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Iceberg Identification of PolSAR Image by HSI Plane Generation and Band Coefficients Consideration

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***Abstract*—Iceberg identification becomes an important and challenging task for the marine traffic control and various offshore operations because of the heavily heterogenous nature of the images. Icebergs exhibits different polarimetric behaviours depending on the various scattering mechanisms.SAR images are very useful for iceberg identification since they do not depend on solar illumination and are available in all weather conditions independent of cloudiness.Specifically,PolSAR images are used because they are free from speckle noise and they have extremely good spatial resolution.In this paper,we put forward a new method of identification of SAR images by the combination of two different polarizations namely co-polarization(HH)and cross-polarization(HV)followed by a HSI plane generation and by the consideration of band coefficients.The objective is to improve the quality of iceberg detection using radar polarimetry for safe and efficient marine operations.**

***Index Terms*—SARimage,PolSAR,co-polarization ,cross-polarization.**

INTRODUCTION

Syntheticaperture radar (SAR)images gives the information of microwave reflectivity of the Earth's surface[1].SAR instruments provides most valuable informations for monitoring polar regions as they do not depend on the solar illumination and can operate in all weather conditions independent of cloudiness.In SAR images icebergs normally appear as bright targets(but not always).Icebergs exhibits different behaviours depending on the type of the scattering mechanism.In most of the cases the major portions aredominated by volume scattering or multiple reflections.It is highly difficult to interpret the signal contrast between icebergs and background clutter using single polarized SAR images[2]-[4].The advanced SAR technology provides images with very high resolution and quad-polarization data.

Polarimetric synthetic aperture radar(PolSAR) is the advanced type of imaging radar used for the continuous long term monitoring of the environment[5].The data contains informations of four different channels including two co-polarization(HH/VV) and two cross-polarization channels(HV/VH),the two letters corresponds to the polarizations of transmit and receive signals.H corresponds to horizontal and V for vertical polarizations respectively.When compared to the conventional radar system PolSAR imagery have several advantages like extremely good spatial resolution,all-time and all weather working capability and the efficient extraction of the surface features etc.Thesuperiority of these PolSARimages are fully exploited in the applications such as soil moisture/roughness estimation[6],wetland mapping[7],land cover classification/change detection [9]and ship and oil spill detection[10]-[11].

Speckle noise filtering is one of the key features of PolSAR image .Speckle is a special type of granular noise produced primarily due to the interference of returning wave at the transducer aperture which degrades the quality of images obtained from various radars used in long term real time applications.Speckle noise appears in the image as bright and dark spots which causes difficulties in image interpretation. The process of PolSAR speckle filtering includes locating pixels of similar scattering property followed by certain statistical estimation processes. [8] discussed about the issue of intuitive frontal area/foundation division in still pictures is of awesome down to earth significance in picture altering. They maintain a strategic distance from the limit length predisposition of chart cut strategies and results in expanded affectability to seed situation. Another proposed technique for completely programmed handling structures is given taking into account Graph-cut and Geodesic Graph cut calculations.

SAR imaging is one of the major strategies in remote sensing where the images are segmented based on the similarity or discontinuity. The major challenge in SAR imaging is the speckle noise challenge. Some of the popular existing techniques of SAR image segmentation are ABC (Artificial Bee Colony),Watershed transformation process and the level set approach model.

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I. PRELIMINARIES

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A. Polarization

A single target in time/space has a fixed polarization and can be characterized with a matrix normally termed as scattering matrix S.The matrix is usually represented as follows

$$[S]=\begin{bmatrix} HH & HV \\ VH & VV \end{bmatrix} \quad (1)$$

Where H denotes linear horizontal and V corresponds to linear vertical.The diagonal elements are referred as co-polarization channels and the off diagonal elements are the cross-polarization channels.Based on the number of polarization in the scattering matrix it is called as single ,dual or quad polarized data.Each pixel in the data corresponds to specific polarimetric character.So filtering(averaging) is performed for retrieving the meaningful data.

The complex vector representation of a polarimetric data can be expressed as

$$k=[S_{hh}, \sqrt{2S_{hv}}, S_{vv}]^{T} (2)$$

where h and v denotes the horizontal and vertical polarization states and T corresponds to the transpose matrix.
In precise ,the complex vector can be expressed as

$$k=\{k_{1,}k_2, k_3 k_4 \dots . k_n\}^T \quad (3)$$

where n is the number of channels that are polarized.The Covarience matrix of multi-look PolSAR data point can be expresses as

$$C=1 \div N \sum_1^N k_i {k_i}^{*T} (4)$$

where * denotes the complex conjugation matrix.

II. PROPOSED SCHEME FOR DUAL POLSAR IMAGES

The polarimetric property of the icebergs are effective in the detection of mainly smaller icebergs.The radar satellites (eg.RADARSAT-2,ALOS-2,TanDEM-X and Sentinel-1)provides dual polarization datas of very large swaths.So a new scheme which combines the HH and HV polarized intensity is proposed here for the detection of smaller icebergs.In the process of iceberg detection,the obtained images are first classified into open water,sea ice and icebergs based upon their back scattering coefficients.

Here a dual polarized scheme is proposed for the iceberg detection.In a dual polarized scheme the intensity data from the any of the two polarized channels)is selected from the quad polarimetric information((HH,HV,VH,VV).Here mainly HH and HV polarized intensities are used.

In the proposed scheme the detection is achieved by considering the band coefficients and the creation of an HSIplane.The band coefficents represents the intensities of image in dual polarized channels followed by the gradient operation and edge extraction methods.In PolSAR images several decomposition techniques are employed to identify the scattering mechanism.Some of them are Freeman-Durden decomposition and H/A/Alpha decomposition[12].

The algorithm uses only two intensities namely HH and HV.Here an FQ19 quad polarized SAR image is used for testing the algortithm.

A.Algorithm

input;(dual polsar plane(HH,HV),(Band coefficients (HH,HV))
d=dimension of polsar image(d= 4)
for i 1:max d
for j 1:max d
A[ij]=mean[polsar image]
B[ij]=correlation [PolSAR image,PolSAR band coefficient image]
End
End
I_{INV}=[eye d+2*t*λ*A]^-1
α=I_{INV}[α*2*t[maxα]+2*t[1*b]]
where α, t, λ are constants

III. MODULES

1) Band coefficients

Band coefficients are calculated from the image which represents the intensities in each pixels.The schemes achieves the desired detection with the use of this estimated band coefficients preceded by the standard image processing steps.Gradient operations are performed in the image preceded by the algorithm execution.The gradient and morphological operations are followed by an angular cosine transformation.

Edge extraction techniques such as otsu and canny operations are applied to the image followed by the basic image processing steps.The major edge extraction techniques used here are otsu and canny methods.

Band coefficients computation is to find the image property of the polsar image which cannot be obtained from the dual polsar image information. Coefficient values are obtained from the coefficient estimation of all quad planar information which is further used in HSI plane generation for efficient boundary computation.Along with the pixel level analysis the band coefficient consideration includes behavioral estimation of each polsar plane.The work considers dual PolSAR image information but the coefficient consideration is chosen for quad plane information of polsar image.

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$$\text{Band coefficients}=\sum \;[H_H H_V V_H\, V_V] \quad (5)$$

where H_H, V_V are co polarized channels and H_V, V_H are cross polarized channels.

2) HSIplane

The conversion of the image from the RGB plane to a new HSIplane is the major step in the proposed scheme.The gradient operated edge extracted image and the band coefficient images are combined to produce a single image .This RGB image is converted to a HSIimage incorporated with several post processing enhancement techniques.Themain step of the proposed work the implementation of the HSI plane ,the conversion of RGB to HSI in the dominant adaptation scheme.H corresponds to the cosine angular value and its Euclidian distances of each RGB plane together.S plane conversion minimal values of RGB plane all together,I refers average values of these planes.The HSI conversion make use of the angular directional pixel average values,since the band coefficients taken under consideration.The equations as follows for the conversion of RGB to HSI.

$$\text{H}=acos\big((0.5*(r-g)+(r-b)\big)\,/\,\sqrt{(r-g)^2+(r-b)+(g-b)} \quad (6)$$

$$\text{S}=1-\sum_{MIN}(r+g+b) \quad (7)$$

$$\text{I}=(r+g+b)/3 \quad (8)$$

Fig.1.Original image

IV. RESULTS

The FQ 19 beam is processed for the detection of icebergs .The original image is converted to a dual polarized image followed by number of post processing techniques for the detection.The images obtained in several steps are shown below.

A. The HH and HV image

The image is first converted into two different polarizations namely HH and HV where H corresponds to the horizontal polarization and V corresponds to the vertical polarization.

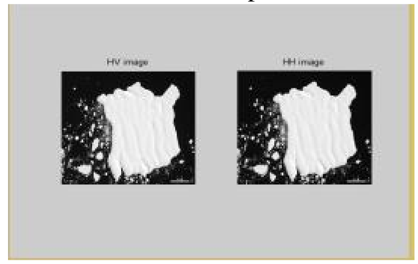

Fig2.The HH image and the HV image

B. HH Band image and HV band image

The band coefficients are obtained from the HH image and the HV image

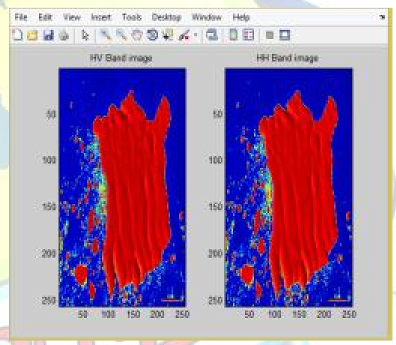

Fig3.The HH band image and HV band image

C. Edge extracted image

Edge extracted images are obtained by the otsu and canny methods.

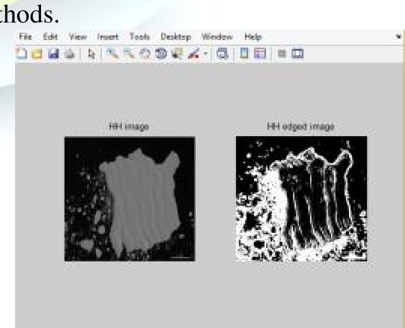

Fig4.Edge extracted image

Dual polarized image

The HH image and HV image are combined to produce the dual polarized image.

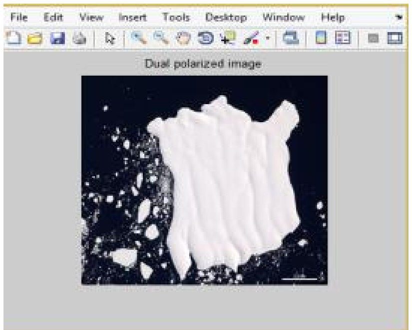

Fig5.Dual polarized image

D. Iceberg detected image

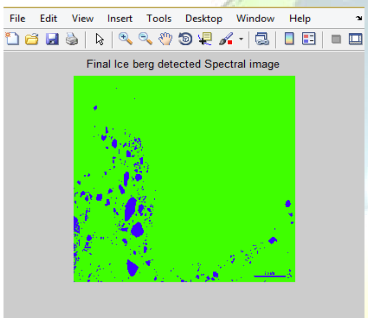

Fig6.Iceberg detected spectral image

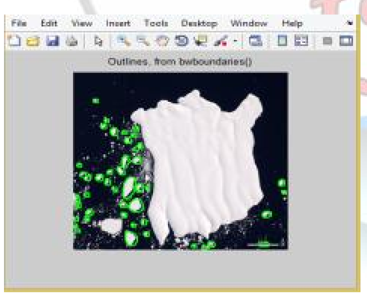

Fig7.Boundaried output

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V. CONCLUSION

A new scheme for the detection of icebergs using dual polarized images is proposed This approach fordetection is carried out by using a FQ 19 image by considering the band coefficients and an HSI plane generation.The results are obtained with the use of the two polarized ie,Dual polarized image.

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