Applied Soft Computing
Manuscript Draft

Manuscript Number: ASOC-D-14-01430

Title: Framework for Segmentation of SAR imagery based on NSCT and IABC Algorithm

Article Type: Full Length Article

Keywords: SAR(Synthetic Aperture Radar)NSCT (Non subsampled Contourlet Transform)IABC (Improved Artificial Bee Colony algorithm)

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***Graphical abstract (for review)**

Abstract

Conventional methods for segmentation on Synthetic Aperture Radar (SAR) images aim to provide automatic analysis and interpretation of data.Usually the task gets failed at many cases due to the influence of speckle in the segmented results. The present work proposes a Hybrid framework for segmentation which will provide approachable segmentation results in SAR imagery for the post processing. This framework uses the full advantage of Non Subsampled Contourlet to achieve promising results. The final results are analyzed using different metrics and it shows that our proposed framework is providing promoting results in Segmentation of SAR images.

Highlights

Non subsampled Counterlet Transform advantages over the other transform clearly explained and how it's mapped with an Active imagery (SAR) system is proven. The segmentation results prove that how efficient is our framework. The overall system is tested with the real time satellite imagery which and the success of the system is shown. This work can be used for real time processing purposes.

Mathematical Background related with the NSCT and Improved Artificial Bee Colony algorithm is explained very clearly on research point.

Framework for Segmentation of SAR imagery based on NSCT and IABC Algorithm

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Index terms: SAR, NSCT (Non subsampled Contourlet Transform), IABC (Improved Artificial Bee Colony algorithm)

1. Introduction

The Synthetic Aperture Radar (SAR), an active imagery system having the potential of imaging in "All weather all time" conditions. The use of SAR based satellites are increased in the past decade because of its vigorous impacts in the applications such as ice Monitoring, surface deformation and detection, oil spills, glacier Monitoring, urban planning and in military applications. SAR imagery has number of merits like multi-band, multi-polarization, variable size perspective and strong penetration ability and so on (Ming Zhang (2010).) The original SAR image is highly influenced by the granular noise which is called as Speckle, formed by the back scattering coefficient and is coherent in nature. The speckle possesses strong hindrances over the preprocessing task such as Segmentation, classification etc. It is reckon that segmentation rely on the quality of the source image which can provide desired information.The segmentation becomes challenging in SAR imagery systems due to the speckle noise.

Image Segmentation is a difficult task due to the complexity and diversity of images. Parting an image into desired regions, but the conjugation of two or more adjacent regions is homogeneous. This can be represented as

$$\text{mathop} \cup s_i = I \text{ and } s_i \cap s_{j=} \varnothing, i != j$$

The segmentation results will affect the subsequent process of the image and understanding, which includes object representation and description, feature measurement, object classification, scene interpretation etc. (Xin Zhanget al, (2011), andYanhuiGuoet al.,(2009)). There are several approaches based on homogeneity such as:

1. Thresholding
2. Edge-Detection

3. Clustering

4. Region growing and merging

In all the approaches some of the drawbacks such as; Thresholding technique is sensitive to noise and ignores spatial information. Region growing suffers from over segmentation and time consuming. In Edge detection approach, Noises produce false edge or wrong edges. In clustering, Over-segmentation appears in SAR Segmentation

The classical segmentation techniques will not work successfully on SAR images because of the Speckle. Generally segmentation techniques of SAR images can be divided into two categories

1. Feature based

2. Model based

These approaches are having some drawbacks mainly feature based methods are highly influenced by the noises. Robust filtering is required to remove the noise which usually deteriorates the quality of the segmentation. The model based methods have computational complexity and these methodswill not solve the issue of disconnected region segmentation and poor contrast in SAR images.

Segmentation is efficiently carried out in the domain of an invertible linear transformation. For example, Wavelet domain.*A potent transform can get the gist of the given signal with some basic function*. Such basic function characterizes the transform; whether basic function is linear or linear dependent. The set of basic function is enriched to make a representation more efficient to seize the signal.

TheRedundant representation is generally more flexible and easier. In preprocessing application a redundant representation can easily outperform the non-redundant one.

Feature of a transform . (Robert O Harger (1970).)

- Stability with respect to the shifts of the input signal

The lack of shift invariance causes Pseudo-Gibbs Phenomenon and Singularities

- Geometrical structure pervasive in natural scene.

2. Background

2.1 Wavelets (Yinhui Zhang et.al(2011) , S. Arivazhagan et al.(2003), Edward H,S.Lo, et.al(2011) and Ming Li et al.(2009).).

Wavelet transform is one of the powerful tools for "time-frequency" analysis. Analyzing signals which have sudden changes like phase and frequency, local maxima and minima, or related parameters, the wavelet transform replace the STFT (Short Term Fourier Transform) in which the basic phenomenon is time-frequency localization and is replaced with the time-scale window with some advantages.

Basically the continuous wavelet transform have the drawback of Heisenberg uncertainty problem which states that "The wavelet functions are localized in both frequency and time but they cannot have exact localization"

The Discrete Wavelet Transform (or DWT) wavelet is an orthogonal function which can be applied to a finite group of data. Functionally, it is similar to Discrete Fourier Transform, in which the transforming function is orthogonal, a signal passed twice through the transformation is unchanged, and the input signal is assumed to be a set of discrete-time samples.

In practice, the Discrete Wavelet Transform (DWT) Fig.1 can be implemented by a Perfect Reconstruction Filter Bank (PRFB). This is completely characterized by a pair of Quadrature Mirror Filters (QMF) h0[], a low-pass filter, and g1[],and the corresponding high-pass filter, known as analysis filters.

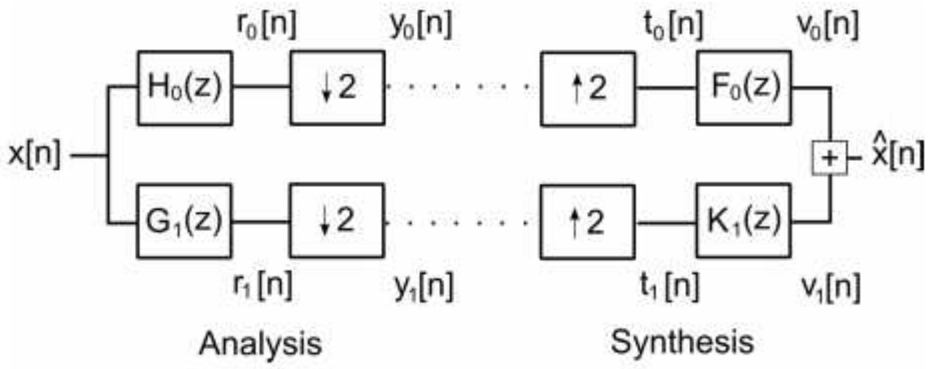


Fig. 1 Wavelet Analysis and Synthesis

2.2 Contourlets (Minh N. Do and Martin Vetterli,(2005).)**:**

Limitation of wavelet transforms is capturing the geometry of an image. In Multi-Resolution Analysis, the wavelet mainly ignores the direction, which is introduced in the Contourlet domain to capture the intrinsic geometrical structure. Contourlet is a 2-D transform that can capture the intrinsic geometrical structure and is an important parameter in visual information. The Discrete Contourlet transform has fast iterated filter bank algorithm which requires order N operations for N-Pixel image. The computational image representation should to be efficient and it should be based on a local, directional and multiresolution expansion.

Key properties of a computational image representation are multiresolution, localization, critical sampling, directionality and Anisotropy. Directionality and anisotropy problems are basically due to the discrete nature of the data: Typically the inputs are sampled in rectangular grids. For example; Directions other than Horizontal and vertical look very different in the rectangular grid. Because of pixelisation the notion of smooth contours or sampled images is not obvious. Contourlet construction extends to a multiresolution, local and directional image representation.

Apart from Contourlets and curvelet there are several other approaches such as i) Bandlets ii) Wedgelets and iii) Quadtree coding which typically restores an edge detection stage followed by adaptive representation.Contourlet is a fixed transform. This feature of Contourlet transform allows it to easily apply on wide range of image processing tasks similar to wavelets which in turn eliminates the use of edge detection which is unreliable and noise sensitive.

Further Multiscale and directional image representations.

1. 2D-Gabor wavelets
2. Cortex Wavelets
3. Streerable Pyramid
4. 2D-Directional wavelets
5. Brushlets
6. Complex Wavelets

The major conflict over the above mentioned representations and Contourlet is the different number of directions at different level of decomposition with critical sampling.

2.3 Non - Subsampled Contourlet Transform (Arthur L. Cunha,et al.(2006).a)

Lack of invariance and redundancy are the limitations of Wavelets and Contourlet. Lack of invariance creates Pseudo-Gibbs phenomenon around singularities. The pyramidal filter bank structure of the Contourlet transform has very small redundancy. Designing filters for Contourlets becomes difficult due to down samplers and up samplers present in both the Laplacian-pyramid and the DFB; the Contourlet is not completely shift variant whereas NSCT is a fully shift-Variant, multi scale and Multidirection expansion that have a fast implementation.

2.4 Optimization problem

ABC: Artificial Bee Colony (D. Karaboga and B. Basturk,(2008).a)

In the recent years natures inspired computation has received significant attention. The two popular algorithms which are generally used are Evolutionary and Swarm Intelligence. Genetic algorithms are evolutionary algorithms and artificial fish swarm and Particle swarm optimization belong to Swarm Intelligence. Similar to the existing nature algorithms few of researchers proposed some mimic based algorithms on the basis of behavior such as Artificial Bee Colony which has a better optimization compared to those Genetic and Particle swarm optimization.

3. Non-subsampled ContourletTransform (Arthur L. Cunha et al.(2006)b .)

3.1 The Nonsubsampled Contourlet Transform:

The NSCT divides the signal into two parts a shift invariant which is called as the NSPS and the NSDFB. The NSPS provides multi-scale properties and NSDFB provides the directionality. The below figure 2(a) depicts the broad view of the NSCT which is proposed. The filter bank which splits the frequency plane in 2D is pictured in figure 2(b)

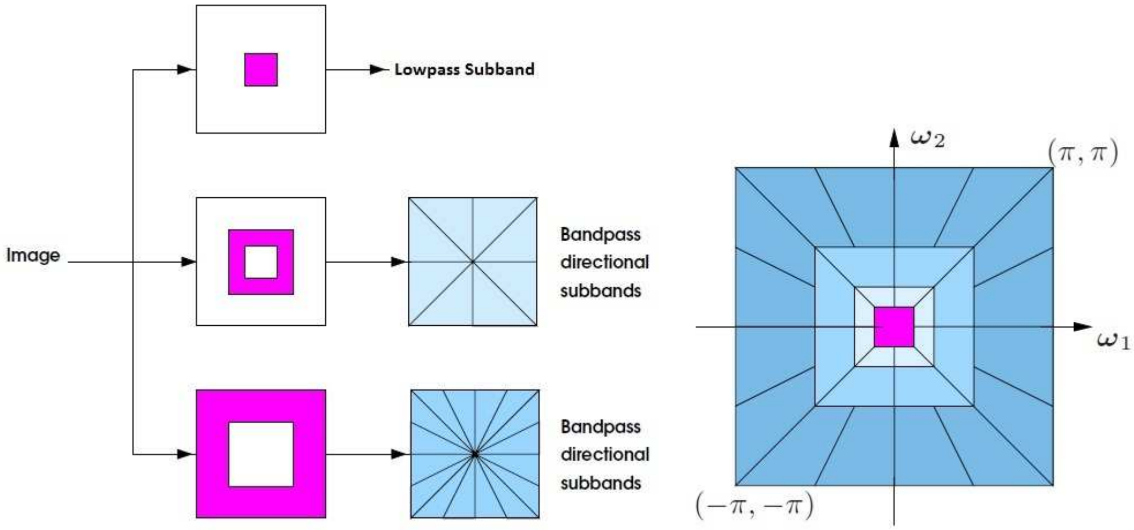


Fig. 2 The NSCT overall system a). NSFB structure b). Idealized Frequency Partitioning

(Arthur L. Cunha et al.(2006).c)

3.2The Nonsubsampled Pyramid (NSP): The NSP provides the multi-scale property which is Shift Invariant. Two channel nonsubsampled 2D filter banks are used to obtain the Invariance property. Decomposition of image up to 3rd level is pictured in fig 2 with L +1 redundancy, where L denotes the number of decomposition stages.

The Ideal low pass filter at j-th stage is in the region $[-\pi / 2^j, \pi / 2^j]$

The Ideal High pass filter at j-th stage is in the region. $[-\pi / 2^{j-1}, \pi / 2^{j-1}]^2 \backslash [-\pi / 2^j, \pi / 2^j$

The filters for the succeeding level are obtained by up sampling the filters of the first level or previous one. The multi-scale property is achieved by this without any additional filter design. The NSFB is different from separable NSWT based on the redundancy results obtained,for NSWT, (3J+1) redundancy and for NSFB , (J+1) redundancy.

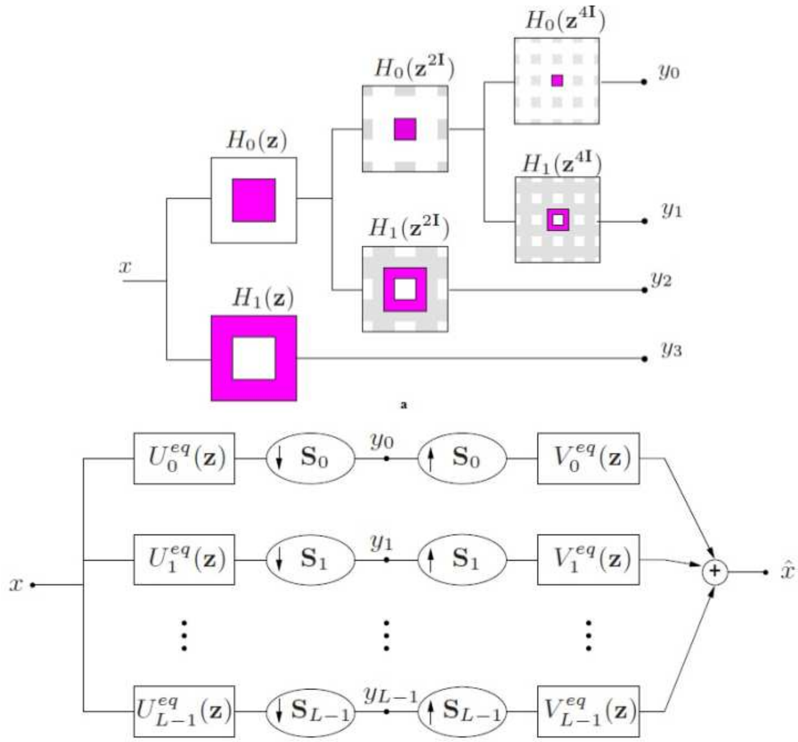


Fig. 3.NSP Structure a). Three stage Pyramid Decomposition b).Multi Channel Filter Bank structure (Arthur L. Cunha et al.(2006).d)

3.3 The Nonsubsampled Directional Filter Bank (NSDFB): Directional filter bank by Bamberger and Smith are constructed by combining critically sampling and resampling operations.

The down sampling matrices is given by

$$s_k = \begin{Bmatrix} diag(2^{l-1}, 2), \text{for } 0 \le 2^{l-1} - 1; \\ diag(2, 2^{l-1}), \text{for } 2^{l-1} \le k \le 2^{l} - 1; \end{Bmatrix}$$

With l denoting the number of stages in the tree structure. The above equation proves that it is shift invariant due to the up samplers and down samplers. Therefore to obtain Shift Invariance the DFB is constructed without using up samplers and down samplers in fig 3(b).

The result of eliminating and switching off the down samplers leads to the tree which is composed of two-channel nonsubsampled filter banks. The second level up sampled filters have checker-board frequency support and combined with the filters, in the first level give the four directional frequency. This Four channel decomposition is depicted in figure 4(a).

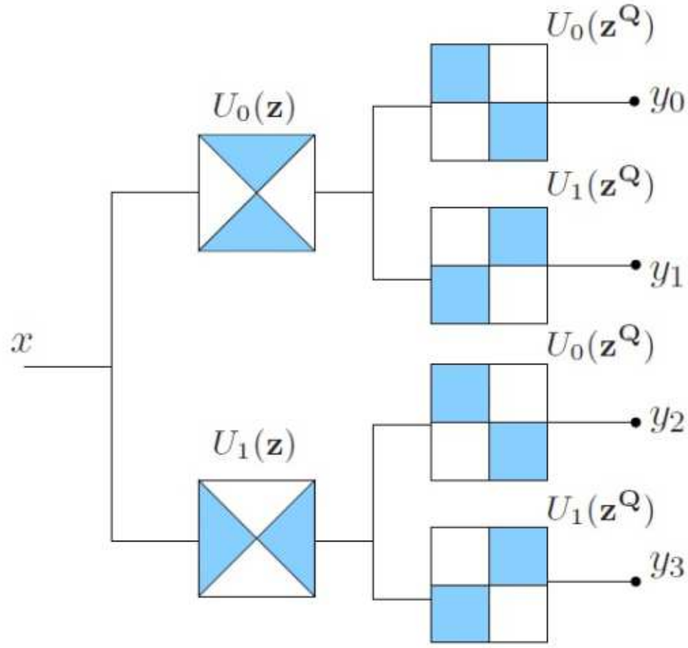


Fig. 4 a). Four Level Decomposition of NSCT (Arthur L. Cunha et al.(2006).e)

3.4 Combining the NSP and NSDFB in the NSCT: Construction of NSCT needs the combination of NSP and NSDFB as shown in fig 2.When directional filters applied to the coarser side of NSP the tree nature of NSDFB leads to the directional response at lower and higher frequencies which basically suffers from aliasing as shown in fig 3(a).It is noticed that there is a considerable loss in directional resolution due aliasing This aliasing problem can be solved by performing up sampling in NSDFB. Let us assume K-th directional filter by $U_k(Z)$ then for higher scales $U_k(Z^{2mI})$ where m will be parameter to choose good part of response with the NSP.

Representation of NSCT

The representation of NSCT comprises the following

1. Multi Resolution
2. Multi Direction
3. Shift Invariant
4. Redundancy (J+1) J is the number of levels

The former mentioned properties of NSCT are explained in the Later.

2.2 a).Multiresolution analysis and Multi Directional Analysis ((Yinhui Zhang et.al(2011).b , S. Arivazhagan et al.(2003).b, Edward H,S.Lo, et.al(2011).b and Ming Li et al.(2009).b.)

$\Phi(\mathrm{t}) \in L^2(\mathrm{R});$ Where $\Phi(\mathrm{t})$ should satisfy (1)

$$\Phi(\mathrm{t}) = 2\sum_{n \in Z^2} g(\mathrm{n}).\Phi(2\mathrm{t} - \mathrm{n}) \quad (2)$$

Eqn (1),(2) are the basic scaling functions in the wavelet transform.

$\{\mathrm{V}_j\}_{j \in Z}$ Provides sequence of Multiresolution nested subspaces

$...V_{-2} \subset V_{-1} \subset V_o \subset V_1 \subset V_2...$ Where V_j is associated with uniform grid of 2^j x 2^j (3)

Difference images in subspace W_j orthogonal difference live in subspace that is orthogonally complement in V_{j-1} or can be represented as shown in eqn (4)

$$\mathrm{V}_{j-1} = \mathrm{V}_j \oplus W_j \quad (4)$$

Multidirection

$\mathrm{V}_j = \bigoplus_{k=0}^{2^l-1} \mathrm{V}_{j,k}^{(l)}$ where k = 0, 1 … $2^l - 1$ which is the total no of wedges (5)

Eqn (5) represents the resultant when Filter Banks is applied to approximation subspace V_j

Multi Direction and Multi Scaling:

The eqn (6) represents the multi direction and multi scaling.

$$L_2(\mathrm{R}^2) = \bigoplus_{j \in Z} W_j \quad \text{Where } W_j \text{ is not shift variant.} \tag{6}$$

Shift Variant

To make it **shift variant** Lifting theorem is applied to the filters and is shown in eqn (7)

$$\begin{pmatrix} H_0^{2D} f(\mathrm{z}) \\ H_1^{2D} f(\mathrm{z}) \end{pmatrix} = \underset{i=0}{\overset{N}{\pi}} \begin{pmatrix} 1 & 0 \\ P_i^{2D} & 1 \end{pmatrix} X \begin{pmatrix} 1 & Q_i^{2D} \\ 0 & 1 \end{pmatrix} \begin{pmatrix} 1 \\ 0 \end{pmatrix} \tag{7}$$

Where $f(\mathrm{z})$ is a 2D function and P and Q having same complexity

Regularity

$\Phi(\omega) = \underset{j=0}{\overset{\infty}{\pi}} H_0(2^{-j}\omega)$ is obtained by scaling the detail of the low pass approximation and the regularity is controlled by low pass filter as shown in eqn(8)

$$H_0(\omega) = \left(\frac{1+e^{j\omega_1}}{2}\right)^{N1} \left(\frac{1+e^{j\omega_2}}{2}\right)^{N2} \tag{8}$$

4. Artificial Bee Colony Algorithm (KarabogaDervis,(2005).a.)

Swarm optimization algorithms rely on two major aspects one is self-organization and the other is division of labor. Self-organization can be achieved through the interaction of low level elements of the system in order to achieve the impact on the High level system.

This leads to establish the rules which ensure the interactions and are executed on the local information without any influence over the global pattern. Basic properties in which the

Self Organization are: Positive feedback, Negative feedback, fluctuations and multiple interactions.Specialized individuals which is called as division of labor performs different task simultaneously which is efficient in comparison with the unspecialized individuals performing simultaneously.

BEHAVIOUR OF HONEY BEE SWARM

The major components which are needed to develop the model of forage selection are:

1. Food sources: The value of source depends on some factors such as proximity to the nest, richness or concentration.

2. Employed Foragers: The foragers are associated with the particular food source, they bring the information related about the source like distance, direction from nest, profitability of source with certain probability.

3. Unemployed Foragers: The foragers continually look out for a food source to be exploited.

Two types of unemployed foragers are the Scout bees and the onlookers.

Scout bee: Bee starts to search in the environment surrounding to its nest

Onlookers or Recruit bee: Bee watches another Bee dance from there it starts searching according to the information of the waggle dance.

Based on the intelligent Foraging behavior of bees the optimization algorithm is designed which is called asArtificial Bee colony Algorithm. This will solve the multidimensional and multimodal optimization problems such as:

1. Positive feedback: when the amount of food source increases the onlookers will be increase in numbers.

2. Negative feedback: The bees will stop exploiting low food source.

3. Fluctuations: The scout bees bring random search information in finding new food source.

4. Multiple interactions: Sharing of information between bees in a common area (Dancing Area).

Algorithm (Artificial Bee colony Algorithm)

1. Send the scouts onto the initial food sources

REPEAT

2. Send the employed bees onto the food sources and determine their nectar amounts

3. Calculate the probability value of the sources with which they are preferred by the Onlooker bees

4. Send the onlooker bees onto the food sources and determine their nectar amount

5. Stop the exploitation process of the sources exhausted by the bees

6. Send the scouts into the search area for discovering new food sources, randomly

7. Memorize the best food source found so far

UNTIL (requirements are met)

The recruitment rate indicates the “Measure” how bee locates and exploit new food source similarly the artificial recruiting indicates the “Measure” how fast the solutions (Feasible or Optimal) are obtained. Survival of the fittest makes rapid solution for difficult engineering problems with good optimal solutions which need to solve in real time.

4.1 Improved Artificial Bee Colony Algorithm (Gao, Weifeng, and Sanyang Liu,(2011)a.)

Initialization

The population initialization plays a vital role in evolutionary algorithms due to its impact over the convergence speed and caliber of the solution. Common methods for such algorithms are basically random initialization. In this improved ABC algorithm, opposition based learning along with chaotic systems to generate initialization in order to get an accelerated convergence towards the solution.

Once initialization is carried out a set of evolutionary operations (Mutation, crossover and selection) will have the Differential evolution (DE) algorithm. The best solution ("DE/best/1") in current population can be used to accelerate the convergence speed and random ("DE/rand/1") values can be used to maintain diversity in population.

Further to make it more efficient a strategy is used by introducing a parameter M which is used to control the different elements between the candidate source and old one.

Algorithm (Improved Artificial Bee colony Algorithm)

1. Initialization: Preset parameter M, selective probability p, population size SN and limit.

2. Perform Algorithm 1 to create an initial population, calculate the function values of the population.

3. Produce new solutions V_i for the employed bees by using Algorithm 2 and evaluate them. Apply the greedy selection process for the employed bees.

4. Calculate the probability values P_i for the solutions X_i by (1). Produce the new solutions V_i for the onlookers by using Algorithm 2 from the solutions X_i selected depending on P_i and evaluate them. Apply the greedy selection process for the onlookers.

5. Determine the abandoned solution for the scout, if exists, and replace it with a new randomly produced solution X_i by (3).

6. If the stopping criterion is satisfied, stop. Otherwise, return to Step 2.

4.2 Mathematical Background for Improved Artificial Bee Colony Algorithm (*D.* Karaboga and B. Basturk,(2008).b ,KarabogaDervis,(2005).b **,**Gao, Weifeng, and Sanyang Liu,(2011).b)

Onlooker chooses food source based on Pi

$$P_i = \frac{fit_i}{\sum_{i=1}^{SN} fit_i} \quad (9)$$

fit_i is fitness value of solution i ;

SN is no of food sources which is equal to number of onlooker bee or employed bees.

Candidate food position

$$V_i = [V_{i.1}, V_{i.2}, ...V_{i.D}] \text{ Current Positions} \quad (10)$$

$$X_i = [X_{i.1}, X_{i.2}, ...X_{i.D}] \text{ Default positions} \quad (11)$$

$$V_{i,j} = X_{i.j} + R_{i,j}(X_{i.j} - X_{k.j}) \text{ Where } \begin{matrix} k \in \{1,2,.....SN\} \\ j \in \{1,2,........D\} \end{matrix} \quad (12)$$

D is number of variables (Problem Definition)

$R_{i,j}$ is a random number between -1 and +1

Determining New food Source

$$X_{i,j} = X_{\min,j} + rand(0,1)(X_{\max,j} - X_{\min,j}) \tag{13}$$

Candidate Food source

$$V_{i,j} = (X_{\min,j} + X_{i,j})/2 \text{ if } V_{i,j} < X_{\min,j} \tag{14}$$

$$V_{i,j} = (X_{\max,j} + X_{i,j})/2 \text{ if } V_{i,j} > X_{\max,j} \tag{15}$$

Population Initialization

$$Ch_{k+1} = \mu Ch_k(1 - Ch_k) \text{ where } \mu \text{ is the controlling parameter} \tag{16}$$

k = 0,1,2,…..K (Iteration Counter)

$Ch_k \in (0,1)$

This Initialization method is used instead of pure random initialization.

Search Mechanism

Differential Evolutions: Frequently used solution search mechanisms as shown in eqn (17)

$$\begin{aligned} &DE/Best/1: V_i = X_{best} + F(X_{r1} - X_{r2}) \\ &DE/Rand/1: V_i = X_{r1} + F(X_{r2} - X_{r3}) \end{aligned} \tag{17}$$

The eq (17) is generally used in the applications.

The proposed solution for the search mechanism is represented in eqn (18)

$$V_{i,j} = X_{best.j} + R_{i,j}(X_{i,j} - X_{j,k}) \tag{18}$$

Introducing parameter $R_{i,j}$ at eqn. 18 is for control number of elements between the candidate source position and the old position.

5. Proposed Framework

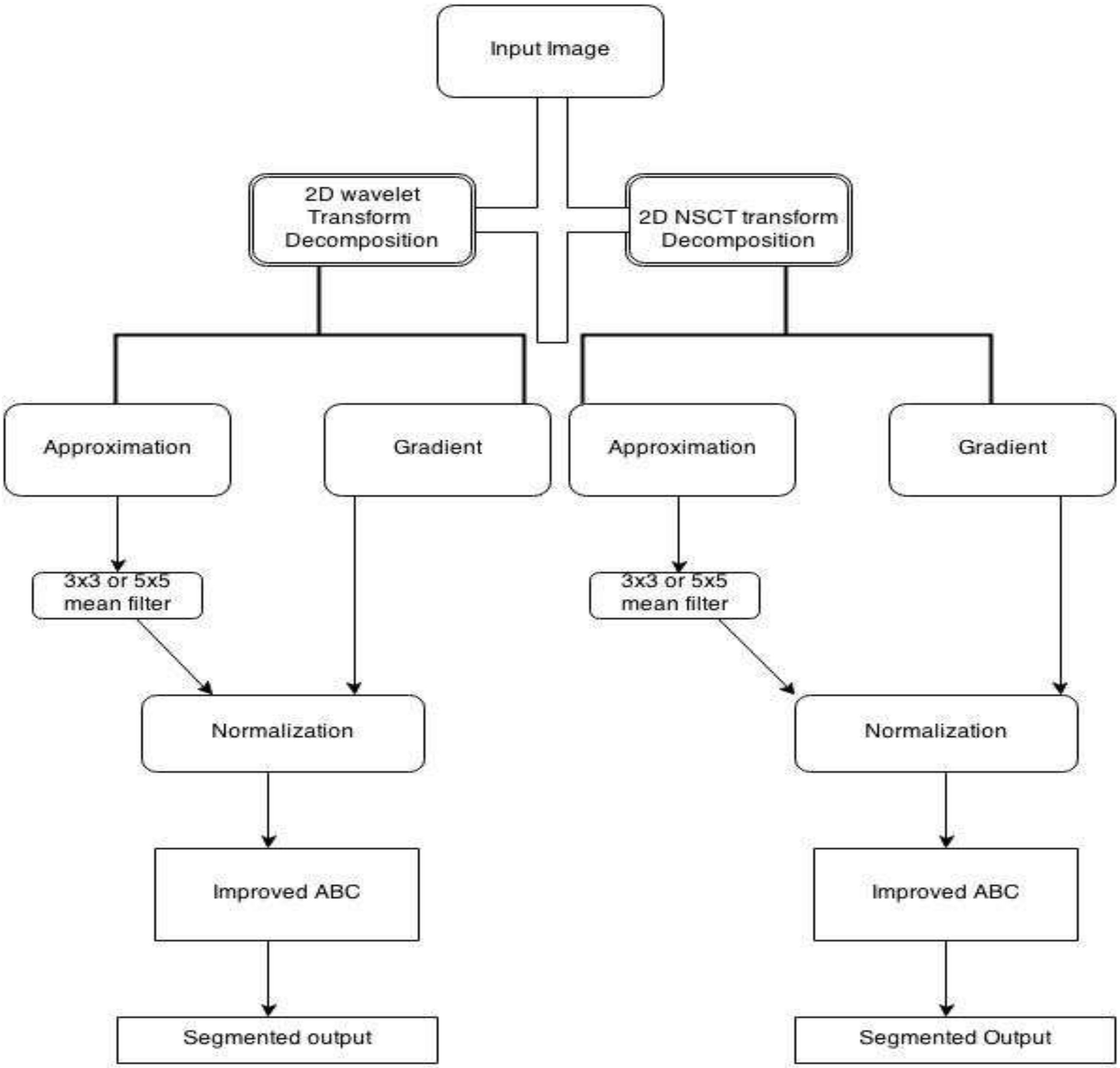


Fig 5. Proposed flow chart

The Fig.5 shows the proposed framework segmentation technique in two domains namely Wavelet and NSCT Domains using Improved Artificial Bee colony Algorithm. The mean filter is applied on the approximated regions to make it free from simple noise, though in frequency domain the mean filter effect is low. The co-occurrence matrix is generated from the filtered approximation and Gradient. The co-occurrence matrix is generated for the normalization process finally generated Co-Occurrence matrix is the initial input for the IABC algorithm. Based on the optimal threshold value generated through IABC the segmented image will be obtained as the output.

6. Results and discussion:

To verify the efficiency of the method the resultant is compared with wavelet domain as well as in the same domain with 3 different evolutionary and swarm optimization algorithms.

1. Run = 10
2. Number of cycles= 30
3. Stopping criteria= optimal value should repeat 3 times

These are the conditions used for the evaluation purposes.

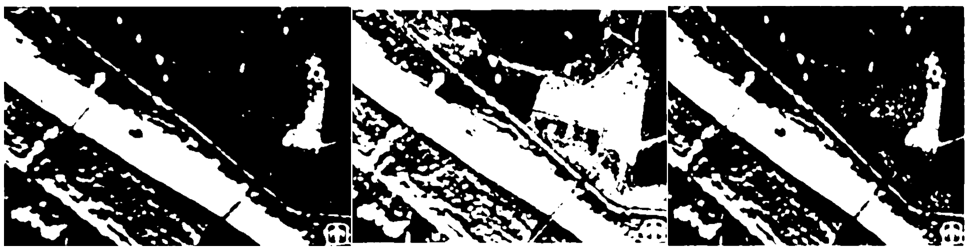
If the optimal values are not obtained with above conditions the runs are increased for IABC 120 cycles in WDT domain and 240 cycles in NSCT domain.

Data Sets used

A Pipeline over the Rio Grande river near Albuquerque, New Mexico which is 1m resolution ku Band downloaded from http://www.sandia.gov/radar/images/piperiver.jpg.

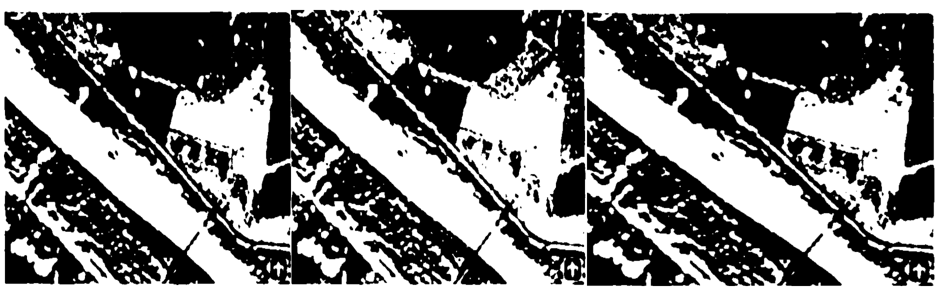
B. Radarsat 2 Data of Vancouver region, Canada – Subset_2_RS2-SLC-FQ15- DES-06-May-2008_14_Intensity_HH:- Single Look complex Data with Horizontal Polarized Intensity image is used.

To evaluate the performances of the proposed system several comparisons have made based on different parameters. The visual results of both the domain has showed in fig.(6-9).It is clear that IABC impact on the NSCT domain (Proposed) produces good results when compared to other segmented results.



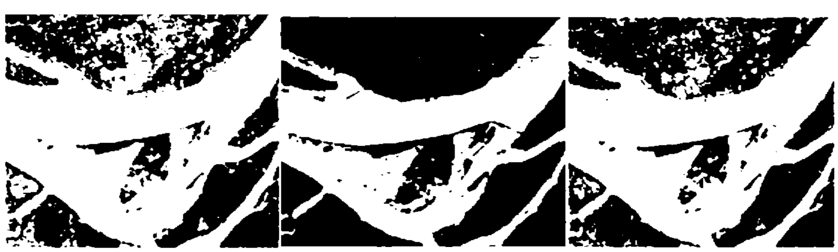
a) IABC b) PSO c) GA

Fig.6 visual segmented results for the NSCT Domain for data set A.



a) IABC b) PSO c) GA

Fig. 7 visual segmented results for the wavelet Domain on dataset A



a) IABC b) PSO c) GA

Fig. 8 Visual segmented results for the NSCT Domain on dataset B

a) IABC b) PSO c) GA

Fig. 9 Visual segmented results for the wavelet Domain on dataset B

The Table 1 represents the result of threshold which is obtained through the experiment carried out. It is observed that the threshold values have a consistency at different iterations.

The convergence time analysis is performed on the proposed framework against the other. The Table 2 represents the quantitative analysis of the method analyzed using time convergence. This is computationally high due to the parameters of IABC. The impact of this computation method over the other algorithms is depicted through the graph fig.10.

Table 1 Threshold value table obtained for the algorithms applied in both the domain

Wavelet Domain			**NSCT**		
IABC	PSO	Genetic Algorithm	IABC	PSO	Genetic Algorithm
98	67	67	119	99	89
96	64	67	116	97	86
98	64	69	118	99	86

Table 2 The qualitative analysis of the method is analyzed by the convergence time which is described through the following table

Wavelet Domain (in secs)			**NSCT (in secs)**		
IABC	PSO	Genetic Algorithm	IABC	PSO	Genetic Algorithm
742	92	3.72	2310	414	3.68
790	78	15	2100	392	14
810	85	8.25	2563	380	6.48

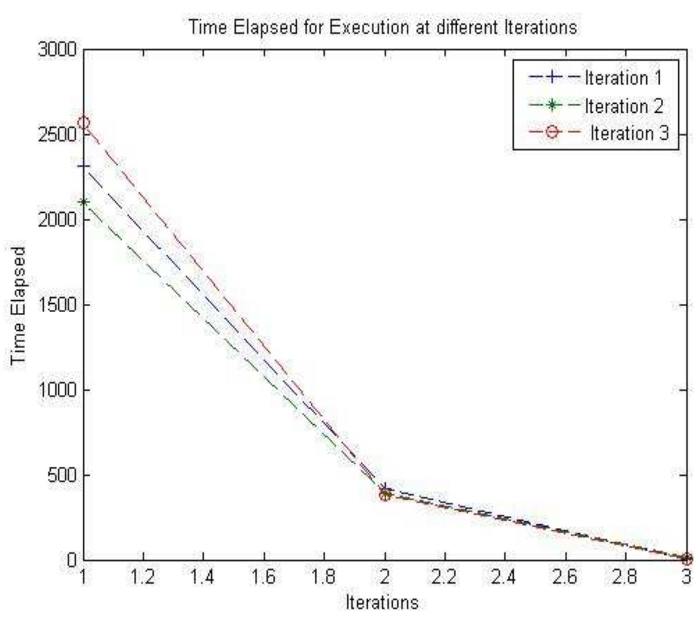


Fig.10 Time Elapsed for the Execution

The qualitative analysis of proposed system is evaluated by two parameters ENL and SSIM. It is calculated for the both the domains and shown in the Table 3 and Table 4 respectively. The impact of IABC over the other swam optimization algorithms on proposed system is depicted through graphs which are shown in fig.11.

Table 3 The qualitative analysis for the output is analyzed by the ENL

Wavelet Domain (ENL)			**NSCT (ENL)**		
IABC	PSO	Genetic Algorithm	IABC	PSO	Genetic Algorithm
2.3236	1.5348	1.1307	3.1334	2.4454	2.1501
2.2459	1.6561	1.2095	3.2004	2.5326	2.1723
2.3658	1.5985	1.1326	3.1869	2.4568	2.1658

Table 4 The qualitative analysis for the output by the SSIM

Wavelet Domain (SSIM)			**NSCT (SSIM)**		
IABC	PSO	Genetic Algorithm	IABC	PSO	Genetic Algorithm
.6782	.6969	.6969	.6163	.6235	.6299
.6754	.6969	.6948	.61.2	.6265	.6299
.6725	.6958	.6969	.6125	.6249	.6255

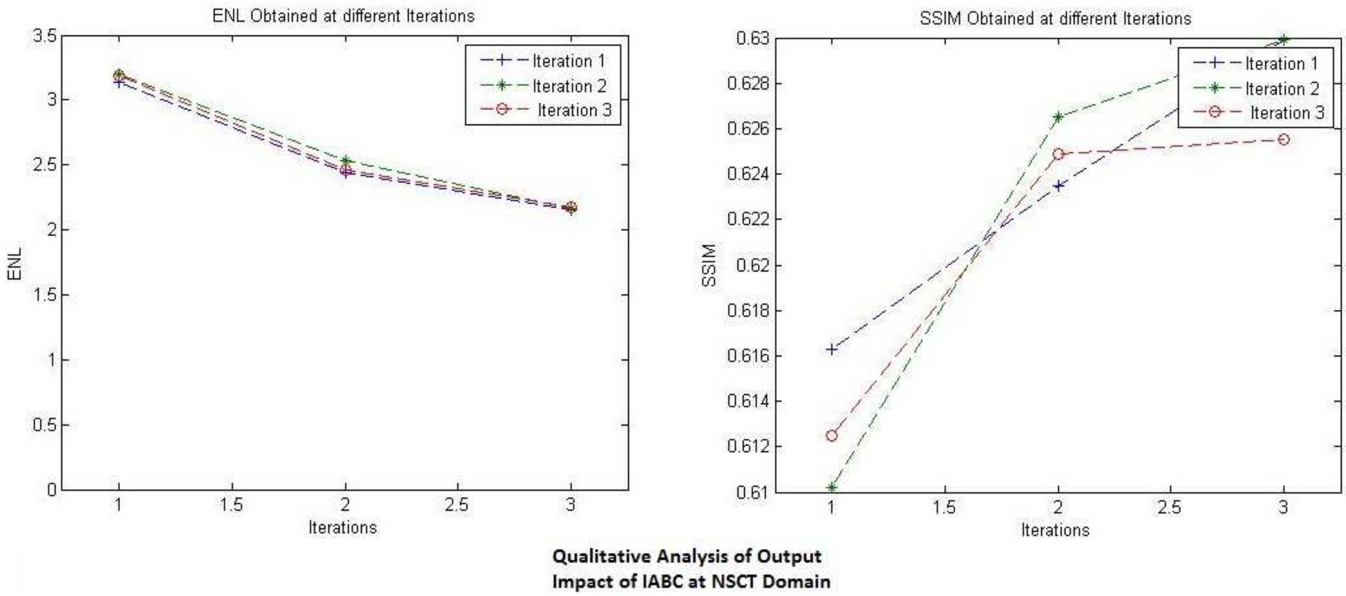


Fig. 11 IABC impact in the NSCT against other algorithms are depicted as graph

By the experimental study it is concluded that this proposed system provides promoting results which can be used for further processing. The results which are obtained through the framework are consistent. The segmentation result of SAR image is good visually as well as on the basis of statistical quality content. The segmentation of the image is not impacted by the speckle because of the properties of NSCT which are discussed at the earlier stages eqn (1-8). The NSCT played an important role to overcome the coherent property of the speckle by its continuity and multidimensionality property.

The IABC role is very important in getting the optimal value and it is been achieved. The IABC is having higher probability of achieving optimal values which is explained in eqn (9-18). The presented system is based on the eqn (1-18)to get the full advantage of NSCT Domain and IABC in Segmentation of SAR imagery.

7.Conclusion

In this paper, Benchmark framework for segmentation based on NSCT and IABC algorithm for SAR imagery is developed. The results were tested with other algorithms and comparative study has been made against other systems. The results show that the proposed system produces high performance results with high robustness against the multiplicative noise. Hence the developed system can be a good alternative for images which are corrupted by multiplicative noise for segmentation. Though the computational cost for this algorithm is high; in future it can be solved by using GPU's for real time processing.

Acknowledgement:

The authors would like to express their sincere thanks to Dr.Manjunath Bhandary, founder Bhandary foundations Mangalore for his constant support and motivations.

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