International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 - 5161

Available at http://inpressco.com/category/ijcet

Research Article

Analysis of First Scale Fusion Images based on Wavelet Decomposition

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Accepted 15 May 2014, Available online 01 June 2014, **Vol.4, No.3 (June 2014)**

Abstract

A image fusion technique and its edge keeping methods are discussed for improving fusion efficiency and accuracy Fusion technique based on wavelet transform. In this paper we propose methods for improving fusion efficiency and accuracy. We also calculate Information entropy (IE), Average cross-over entropy(ACE),Standard deviation(SD), for minimum, mean, min-mean method, and maximum methods. Comparative result obtained by conventional methods and proposed methods which have been discussed.

Keywords: *Methodology, Wavelet transform, Discrete wavelet transform, Fusion principle, Fusion algorithms*

1. Introduction

Image fusion is an image processing methods that can synthesize a new image from several images that are divided from different sensor it take a advantage of information and feature that are proposed by each images. Fused image analyzed the more accurate description with comparative input fusion images. The quality of image could be improved (chandana, et al 2011). It is consider with human characteristic of visual perception.

An Image fusion process is combining the relevant information from two are more images into a single image. The resulting image will be more informative than any of the input images(J, et al,2010). The process of fusion technique provide the easy way to obtained relevant information from each of the input images.

The Technique of obtaining the fused images in initiating time complete into two domain i.e. special domain and transformation domain (Sahu, et a, 2012). Special domain technique deal with consideration of image pixel position. The pixel value are arranged in a sequence to obtained the desired result. In special domain analysis many different methods like as Intensity hue saturation, principle of component analysis, Brovey methods are discussed to obtain the highly accurate fused image. The disadvantage of the special domain is the they produces special distortion.

In the transform domain fusion methods transform into frequency domain. All the fusion operation is performed on discrete Fourier transform of images and then IFT is perform to get the resultant image. After some time Discrete wavelet transform has become a very useful tool for analyzing remote sensing in image. First scaling of fusion images based upon the discrete wavelet transform (W.H, et al,2006) .In the process of first scaling of fusion images, images given to the wavelet transform as a input. Discrete wavelet transform divided the information of images into discrete frequency of component (K Y, et al, 2007).

2. Methodology

Fusion Methodology preserve the detail information like high frequency and give the prominence to the out line information of the target at the same time. It is necessary to use different methods strategy. Methodology can be explained by flow charts.

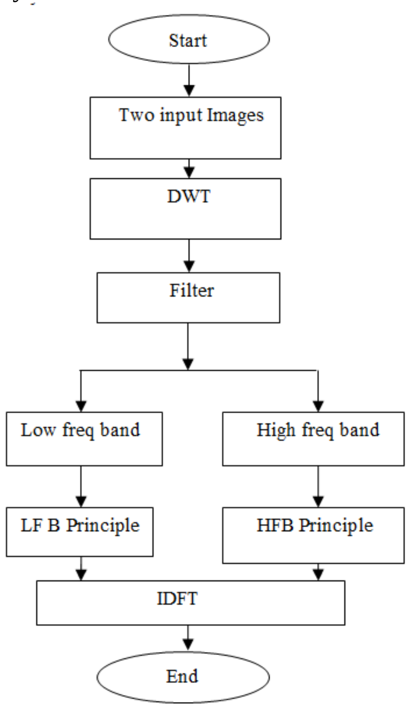

Figure (1) Flow chart diagram of image fusion

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Fusion methodology illustrates the fusion process. An image fusion methods are based on wavelet transform. In fusion methodology process two images taken as a input of Discrete wavelet transform DWT. Wavelet transform passes it through the filter by which two frequency component are obtained. On this frequency sub band apply different fusion principle. Output of the fusion principle given to the inverse discrete wavelet transform. At the last fused image obtained through IDFT. This fused image represent highly accurate information of the fusion image. Thus efficiency and accuracy of the image improved.

2.1 Discrete Wavelet Transform

Wavelet transform decompose a signal into a set of basic function . DWT is powerful implementation of wavelet transform using dyadic scales and positioned. Basic function of the wavelet transform can be explain bellow

$$W_{\varphi}{}^{(m,n)=\int_{-\infty}^{\infty} x(t)\varphi_{(m,n)}(t)} \quad (1)$$

Where wavelet $\varphi_{(a,b)}(t)$ obtained from single prototype wavelet called the mother wavelet by dilation and shifting.

$$\varphi_{(m,n)}(t) = \frac{1}{\sqrt{m}}\varphi\left(\frac{t-m}{n}\right) \quad (2)$$

Where a and b dilation and shifting parameter. The equation 2 can be discretized by restraining a and b to a discrete lattice by which we can obtained the lower frequency component and higher frequency coefficient. Lower frequency component and higher frequency component give the approximation and detail information of the image respectively.

2.2 2D Discrete wavelet transform

This technique applies to the multi-focused images. as the result there are four sub-band(LL,LH,HL,HH) image at each scale .The sub-band LL is used for next 2D DWT.

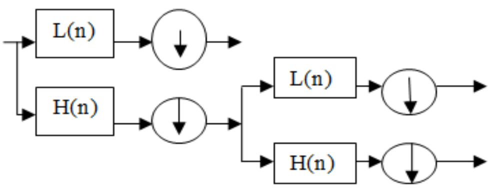

Figure (2) Schematic diagram of 2D DWT

2.3 Fusion principle

2.3.1 Fusion principle for low frequency band

The low frequency sub-band of wavelet coefficient contains the main outline information of the image. it is an approximate image of the original image at certain dimensions, and most information and energy of the image is included in this sub-band. Based on consideration of properties of the human visual system, the fusion principle for this part should use the even degree to measure the fusion result. The even degree of a image block is defined as follows: suppose the block has size of L×L, referred to as C_k, then, its even degree J is:

$$J(C_k)=\frac{1}{L*L}\sum_{(x,y)\in k}\omega(m_k)*\frac{|f(x,y)-m_k|}{m_k} \quad (3)$$

Where m_k is the average value of $C_k, f(x,y)$ and $\omega(m_k)$ denote a weight factor according to the average luminance of the block. It can be obtained by formula.

$$\omega(m_k) = \left(\frac{1}{m_k}\right)^2 \quad (4)$$

In this study we determines L = 8 and $\alpha = 1$through trial-and-error method. Suppose there are two images, A1 and A2, to be fused. We first calculate their even degrees $J(A1_k)$ and $J(A2_k)$ respectively, then compare the J of corresponding block, to obtain the Bi.

$$B_{i=} \begin{cases} \omega_1 A_K + I_2 A_K, J(A1_k) \geq J(A2_k) + \mathrm{Th} \\ \omega_2 A_K + I_1 A_K, J(A1_k) \geq J(A2_k) - \mathrm{Th} \\ \omega_1 1_K + I_2 2_K/2, \text{otherwise} \end{cases} \quad (5)$$

Where ω_1 and ω_2 are the weight factor satisfying $\omega_1 > \omega_{1_2}$ and This an predefine threshold.

2.3.2 Fusion principle for high frequency band

The high frequency sub-band of wavelet coefficients contains the detail information of the image, such as edge of the target. If the coefficient changes acutely, it is the major detail area of the image. So we can fuse the high frequency sub-band image according to its absolute values of wavelet coefficient of each block.

Suppose $C1^{LH,}C1^{HL}, C1^{HH}$ are the LH,HL,HH sub band wavelet coefficient of the image M1 respectively $C2^{LH,}C2^{HL}, C2^{HH}$ are the LH, HL,HH wavelet cofficient of the image M2 respectively , $F2^{LH,}F2^{HL}, F2^{HH}$,wavelet coefficient of the fused image respectively. Then the edge preserve principle is as bellow

$$F^{LH}i = \begin{cases} C1^{LH} \mid C1^{LH} \geq C2^{LH} \mid \\ C2^{Lh}, \text{ Otherwise} \end{cases}$$

$$F^{HL}i = \begin{cases} C1^{HL} \mid C1^{HL} \geq C2^{HL} \mid \\ C2^{HL}, \text{ Otherwise} \end{cases} \quad (6)$$

$$F^{HH}i = \begin{cases} C1^{HH} \mid C1^{HH} \geq C2^{HH} \mid \\ C12^{HH}, \text{ Otherwise} \end{cases}$$

3. Conventional methods

The trivial image fusion methods perform a general methods like as pixel selection, addition subtraction, averaging , mean . These methods are not effective but at a time critical based on the kind of image consideration. The following some of the trivial image fusion technique studied and develop as the part of the project.

3.1 Averaging methods

Image fusion also saw a similar background, wherein the most simplistic was to fuse a set of input image. In this methods average the intensity of corresponding pixel. The fused image produced by this methods .In this methods both type of fused image obtained like as good and bad from input images. Due to the averaging operation both good and bad information are minimized arriving at an averaged image. Thus the algorithms does not actually fuse the image accurately. This algorithms can be put into one step as the following:

(1) Calculate the average intensity value of each corresponding pixel.

3.2 Maximum Methods

The criterion of selection is self explained by maximum methods. Every corresponding pixel of the input images, The pixel take into consideration with maximum intensity and put in as the resultant pixel of the fused image. One advantage of this methods compare to averaging methods is that there is no compromise made over the good information available in the input images. A straight forward selection of the better pixel intensity is made here. Steps of this methods explain in bellow given sequence.

(1) Compare the intensity value of the corresponding pixel
(2) Generate the selection matrix based on the comparison performed in 1, Assign value 1 for condition being true and 0 otherwise.
(3) Multiplying the corresponding value in selection matrix with first image matrix.
(4) Multiplying the corresponding value in the negated selection matrix.
(5) Resultant image matrix id calculated by adding the matrix calculated in 3& 4.

3.3 Minimum methods

Minimum methods are another very popular methods in which the minimum density is picked up. This methods are differ from the another maximum and averaging methods. In this methods pixel position of the fused image are arrange same as corresponding to the input images. Fused image obtained by this methods seen blurred. In certain cases say that image would be generate dark shaded. Steps of this methods are given bellow:

(1) Compare the intensity value corresponding to the input image.
(2) Generate the selection matrix comprises it with which perform in 1, Assign value 0 for condition true and otherwise 0.
(3) Multiply the corresponding value with selection matrix1.
(4) Multiplying the corresponding value in the negated selection matrix.
(5) Resultant image matrix id calculated by adding the matrices calculated in 3& 4.

3.4 Purposed methods

Proposed method adopt to obtained the highly more relevant information and preserve the edge information .In this paper proposed (max) methods apply to increase the fusion efficiency. Max method become very popular than other methods. The following steps of proposed methods are given bellow to obtained the batter fused image.

(1)In first step apply the input images to discrete wavelet transform.DWT divided the image information into low frequency component and high frequency component.
(2) Apply the low frequency coefficient of low frequency component to the low frequency fusion principle in equation 5.
(3) Apply the high frequency coefficient of high frequency component to the high fusion principle in equation 6.
(4) Apply the output of the step 2&3 to the discrete wavelet transform and obtained the highly accurate fused image.

4. Performance measurement parameter for image

The general requirement of an image fusion process that preserve all the valid use full pattern of information of source image . Performance measure are used to get highly improved result. Performance of the image fusion can be check through various parameter which is normalized cross correlation (NCC), Information Entropy, Average crossover entropy, Standard deviation and average gradient parameter which can explain in bellow.

4.1 Information entropy

Information is an index to evaluate the information quantity in an image. If the entropy become higher after fusing it indicate that information increases and fusion performance are improved.

$$EI= -\sum_{l=0}^{l=1} p_i \log_2 p_i \tag{7}$$

Where L is the total of grey levels, $p = \{p0,1,\ldots..pL-1\}$ is the probability distribution of each level

4.2 Normalized Cross Correlation (NCC)

Normalized Cross correlation are used to find out similarity between fused image and original images. It provide the comparative result of image . It can be explain by following equation.

$$NCC=\frac{\sum_{I=1}^{M} \sum_{J=1}^{N} (A_{IJ} - B_{IJ})}{\sum_{I=1}^{M} \sum_{J=1}^{N} (A_{IJ})^2} \tag{8}$$

4.3 Average Cross over Entropy

Average cross over entropy represent the losses in fused process. If ACE of the fused image decreases then accuracy and fusion efficiency will be increase. It can be explain by given formula.

$$ACE= \frac{1}{2}\left(\sum_{I=0}^{L-1} P_{A1I} \log\frac{P_{A1I}}{P_{FI}} \sum_{I=0}^{L-1} P_{A2I} \log\frac{P_{A2I}}{P_{FI}}\right) \tag{9}$$

4.4 Standard deviation

The bigger standard deviation means the pixel of the image is more scattered and the change the gray level can reflect the Detail texture and edge information of the image .Calculation can be taken in account by given bellow formula.

$$SD=\sqrt{\frac{\sum_{I=1}^{M}\ \sum_{J=1}^{N}\ (F_{IJ}-F)^2}{MN}} \qquad (10)$$

4.5 Average gradient

Average gradient in fusion method give the detail information of the image and also tellus the clearness of image. If the gradient value increases then fused image obtained more accurate and clear.

$$AG = \frac{1}{MN}\sqrt{\frac{[f(I+1,J)-f(i,j)]2+[f(I,J+1)-f(i,j)]2}{2}} \qquad (11)$$

5. Result and discussion

We use the multi-focused CT and MRI body cells images of size 200∗2oo (jpg) shown bellow in figure 3(a) & 3(b)as a text images . figure 3(c),3(d),3(e),3(f) represent the fused image obtained by min ,mean, mean-min, max(our proposed) methods. Minimum methods provides the fused image which very blurred while fused image obtained by mean method get the some improvement than the minimum methods. After this apply the min-mean methods which provide the sharp fused image than apply other methods shown in figure 3(e). At the last we apply the Proposed (max) method that provide highly more accurate fused image than applying other methods.

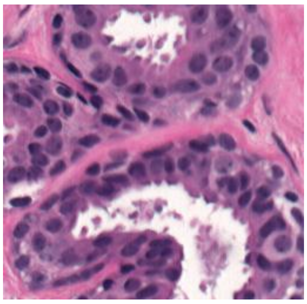

Figure3 (a) body cell CT Image

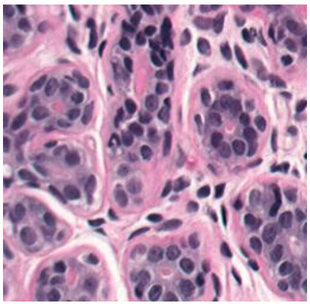

Figure3(b) body cell MRI Image

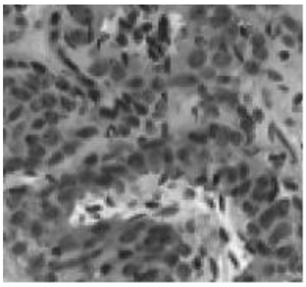

Figure 3(c) Min method

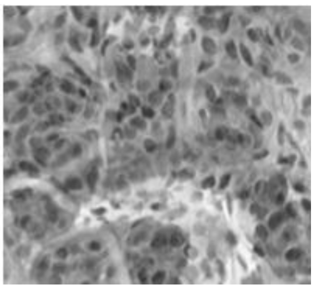

Figure3 (d) Mean method

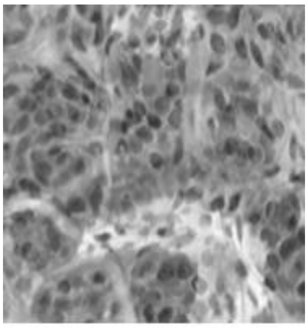

Figure3 (e) min-mean Method

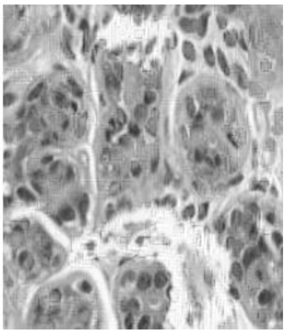

Figure3 (f) Proposed methods

5.1 Comparative result

Comparative result obtained between conventional method & proposed methods which all parameter shown in table i.e. Information entropy(IE) ,Average cross over entropy(ACE), Standard deviation (SD), Average gradient(AG).

Table 1: Comparative table between Conventional method and Proposed Method

FS Methods	IE	ACE	SD	AG
Image 1	6.9884	-	51.038	3.3763
Image 2	6.9532	0.0437	51.206	2.6456
Mean method	7.3852	0.3507	51.023	2.7554
Min method	7.2324	0.3488	50.528	2.2512
Min-mean method	7.3694	0.3374	50.743	3.7443
propose method (max)	15.4232	0.3321	56.743	8.7443

IE represent the total information contained in the image, where ACE represent the loss degree of image information .The standard deviation of the image reflected scattered degree for each pixel. The bigger standard deviation means the pixel of image is more scattered. Change of the gray level can reflect the detail texture and edge information of the image. The bigger average represent the clear figure of image.

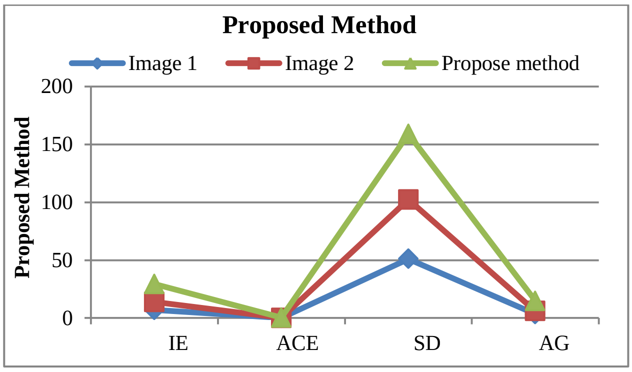

Figure 4 Proposed fused image parameter

In this paper the graph showing input image parameter and proposed parameter i.e. IE, ACE, SD, AG . From these parameter we comprises and observed accuracy and efficiency of fused image. These graph shows that as the IE, SD, AG increases and ACE decreases then efficiency and accuracy will be improve.

Conclusion

(1)Applying the all fusion methods it is clear that proposed methods give the clear fused image which shown in above figure.
(2)After apply discrete wavelet transform on the image low and high frequency band are fused by different rule. At last highly accurate fused image are obtained.
(3)In this paper comprises the different method to obtained the fused image in which maximum method is better than other methods.
(4)At the last we can say that proposed method preserve the total information of image and increase the fussion accuracy.

Future scope

In the future fused image can be obtained highly accurate and sharp applying 2D Discrete wavelet transform at each dimension on second level scaling images. Thus due to the second level scaling of fusion images fusion efficiency and accuracy will be increase. Comparative analysis of second level scaling images will be obtained easily by min, mean, min-mean, max methods.

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