Research Article Impact Factor: 4.226 ISSN: 2319-507X
Pranoti A. Kale, IJPRET, 2015; Volume 3 (9): 72-80 IJPRET

INTERNATIONAL JOURNAL OF PURE AND APPLIED RESEARCH IN ENGINEERING AND TECHNOLOGY

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COMPARATIVE ANALYSIS OF IMAGE FUSION USING DIFFERENT WAVELET FAMILIES

MISS. PRANOTI A. KALE[1], PROF. DINESH S. CHANDAK[2]

1. Research Scholar, Prof. Ram Meghe COE & Management, Amravati.
2. Dept. of E&TC COE Amravati, Prof. Ram Meghe COE & Management, Amravati.

Accepted Date: 05/03/2015; Published Date: 01/05/2015

Abstract: Image fusion is a process of combining the relevant information from a set of images into a single image, where the resultant fused image will be more informative and complete than any of the input images. Image fusion is a technique that integrates complimentary details from multiple input images such that the fused image is more suitable for processing task. The fused image has more complete information which is useful for human and machine perception. The reason for using Wavelet transform is to obtain the original secret image without any distortion. Image fusion techniques can improve the quality and increase the application of these data. The paper starts with the study of initial concepts for image fusion with their importance, use of image fusion. This paper presents a review on different wavelet families and implementation of image fusion using wavelet transform from different wavelet families.

Keywords: Fusion, Wavelet Family, Wavelet Transform**,** Wavelet base fusion, fused image.

Corresponding Author: MS. PRANOTI A. KALE

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How to Cite This Article:

Pranoti A. Kale, IJPRET, 2015; Volume 3 (9): 72-80

PAPER-QR CODE

INTRODUCTION

Image fusion find application in the area of navigation guidance, object detection and recognition, satellite imaging for remote sensing and civilian etc. lots of images need to be processed to obtain the clear information about the problem a patient has in the case of medical field, to obtain the information about the attackers or terrorists in the field of military, to obtain the information about the fields which provide good crop or mining facility etc. In the field of geography, all these applications use the different kinds of images taken from different sources and processed based on the requirements by using various image processing tools.

The result of image fusion is a new image that retains the most desirable information and characteristics of each input image. It has been found that the standard fusion methods perform well spatially but usually introduce spectral distortion. To overcome this problem numerous multi-scale transform based fusion schemes have been proposed. Image fusion algorithms can be categorized into different levels: pixel, feature and decision levels. Pixel level fusion works directly on the pixels of source images while feature level fusion algorithms operate on features extracted from the source images. There are some important requirements for the image fusion process: The fused image should preserve all relevant information from the input images and the image fusion should not introduce artefacts which can lead to a wrong diagnosis. The fusion performance is evaluated on the basis of the root mean square error (RMSE) and peak signal to noise ratio (PSNR). The wavelet transforms is the very good technique for the image fusion provide a high quality spectral content. In this paper we are proposing comparative analysis of image fusion using different wavelet family and implementation of fusion using wavelet transform from different wavelet families.

I. LITERATURE REVIEW

Deepak Kumar Sahu, M.P. Parsai [1] Deepak Sahu presents a literature review on some of the image fusion techniques for image fusion like, primitive fusion, Discrete Wavelet transform based fusion, Principal component analysis (PCA) based fusion etc. Finally this review concludes that a image fusion algorithm based on combination of DWT and PCA with morphological processing will improve the image fusion quality and may be the future trend of research regarding image fusion.

Hari Om Shankar Mishra and Smriti Bhatnagar [2] present a method of image fusion based on discrete wavelet transform. 2 dimensional DWT is used to decompose the image. The fusion performance is evaluated on the basis of the root mean square error (RMSE) and peak signal to noise ratio (PSNR).Combined the wavelet transform and various fusion rules to fuse CT and MRI images. This method gives encouraging results in terms of smaller RMSE and higher PSNR values. it achieved least MSE and highest PSNR values. The images used here are greyscale CT and MRI images. However, the images of other modalities with their true colour nature may also be fused using the same method.

P. Devaki, Dr G Raghavendra Rao, P. Devaki [3] proposing an algorithm for protecting the secret image whose confidentiality needs to be maintained and also to authenticate the distributor who distributes that secret image to multiple users. The secret image will be fused with the fingerprint of the dealer for authentication purpose. Fusion of the finger print will be done by using image fusion technique to generate a single image consisting of the secret image as well as the finger print image of the dealer. The fused image will be divided in two number of shares based on the threshold secret sharing technique. This provides both confidentiality of the secret image and as well as the authentication of the dealer who has sent the image. The verification will be done during reconstruction of the secret image. The secret image can be of medical, organizational information, military or any other sensitive information.

Kusum Rani, Reecha Sharma Kusum Rani [4] presents a review on some of the image fusion techniques (simple average, simple minimum, simple maximum, PCA, DWT). Comparison of all the techniques concludes the better approach for its future research. The Wavelet transforms provide a high quality spectral content. Combination of DWT and PCA provide better performance and improve the image fusion quality.

III. PROPOSED WORK

Wavelet transforms allow time frequency localization. Wavelet means "small wave" so wavelet analysis is about analyzing signal with short duration finite energy functions. They transform the signal under investigation in to another representation which presents the signal in a more useful form. Image fusion techniques are broadly classified in to two types. One is spatial domain fusion and the other one is transform based fusion. Spatial domain fusion can be performed based on averaging method, discrete wavelet transform based, Principal component analysis based etc. Transform based fusion can be based on Fourier transform, wavelet transform etc. While processing images it is better to compress the images so that processing time, storage and bandwidth can be saved. Depending on the application lossless compression can be applied. Wavelet transform is a lossless compression algorithm which has been extensively used in the recent past in the field of digital signal processing. Wavelet transforms are multi-resolution image decomposition tool that provide a variety of channels representing the image feature by different frequency sub bands at multi-scale. It is a famous technique in analyzing signals. When decomposition is performed the approximation and detail component can be separated 2D discrete wavelet transformation converts the image from the spatial domain to frequency domain. The image is divided by vertical and horizontal lines and represents the first order of DWT and the image can be separated with four parts those are LL1, LH1, HL1 and HH1. The 1D DWT coefficients can be decomposed again using the 1D DWT. This scheme is called multilevel 1D DWT.2D DWT is very useful for image processing because the image data are discrete and the spatial spectral resolution is dependent on the frequency. The DWT has the property that the spatial resolution is small in low frequency bands but large in high frequency bands. Thus, the DWT is suitable for image compression. The DWT fusion method may outperform the standard fusion method in terms of minimizing the spectral distortion. It also provide better signal to noise ratio than pixel based approach. Fig.2. Shows example of DWT for lena image.

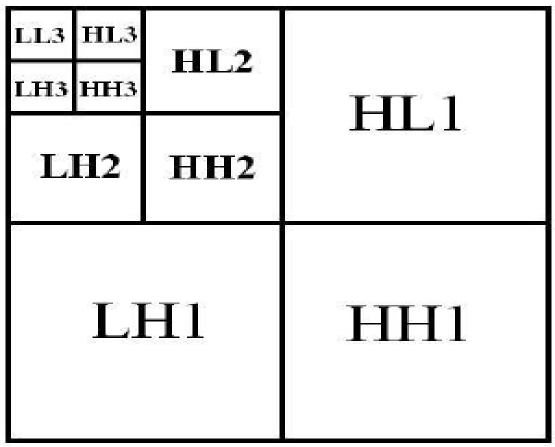

Fig.1. Level Wavelet Decomposition

Fig.2. DWT for Lena image (a) Original Image (b) Output image after the 1-D applied on column input (c) Output image after the second 1-D applied on row input.

Wavelet function will give satisfying results for other types of images. If scale and position is varied very smoothly, then transform is called continuous wavelet transform. If scale and position are changed in discrete steps, the transform is called discrete wavelet transform. Wavelet transforms provide a framework in which an image is decomposed, with each level corresponding to a resolution band. The basic idea of wavelet transform is to represent any function *f* as a linear superposition of wavelets. Any such superposition decompose *f* to different scale levels, where each level can be then further decomposed with a resolution adapted to that level. One general way to do this is writing *f* as the sum of wavelets Ψ m, n (*t*) over *m* and *n*. This leads to discrete wavelet transform.

$$f(t) = \sum C_{m,n} \Psi_{m,n}(t)$$

In wavelet transform, we use wavelets *as* transform basis. Wavelet functions are functions generated from one single function Ψ by scaling and translation:

$$\Psi_{a,b}(t) = 1/\sqrt{a}\, \Psi(t - b/a)$$

The mother wavelet Ψ (t) has to be zero integral, ∫ Ψ (t) dt =0, High frequency wavelet correspond to a<1 or narrow width while low frequency wavelets correspond to a>1 or wider width. Wavelets are functions defined over a finite interval and having an average value of zero. The basic idea of the wavelet transform is to represent any arbitrary function f(x) as a superposition of a set of such wavelets or basis functions. These basis functions are obtained from a single prototype wavelet called the mother wavelet Ψ(x), by dilations or scaling and translations. Wavelet bases are very good at efficiently representing functions that are smooth except for a small set of discontinuities.

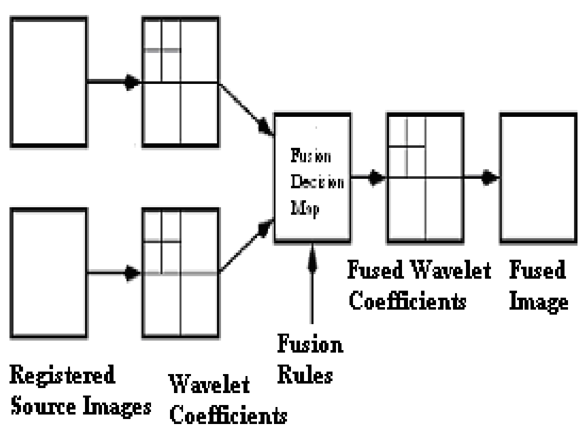

Fig.3. Wavelet Based image fusion

Wavelet image processing enables computers to store an image in many scales of resolutions Fig. 3, thus decomposing an image into various levels and types of details and approximation with different valued resolutions.Hence, making it possible to zoom in to obtain more detail of the trees, leaves and even a monkey on top of the tree. Wavelets allow compressing the image using less storage space with more details of the image. In our experiment three types of wavelet families are examined: haar, daubechies, biorthogonal.

Wavelet Families: Wavelet families vary in terms of several important properties.

1. Support of the wavelet in time and frequency and rate of decay.
2. Symmetry of the wavelet. The accompanying perfect reconstruction filters have linear phase.
3. Number of vanishing moments. Wavelets with increasing numbers of vanishing moments result in sparse representations for a large class of signals and images.
4. Regularity of the wavelet. Smoother wavelets provide sharper frequency resolution. Additionally, iterative algorithms for wavelet construction converge faster.
5. Existence of a scaling function, ϕ.

Haar: Any discussion of wavelets begins with haar wavelet, the first and simplest. Haar wavelet is discontinuous and resembles a step function. It represents the same wavelet as daubechies db1.

Daubechies (dbN): The dbN wavelets are the daubechies external phase wavelets. N refers to the number of vanishing moments. daubechies wavelets are families of orthogonal wavelets that are compactly supported. Compactly supported wavelets correspond to finite impulse response (FIR) filters and thus lead to efficient implementations, thus making discrete wavelet analysis practicable.

Biorthogonal: Biorthogonal exhibits the property of linear phase which is needed for signal and image reconstruction. By using two wavelets, one for decomposition (on the left side) and the other for reconstruction (on the right side) instead of the same single one interesting properties are derived.

A major disadvantage of these wavelets is their asymmetry, which can cause artefacts at borders of the wavelet sub bands. Symmetry in wavelets can be obtained only if we are willing to give up either compact support of wavelet.

The image is coded using different wavelet functions from each wavelet family. Image quality is measured using (PSNR).

Peak Signal to Noise Ratio (PSNR): It is the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation. The PSNR measure is given by:

PSNR (db) = 20*log 10(255/MSE)

Mean Squared Error (MSE): The most commonly used error projection method where, the error value is the value difference between the actual data and the resultant data. The mean of the square of this error provides the error or the actual difference between the expected results to the obtained result. The difference between the pixel density of the perfect image and the fused image is squared and the mean of the same is the considered error. MSE value will be 0 if both the images are identical. The mathematical equation of MSE is given by the equation:

MSE = mse term / (r * c)

IV.RESULT AND DISCUSSION

In this work we have provided the basics of wavelet transform and after comparisons of different wavelets families used in image fusion, biorthogonal wavelets provide effective image. Their results are also compared for the processing of different images.


Image (1)


Image (1)


Image (2)


Image (2)


Fused Image (3)


Fused Image (3)

Fig. 4(a).Plane Fig. 4(b).Clock

Fig.4. Image Fusion using different wavelet families.

The results of image fusion using wavelet transform from particular wavelet families are shown in Fig. (4), Fig. 4(a) Right plane Images (1) and (2) out of focus, respectively; (3) the resulting fused image from (1) and (2) with the two plane in focus. Fig .4 (b) Left clock images (1) and (2) out of focus, respectively; (3) The resulting fused image from (1) and (2) with the two clock and in focus.

Table1. Comparison of Wavelet Families

Sr. No.	Image Name	Wavelet Families					
		Daubechies (for db3)		Haar		Biorthogonal (for bior 1.5)	
		PSNR	MSE	PSNR	MSE	PSNR	MSE
1.	Plane	5.945	128.6	5.668	132.7	5.55	134.5
2.	Clock	7.466	107.9	7.106	112.5	6.57	119.6

For the above mentioned method their performance is measured in terms of MSE, PSNR and the results are tabulated in Table 1.

V. CONCLUSION

It is possible to implement image fusion using wavelet transform from different wavelet families has made great progress in the last four years so that choosing the best wavelet is more crucial for a successful wavelet transform to avoid highly complex and lengthy level decomposition. This is even more important than relying on the value of MSE alone. In this study, our results have shown that the biorthogonal wavelet family is the effective.

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