Image Fusion of San Francisco Bay SAR images based on ADWT with optimization technique

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Abstract

The monitoring of the Earth is crucial in today's world. Remote sensing is of utmost importance for the monitoring process. SAR (Synthetic Aperture Radar) sensor images are more desirable than optical sensor images because they can capture data in all weather conditions. Image fusion is a powerful technique used to extract the desired information from two or more images. For this study, two SAR multitemporal pictures were selected to be fused. ADWT is presenting a unique technique for picture fusion that involves picking filter coefficients through an optimization process.Initially, the Discrete Wavelet Transform (DWT) is conducted using various wavelets such as Daubechies and symlet. This is then compared with the Adaptive Discrete Wavelet Transform (ADWT), which involves using DWT with optimized filter coefficients obtained by the BAT optimization process. Ultimately, the outcomes are evaluated by comparing them based on the metrics of Peak Signal-to-Noise Ratio (PSNR) and Mean Squared Error (MSE).

Key words:DWT, ADWT, SAR, BAT, MSE and PSNR

1. INTRODUCTION

Image fusion of the multiple remote sensing images produces the most useful information. Main aim of merging two or more images is extracting the required content from multiple images. Fusion could be performed by DWT (Discrete Wavelet Transform). Meaning while two remote sensing images have been considered for performing fusion [1]. The data images are captured at same geographical location but at multiple timings. In this regard SAR (Synthetic Aperture Radar) images are utilized. It is known that various remote sensors(optical sensors and SAR sensors) have been used to sense the Earth remotely.The reason using SAR sensor other than optical sensor is it can able to capture the object irrespective of climate conditions.

Employing the ADWT (Adaptive Discrete Wavelet Transform) process rather than conventional DWT (Discrete Wavelet Transform) is to reduce the error. In any processing system less error in output is demanded. Consequently, in image fusion process reduction of MSE (Mean Square Error) and improving the PSNR (Peak Signal to Noise Ratio) is needed. Therefore, in this paper ADWT is proposing to reduce the MSE which is occurred due to quantization error in DWT process. In this regard, optimized filter coefficients have been chosen for DWT filter bank instead of conventional filter coefficients (Daubechies, Symlet). BAT optimization algorithm has been chosen for selecting the filter coefficients. After selecting the filter coefficients through optimization algorithm these coefficientsare applied to DWT process which will be called as ADWT [2-7]. Finally, the results with DWT and ADWT are compared in terms of MSE and PSNR. This paper is organised as, section II gives the proposing methodology,section III consisting the ADWT, section IV explains about BAT optimization algorithm and section V gives the results and discussions.

II. PROPOSING METHODOLOGY

The proposed methodology of this paper is illustrated in fig.1.

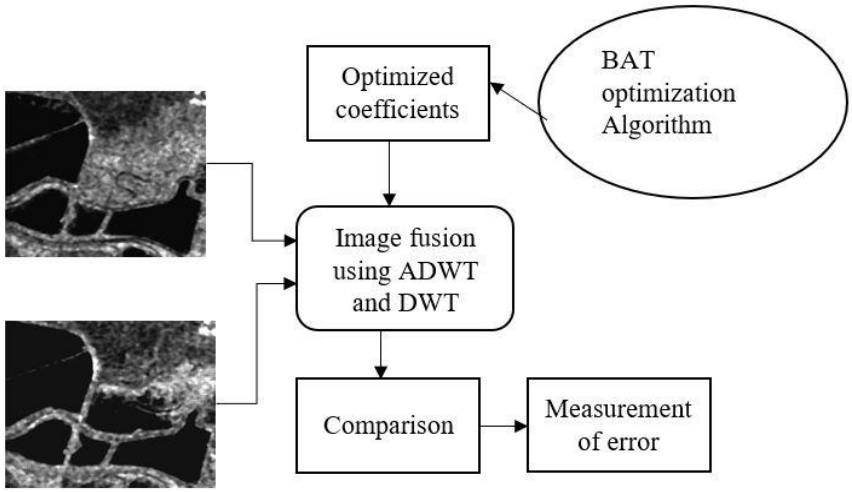

Fig.1. Proposed model

As shown in fig.1. two SAR images are taken for performing the fusion process. In this regard, conventional DWT has been performed with two types discrete wavelets such as Daubechies and Symlet wavelet filter coefficients. ADWT process has been implemented by choosing filter coefficients through BAT optimization algorithm. The output images of DWT and ADWT have been compared and corresponding MSE and PSNR have been calculated by consideringDWT image with Daubechies as a reference.

III. ADWT (ADAPTIVE DISCRETE WAVELET TRANSFORM)

Adapting filter coefficients in DWT filter bank through optimization algorithm is known as Adaptive Discrete Wavelet Transform (ADWT).Consequently, the process of ADWT model has been depicted in fig.2.Initially BAT optimization process will be performed and corresponding filter coefficients have been chosen by satisfying thebio-orthonormal property and symmetrical property. After selection of filter coefficients these will be used for image fusion process.

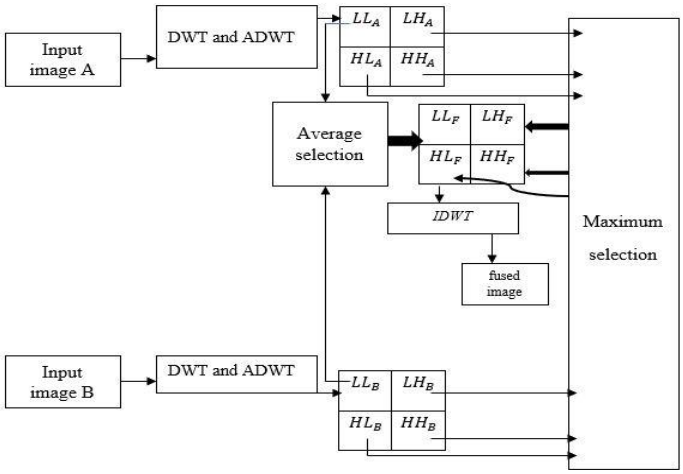

Fig.2. 2D-ADWT Model

As shown in fig.2. single level 2-dimensional DWT and ADWT has been implemented. Main cause to prefer ADWT rather than conventional DWT is to reduce processing error. During the process of images in digital type so many stages involved such as ADC, DAC, quantization, encoding and decoding. In this process MSE might be increased hence in this paper a novel technique ADWT is proposing to minimize the MSE.

Unfortunately, the reconstructed image from DWT process might not be same as original image, but there is a chance of minimizing the MSE and PSNR could be improved. Consequently, losing of the required content in the DWT process could be compensated by adopting optimized filter coefficients.IDWT (Inverse Discrete Wavelet Transform) will be applied to reconstruct the original image from the output image of DWT.

IV.BAT OPTIMIZATION ALGORITHM

Fig .2. illustrated the flow chart of BAT optimization algorithm.

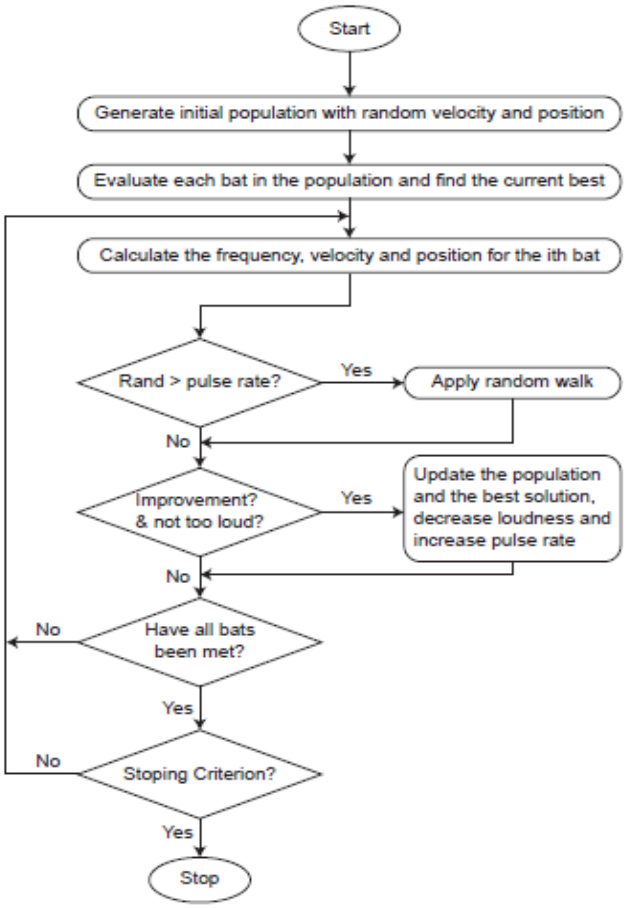

Fig.3. BAT algorithm flowchart

BAT algorithmworks according echolocation of the microbats. Microbats emits sonar waves to identify the prey location it is called as echolocation. BATS can able to see in darkness by using echolocation of and they can differentiate the prey and enemies. The bats emit loud ultrasonic sound waves and listen to the echo that reflects back from the surrounding objects. The bat algorithm uses some idolized rules for simplicity.

(1) Bats use echolocation to sense prey, predator, or any barriers in the path and distance.

(2) Bats fly with a velocity v_i and position x_i. They have frequency f and loudness a_i to reach their prey. They can adjust the frequency of pulse emission r.

(3) As they get close to the prey, pulse increases and loudness decreases.

V. RESULTS AND DISCUSSIONS

Two SAR images have been chosen to verify the proposing technique with conventional DWT.The data images are the images of San Francisco Bay which are captured by ERS-1 satellite.

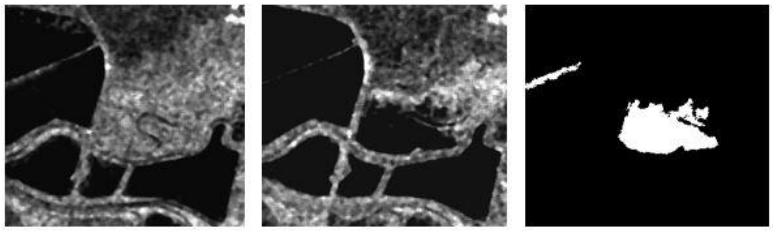

Fig.4. a) pre-image b) post-image c) Ground-truth image

Fig.4. represents about the data images which represents the San Francisco Bay.

Fig.5. Fused images a) Daubechies_DWT b) Symlet_DWT c) ADWT_BAT

Fig.5. illustrates the output put images of DWT and ADWT process.Fig.5.a) represents the output fused image of DWT with Daubechies 2 wavelet coefficients and fig.5.b) represents the output image of DWT with Symlet wavelet coefficients. Fig.5.c) represents output fusion image of ADWT with optimized filter coefficients through BAT optimization algorithm.

Measuring parameter	DWT_Symlet	ADWT_BAT
MSE	0.095	0.098
PSNR	30.947	47.767

Table 1. Performance analysis of ADWT and DWT

Table 1 shows the performance of the ADWT with DWT. Fig 6 represents the performance of proposed methodology graphically.

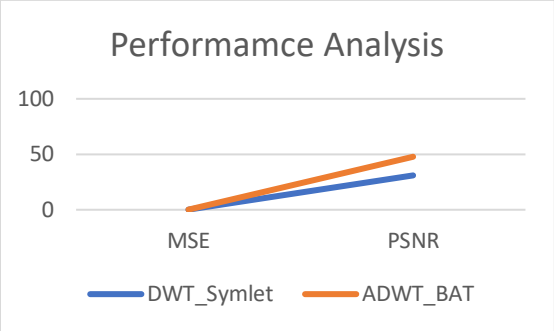

Fig.6. Graphical representation of performance analysis of ADWT and DWT

VI. CONCLUSION

In this paper, a novel technique ADWT has been proposed for image fusion process. Due to various processing stages the quantization noise occurs in the conventional DWT. In order to minimize the noise, the filter coefficients have been adopted through the optimization algorithm. The proposing ADWT given betterment results for reducing the MSE and to increase PSNR. ADWT is reduced MSE of 0.30% than conventional DWT with Symlet coefficients. ADWT is better than DWT with Symlet coefficients of 16.87 for increasing the PSNR.

REFERENCES

[1] Gong, M., Zhou, Z., & Ma, J. (2012). Change detection in synthetic aperture radar images based on image fusion and fuzzy clustering. IEEE Transactions on Image Processing, 21(4), 2141–2151.

[2] Thrisul Kumar Jakka, Y. Mallikarjuna Reddy, B. Prabhakara Rao "GWDWT-FCM: Change Detection in SAR Images Using Adaptive Discrete Wavelet Transform with Fuzzy C-Mean Clustering", Journal of the Indian Society of Remote Sensing (ISRS), ISSN 0255-660X, March 2019, Vol 47, No. 3, pp - (379-390).

[3] J. Thrisul Kumar, Y. Mallikarjuna Reddy, B. Prabhakara Rao "WHDA-FCM: Wolf Hunting-Based Dragonfly with Fuzzy C-Mean Clustering for Change Detection in SAR Images" published in The Computer Journal (online), on 9th December 2019. ISSN 0010-4620, EISSN 1460-2067.

[4] J. Thrisul Kumar, Y. Mallikarjuna Reddy, B. Prabhakara Rao "Image Fusion of Remote Sensing Images using ADWT with ABC Optimization Algorithm" International Journal of Innovative Technology and Exploring Engineering (IJITEE), ISSN: 2278-3075, Vol -8 Issue-11, Sep 2019, pp- (3865-3869).

[5] J. Thrisul Kumar, Y. Mallikarjuna Reddy, B. Prabhakara Rao "Change Detection in Sar images Based on Artificial Bee Colony Optimization with Fuzzy C - Means Clustering", International Journal of Recent Technology and Engineering (IJRTE), ISSN: 2277-3878, Vol -7 Issue-4, Nov 2018, pp- (156-160).

[6] J.Thrisul Kumar, N.Durgarao, E.T.Praveen, M.Kranthi Kumar " Modified Image Fusion Technique For Dual-Tree Complex Wavelet Transform" International Journal Of Advanced Science And Technology , Vol. 29, No. 5s, (2020), pp. 895-901

[7] N.Durgarao, J.Thrisul Kumar , M.Kranthi Kumar, E.T.Praveen " Novel Dct Co-Efficients Based Object And Face Recognition" International Journal Of Advanced Science And Technology , Vol. 29, No. 5s, (2020), pp. 883-888

[8] J. Thrisulkumar, N. Durga Rao, E.T. Praveen, M. Kranti kumar "Image Fusion of Remote Sensing Kerala Flood Images based on DWT with Multiple Wavelet Families" TEST Engineering and Management, May – June 2020, ISSN: 0193-4120 Page No. 2345 - 2348

[9] N.Durgarao, J.Thrisul Kumar, M. Kranthi Kumar, E. T. Praveen " Interactive Segmentation using improved FLICM" TEST Engineering and Management, May – June 2020, ISSN: 0193-4120 Page No. 2621 – 2624

[10] B.M.S. Rani, M.DivyaSree, B. spandana, J.Thrisulkumar " Novel Retina Recognition System Using GUI" TEST Engineering and Management, May – June 2020, ISSN: 0193-4120 Page No. 2316 – 2320

[11] Sweta Srivastava and Sudip Kumar Sahana "Application of Bat Algorithm for Transport Network Design Problem" Applied Computational Intelligence and Soft Computing Volume 2019, Article ID 9864090,