Image Fusion of Remote Sensing Images using ADWT with ABC Optimization Algorithm

J. Thrisul Kumar, Y. Mallikarjuna Reddy, B. Prabhakara Rao

Abstract: ***Synthetic Aperture Radar (SAR) is imaging radar and it generates images in any weather condition. In fact, SAR images are high resolution images therefore to process these images in digital format compression is compulsory, but during reconstruction of these signals some part of the signal component in image will be loosed due to quantization error. Hence in this paper a new approach is proposed to reconstruct the image as near to the original image. Two SAR images are taken for implementing this technique. The quantization error will be reduced by using adaptive discrete wavelet transforms with Artificial bee colony optimization and the output signal would be reconstructed. DWT is used for image fusion which decomposes images. After optimizing the filter coefficients in DWT then the image will be reconstructed by using IDWT and the performance is measured and compared with Genetic Algorithm (GA) in terms of MSE and PSNR.***

Key Words: SAR, DWT, ADWT, GA, ABC, MSE and PSNR

I. INTRODUCTION:

Main approach in this paper is evolving optimized Discrete Wavelet (DW) Filter's coefficients by using the ABC optimization technique. As it is well known that discrete wavelet transform is mostly used in image processing for various application such as image compression, reconstruction and the fusion. Especially in compressing process of very high-resolution images, DWT is mostly employed technique. But during compression process the original image information will be permanently loosed due to quantization noise. Hence in this paper a new technique is proposed that to compensate the loss of the image before reconstructing the original image. The error can be minimized by selecting the optimal solution to the filter coefficients. DWT filter coefficients are optimized by ABC optimization technique and these are used in the inverse DWT process to reconstruct the image as nearly as the Original image.

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II. SYNTHETIC APERTURE RADAR (SAR):

SAR can able to generate the images in cloudy conditions because it can able penetrate into clouds whereas optical sensors not able to generate images in cloudy conditions. SAR produces images with very high resolution irrespective of the weather conditions that means during day time as well as night time also. Hence the Mapping of hazards and disasters using the synthetic aperture radar imagery has proven very successful results in the various fields of applications. SAR is frequently using in disaster management applications such as the floods monitoring, earthquakes, wildfire, landslides and urban heat islands (Joyce, et al., 2009, Nichol 2005 et al, Tralli et al., 2005, Voigt et al., 2007). SAR can able to synthesize signals as long antenna by combining the reflected signals as one signal.

SAR imaging is based upon estimating the relation between transmitted waves and reflected waves from surface. Along with this phenomenon SAR imaging depends upon system parameters such as frequency, incidence angle and polarization as well as surface properties roughness, surface and volume scattering and terrain geometry. SAR images are analyzed by interpreting parameters such as shadow, pattern, size, shape, texture and tone. Image Texture is relating to surface roughness and it may be smooth or rough, either speckle and grainy or salt and pepper. Context analysis could be performed by examining each pixel or group of pixels in surrounding of the scene or whole of the scene.

III. ADAPTIVE DISCRETE WAVELET TRANSFORM (ADWT)

It is well known that the adaptive filters are mostly used in image processing. The concept of adaptive filters is to extract the information from the original signal and reconstruct the output signal. Adaptive finite impulse response filter coefficients are adjusted to reconstruct the output signal as same as the original signal. Most of the designers are focusing in the filter design to find the optimal solution for adaptive filters coefficients. To search the optimal solution, different is employed. These optimized coefficients are applied to DWT to decompose images and IDWT is used to reconstruct the image. Image fusion is the process of integrating two images one is panchromatic image and second one is the multispectral image [4]. Image fusion is the technique to extract high spatial resolution of the image. The need of the image fusion is to extract high spectral information and high spatial information in a single image.

Fusion can be performed by using different techniques [4] bravery method, Principal component Analysis, High pass Filter and Intensity Hue saturation. But these are well in the frequency domain only. Therefore, DWT is preferred because it can able to give both the frequency components of the signals and the positions of those signals. The given signal energy will be redistributed by using the DWT. The major components of DWT are given as 1) scaling function$\phi(t)$ 2) wave let function $\psi(t)$ where these functions are given as

$$\phi(t) = \sum_n h_n \, \phi\,(2t - n) \quad (1)$$

(1)

$$\psi(t) = \sum_n g_n \, \phi\,(2t - n) \quad (2)$$

Where

h_n Contains filter coefficients to project the basic function for the LPF part of the DWT and $g_n$consists of filter coefficients to project the basic function of the high pass filter section of the DWT. The signal will be converted into discrete signal in wavelet domain after performing DWT. Inverse of the DWT (DWT^{-1}) converts wavelet domain into original signal domain. The DWT decomposition is illustrated in fig1.It can be observed from fig1 the original image is applied to LPF and HPF in DWT decomposition, LPF provides the approximation coefficients and HPF contains detailed coefficients. By applying the DWT Decomposition original image will be converted into four output images of equal size. These are

1. Approximation image (LL)
2. Horizontal image (LH)
3. Vertical image (HL)
4. Diagonal image. (HH)

These decomposition images are 'LL' is called approximation image and it will be obtained by performing vertical and horizontal low pass filtering. This approximation image is used for next level of the image decomposition process. 'LH' is the horizontal detail image and it is obtained by the vertical high pass filter and the horizontal low pass filtering. 'HL' is the vertical detail image and it is obtained by the vertical LPF and the horizontal HPF.

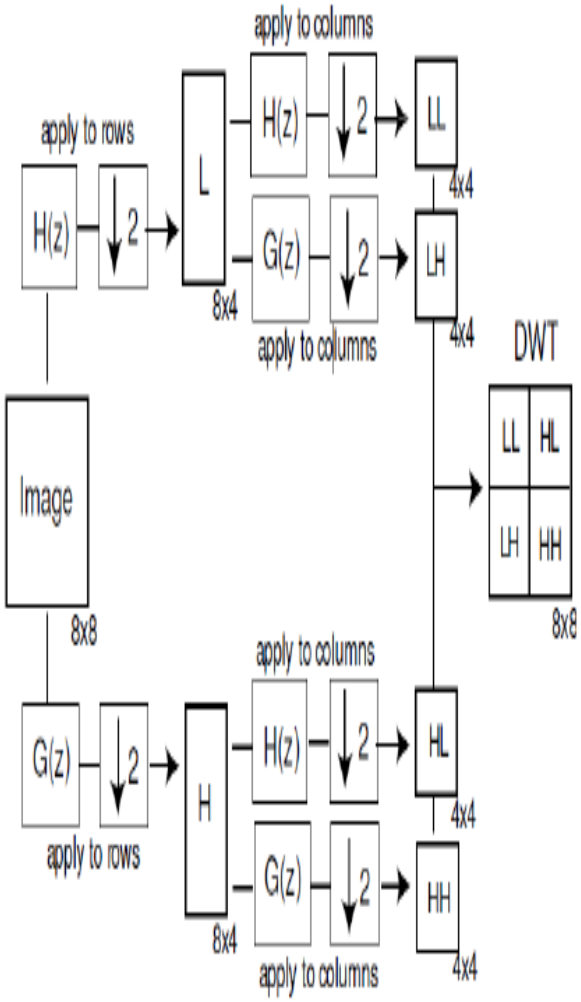

Fig1: Decomposition of single level DWT

'HH' is the 'diagonal detail' image and it is obtained by the vertical and the horizontal high pass filtering. The filter coefficients of the DWT filters are chosen by searching the optimal solution by using the optimization algorithms. This process is called as the Adaptive Discrete Wavelet Transform (ADWT). Therefore, in this process to fuse the original two images initially some default coefficients are chosen and from these coefficients the low pass filter coefficients (Lo_D) and high pass filter coefficients (Hi_D) are selected by performing the optimization. Consequently, by using the coarse coefficients (Lo_D) and the detail coefficients (Hi_D) 2DWT will be performed for the two images. Past Image produces four images and present image produces four images. Therefore, the average of two LL images the approximation image of decomposition image will be produced. By taking the maximum of LH, HL and HH images then the horizontal, vertical and diagonal images of decomposed image will be generated. By using decomposed image, the image will be reconstructed by IDWT.

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IV. ARTIFICIAL BEE COLONY ALGORITHM

The ABC optimization algorithm is given as below flow chart. ABC algorithm ensues the following phenomena; one possible solution is present for every food source according to problem deliberation. Nectar amount speaks for nature of the solution and this nature of the solution performed by fitness value. Employed bee (EB) number is equal to the count of food source. Onlooker bees (OB) consider the probability value (p_i) to perform food source selection. All bees are put their effort to search the food location and selection of the food. EB presents in the first fifty percentage of the total swarm and OB presents second fifty percentage of the total swarm size. EB number is equal to the total amount of the food source. The detailed ABC algorithm is illustrated in below fig2.

This probability value will be collaborated with the food source.

The probability value p_i is given as

$$pi = \frac{FITi}{\sum_{i=1}^{SN} FITi} \quad (3)$$

Fit $_i$ specifies fitness of obtained solution and SN specifies number of sources. The value of SN is equal to count of EB and count of OB. This algorithm follows below expression to obtain new food source position (V_i) from old source position (X_i) and by choosing k, j as random indexes. It is expressed as

$$v\,i,j = x\,i\,,j + \phi\,i,j\,(x\,i,j - x\,k,j)$$

The position of old food source is expressed as $Xi = [xi,1,xi,2,xi,3 \dots \dots .xi,D]$

The position of new food source is given as $Vi = [vi,1,vi,2,vi,3 \dots \dots .vi,D]$

Where $k = [1,2 \dots \dots \dots \dots SN]$ and

$$j = [1,2,3 \dots \dots \dots D]$$

Where D is the count of variables and $\phi_{i,j}$ is a random number with value range from -1 to 1.

Artificial Bee verifies and evaluates the position of candidate and compares with previous position. When present position is better than previous position then previous position replaced by present position otherwise no change in previous position of food source. When better position was not attained through number of repeated cycles, at this case the source will be neglected. In this kind of situation scout hunts for new source with

$$.xi,j = x\,min,j + rand\,(0,1)\,[(x\,max,j - x\,min,j)].$$

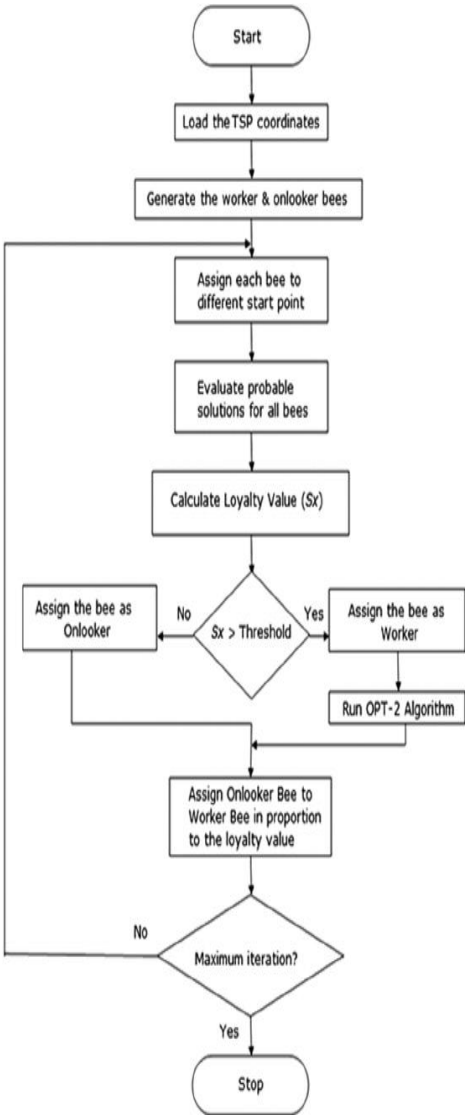

Fig3:ABC optimization Algorithm

Initialization Phase
{
REPEAT
Phase of Employed Bee
Phase of Onlooker Bee
Phase of Scout Bee
Register Best solution found so far
UNTIL (Maximum number of cycles or maximum CPU time)
}

V. RESULTS AND DISCUSSIONS

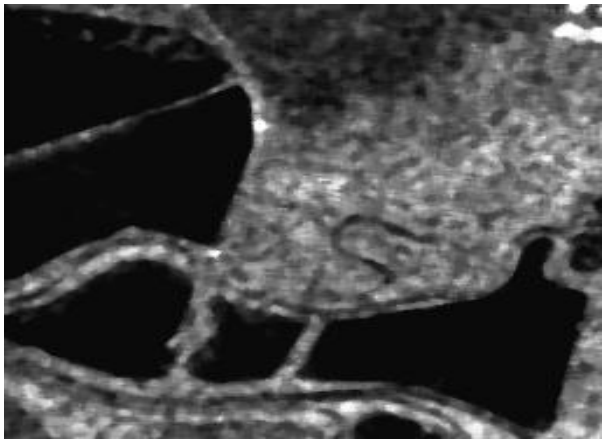

Fig3: Previous image

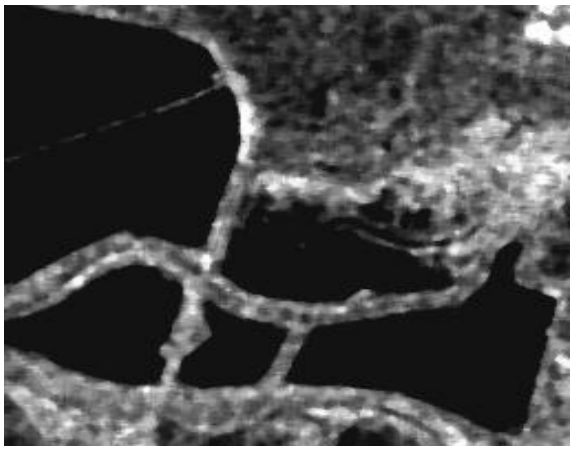

Fig4: Present Image

Fig5: Ground Truth Image

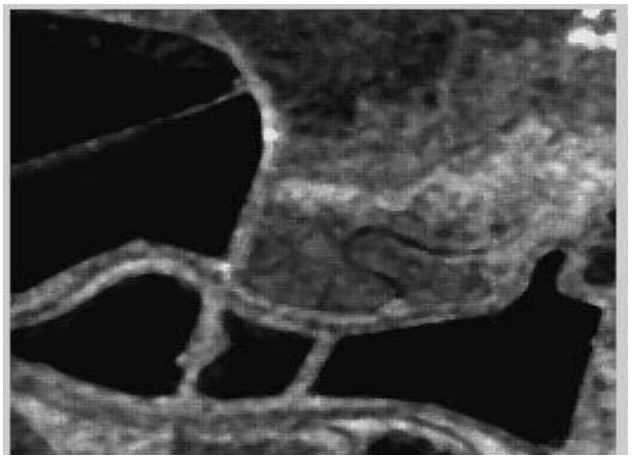

Fig6: Image fusion _DWT

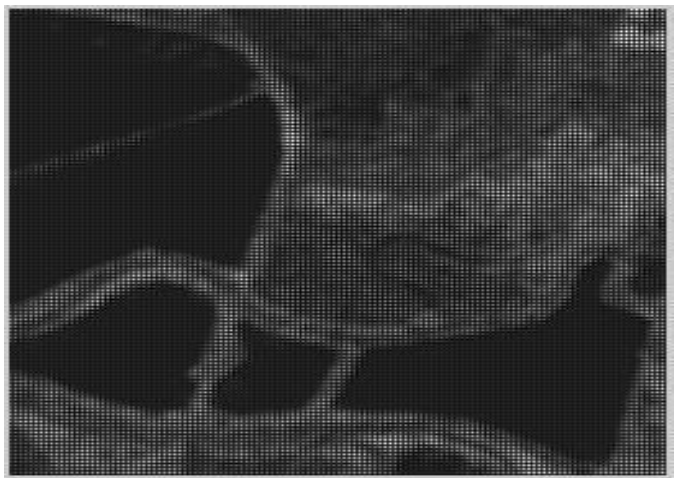

Fig7: Image fusion _ADWT_ABC

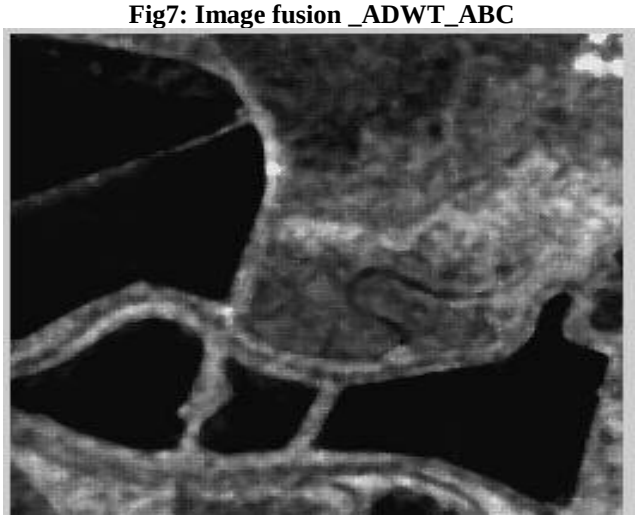

Fig8: Image fusion _ADWT_GA

Table1.performance measurement of ABC Algorithm and GA optimization Algorithm

S.NO	Performance Measurement Parameter	DWT-GA	DWT-ABC
1	MSE	0.0077	0.0977

2	PSNR	41.1565	30.0995

To verify the proposed ABC optimization algorithm two SAR images have been captured at same place at different times. Initially image fusion was applied using DWT with Daubechies2 wavelet to get required information. In this paper to perform image fusion process, ADWT is employed by using the ABC optimization algorithm. The corresponding results of Genetic Algorithm and ABC algorithm are compared with conventional DWT in terms of MSE and PSNR. As illustrated in Table1 Genetic Algorithm gives more PSNR and MSE compare with ABC optimization, and also it gives better results regarding error minimization of DWT process by using ADWT.

VI. CONCLUSION

Therefore, as per results shown in Table1 it can be concluded that optimization of DWT filter coefficients gives better error minimization and also an acceptable reconstruction of the original image.

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