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A Hybrid Pixel based Fusion Approach

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***Abstract:** Visual information transmitted in the form of digital images is becoming a major method of communication in the modern age, but the image obtained after transmission is often corrupted with noise. The received image needs processing before it can be used in applications. Image Fusion involves the manipulation of the image data to produce a visually high quality image. This thesis reviews the existing Pixel based fusion algorithms, such as Principle Component Analysis, Brovey, Intensity-Hue-Saturation, Discrete Wavelet Transform, DCT and our proposed Fusion method and performs their comparative study. It is necessary to have knowledge about the IHS and Wavelet algorithms. The filtering approach has been proved to be the best when the image is fused. The wavelet based approach finds applications in image fusion. In the case where the noise characteristics are complex, the neural filter can be used. A quantitative measure of comparison is provided by the peak signal to noise ratio, root mean average error, mean square error and the normalized cross correlation of the image.*

***Keywords:** Image fusion, Multifocus image, IHS, wavelet transforms.*

I. Introduction

Image fusion is a vital research topic in several related areas such as computer revelation, surveillance system, automatic object detection, remote sensing, image processing, robotics, medical imaging and aerial and satellite imaging. “Fusion means merging of similar or different things into a union.” Image fusion is process of merging or combining relevant information of two or more images into a single image. The resultant image retaining the important features improving the signal to noise ratio from each of the original image. In other word, it is used to generate a result which describes the scene “better” than any single image with respect to important properties. Image fusion can process the images obtained from different sensors by a specific algorithm so that the resultant image is more reliable, clear, and understandable. From few last years, image fusion techniques have interest within the remote sensing community. The reason of this is that in most cases the new generation of remote sensors with very high spatial resolution acquires image datasets in two separate modes: the highest spatial resolution is obtained for panchromatic images (PAN) whereas multispectral information (MS) is associated with lower spatial resolution.

Need of Image Fusion:

- To get relevant information in a single image by extracting all the useful information from the source images.
- Fusions do not introduce artifacts or inconsistencies which will distract human observers.
- Consistent and strong to imperfection such as miss-registration.
- Image fusion Improve reliability.

II. PIXEL LEVEL IMAGE FUSION

Pixel level image fusion represents the visual information of the same scene from the number of registered image signals which can be obtained using different sensors.

For simplicity, only two imaging sensors survey the environment, producing two different representations of the same scene. The representations of the environment are, again, in the form of image signals which are corrupted by noise arising from the atmospheric aberrations, sensor design, and quantization. Another important consideration in pixel-level fusion is the number of input images and the color characteristics of the input and output images.

A. Discreate Wavelet Transform:

Camera has limited depth of focus so it is possible sometimes to loss relevant information from the image. One possible solution to this problem is image fusion. This kind of fusion combines several CCD images, each of which contains some part of the objects in focus. Consider there are two CCD images A and B. If A and B have similar spatial resolution, a RS followed by an IR are previously required, as shown in Fig.

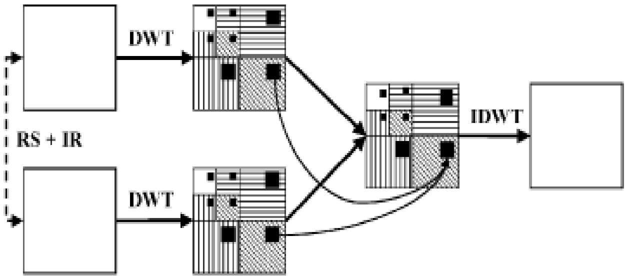

Fig 1(a). DWT

If the resolution of one image, say B, is smaller than 1/2n resolution of another image, say A, a n-level DWT is only applied to B. If B and the approximation (LL) sub-image of A still have different resolution, IR and RS is still required (see Fig.2(b) with n=1). Besides, the histogram matching is neglected since the histogram reference is not determined.

For merging the DWT coefficients, the “substitution” strategy used in all fusion methods is no longer suitable in this example. A simple and straightforward method is “choose-max” (CM), i.e. choosing the maximal DWT coefficients between A and B i.e shown in Fig.2(a).

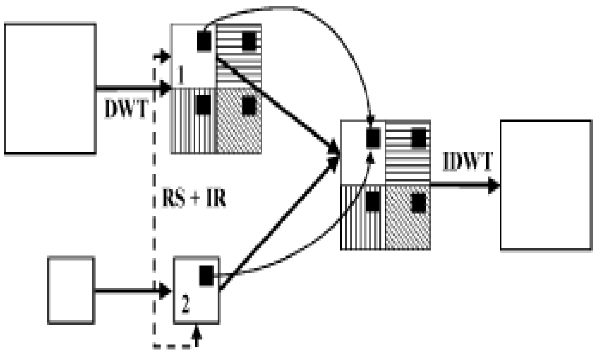

Fig 1(b).DWT

The steps of this method are as follows:

1) Perform IR and RS to A and B.

2) Apply DWT to both A and B, and their coefficients in pixel p are DA(p) and DB(p),respectively.

3) The output DWT coefficient in pixel p is DR(p).

4) Perform Inverse DWT to DR.

B. IHS image fusion:

The IHS technique is a standard procedure in image fusion, with the major limitation that only three bands are involved. 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.

The IHS technique usually comprises four steps:

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.

III. PROPOSED APPROACH

The proposed Hybrid fusion method used IHS and DWT pixel level fusion rules in a single fused image. Pixel level image fusion works on individual pixels in the image, but doesn't take into account some important details like edges, boundaries and salient features larger than a single pixel. Pixel level rules may reduce the contrast in some images and does not always succeed in effectively removing ringing artifacts and noise in source images. The inadequacies of these types of fusion rules point to the importance of developing a Hybrid algorithm to improve the visual quality by combining the advantages of pixel based methods.

The proposed Hybrid Image Fusion method is based on Pixel level image Fusion methods. These methods are basically based on various standard Pixel level fusion rules. Combination of various fusion rules is done to get better quality final fused image. Here the image fusion techniques used are based on wavelet transformation. First level is based on IHS of original image and second level decomposition of resultant image of HIS is based on Discrete Wavelet Transformation (DWT).

This method is implemented to perform Intensity-Hue-Saturation (IHS) transform on multi-focus color images to get intensity (I) components, and get wavelet coefficients by taking Discrete Wavelet Transform (DWT) on I components as basis of calculation of activity level of each pixel, then according to the activity level to form a fused image by a selection mode. Experimental results indicate that the proposed method outperforms the traditional approaches.

Steps Followed in proposed approach:

1) Pre-processing module: Load left blur image and right blur image

2) Feature Extraction Module: Perform Combined HSI and DWT transform on the pre-processed image

3) Image Enhancement Module: Applying contrast enhancement filter for enhancing of the fused image.

Performance Matrix:

i. Root mean square error (RMSE):

A commonly used reference-based assessment metric is the root mean square error (RMSE) which is defined as follows:

$$RMSE = \sqrt{\frac{1}{MN}\sum_{m=1}^{M}\sum_{n=1}^{N}(R(m,n) - F(m,n))^2}$$

Where R(m,n) and F(m,n) are reference and fused images, respectively, and M and N are image dimensions.

ii. Peak signal to noise ratio (PSNR):

PSNR computes the peak signal-to-noise ratio, in decibels, between two images. This ratio is used as a quality measurement between the original and a reconstructed image. The higher the PSNR, the better is the quality of the reconstructed image. To compute the PSNR, first we have to compute the mean squared error (MSE) using the following equation:

$$PSNR = 10 \times \log_{10}\left(\frac{peak^2}{MSE}\right)$$

PSNR value should be as high as possible.

iii. Normalized Cross Correlation (NCC):

Normalized cross correlation is used to find out similarities between fused image and registered image is given by the following equation:

$$\mathrm{NCC} = \frac{\sum_{i=1}^{m}\sum_{j=1}^{n}(A_{ij} * B_{ij})}{\sum_{i=1}^{m}\sum_{j=1}^{n}(A_{ij})^2}$$

Results:

(a)

(b)

(c)

(d)

(e)

(f)

Figure:2: Results for image “Clock” type=Blurred Image (a) original image of clock left blur (256*256) (b) original image of clock right blur (256*256) (c) fusion of “Clock” by IHS transform (256*256) (d) fusion of “Clok” by DWT transform (256*256) (e)&(f) Result of“Clock” by proposed method.

Performance Metrics		HSI Transform	DWT Transform	Proposed Approach
Blurred Image	RMS Error	174.0831	172.5342	171.9973
	NCC	0.6931	1.1737	0.4903
	PSNR	44.8151	44.7375	44.8209

Table:1 Shows the comparison of Existing IHS and DWT image fusion method with proposed hybrid approach

IV. Conclusion

It is very clear from the above figures that there is change in the quality of image after fusion with the proposed method over the existing techniques. This represents the improvement in the objective quality of the image. The proposed approach is tested and implemented over the existing techniques as Intensity-Hue-Saturation, Fusion by Discrete wavelet Transform, and Fusion by Proposed Hybrid Approach. So we conclude the proposed approach gives the significant results over the existing techniques.

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