values and eigen vectors & then at last we done convolution to find the fused image through PCA.

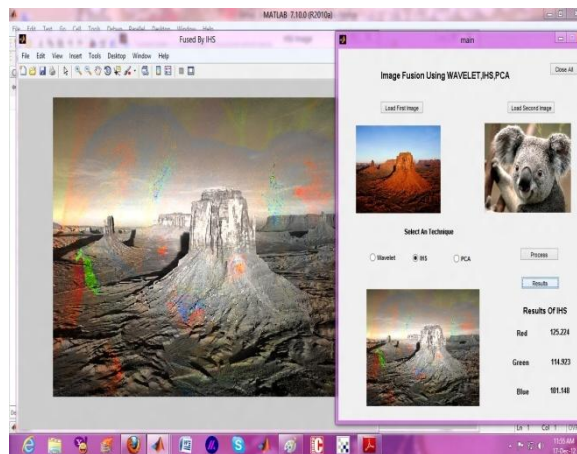
#### **IV Fused images through different Techniques**

Here we apply these different fusion techniques i.e. Wavelet, IHS, PCA on images and get the different fused images and different- 2 results for RGB values.

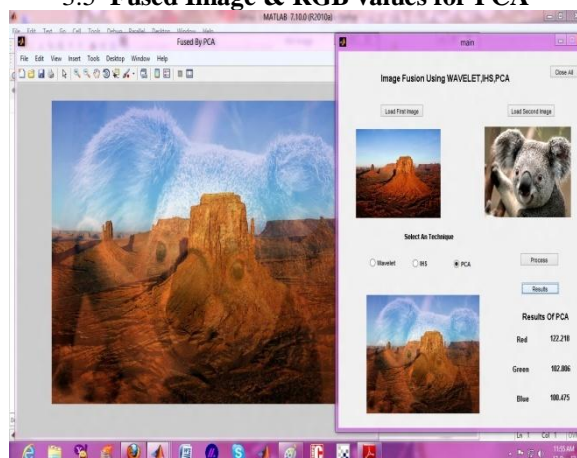
##### **4.1 Fused Image & RGB values for Wavelet**



##### **3.4 Fused Image & RGB values for IHS**



##### **3.5 Fused Image & RGB values for PCA**



**V Experimental Results ( RGB values for different techniques)**

<b>Image Fusion Scheme Used</b>	<b>Red</b>	<b>Green</b>	<b>Blue</b>
<b>WAVELET</b>	122.32	106.9	101.135
<b>HIS</b>	125.224	114.923	101.148
<b>PCA</b>	122.218	102.806	100.475

**VI CONCLUSION**

Along this research, some image fusion approaches have been studied. All of them were found reliable fusion methods in multifocus applications, and in conjunction they gave acceptable results in multisensor fusion schemes, excepting the spatial frequency approach. As previously mentioned, due to the subjective characteristic of the fusion quality evaluation, it is difficult to conclude which method is the best one for a certain application.

**REFERENCES**

- [1] L.Wald, "Some terms of reference in data fusion," *IEEE Trans. Geosci.Remote Sens.*, vol.37, no. 3, pp. 1190–1193, May 1999
- [2] Ravi K. Sharma, *Probabilistic Model-based Multisensor Image Fusion. PhD thesis, Oregon Graduate Institute of Science and Technology, Portland, Oregon, 1999.*
- [3] Bogdan J. Matuszewski, Lik-Kwan Shark, Martin R. Varley, *Region-Based Wavelet Fusion Of Ultrasonic, Radiographic And Shearography Non-Destructive Testing Images, 15th World Conference WCNDT, 15-21 October 2000, Rome.*
- [4] J. Zhou, D. L. Civco, and J. A. Silander, "A wavelet transform method to merge Landsat TM and SPOT panchromatic data," *Int. J. Remote Sens.*, vol. 19, no. 4, pp. 743–757, 1998.