A Review on Sea Ice Floe Analysis

Mandeep Kaur[1], Gagandeep Singh[2]

[1]'Department of Electronics and Communication System, Chandigarh Engineering College Landran

[2]'Department of Electronics and Communication System, Chandigarh Engineering College Landran

Abstract: ***Sea ice mapping is one of the important applications of remote sensing technology. Remote sensing is safe navigation for ships where ice caps are form and it is essential to understand the climate conditions of the oceans. The main function of ice mapping is to generate the maps of sea ice according to their geographical location. This paper reviews most of the recent research work on Sea ice floe and various algorithms are discussed in the Literature.***

Keywords*:* *SAR, segmentation, RADARSTAT, MIRGS.*

1. Introduction

Sea ice coverage varies seasonally, covering up to ten percent of the ocean's total area at its greatest amount. Consequently, the formation of sea ice serves to act as an environmental indicator of the local seasonal climate. Also, the growth of sea ice is significant because of the biological communities that rely on the ice to thrive. By studying the processes that are related to ice formation, we can better understand the factors that may affect its seasonal growth. In general, sea ice forms by the collision and grouping of pancake ice caused by ocean waves, and it is necessary to be able to model the floe's motion under wave action.

The sea ice cover has a effects on the Earth's climate system in different ways. It limits the exchange of heat, moisture, and momentum across the ocean-sea ice-snow-atmosphere interface. Remote sensing is safe navigation for ships where ice caps are form and it is essential to understand the climate conditions of the oceans. The main function of ice mapping is to generate the maps of sea ice according to their geographical location. It also mentioned its different development stages and its properties. For image data RADARSTAT 1 is the main source and later on RADARSTAT 2 (R2) is main source for sea ice mapping. R2 is the enhancement in R1 offered by Canadian SAR (synthetic aperture radar). R2 has better spatial resolution and ahs some additional feature like imaging mode which discriminate water from ice better than R1.

R2 is a relatively new satellite and tiny work has been done on evaluating the actual value of these expected enhancements. Moreover, current operational sea ice maps are formed by human analysts with visual inspection of the image data. This process is rather subjective as different ice analysts can produce different results given the same data set. It is also extremely difficult for humans to produce a highly detailed, pixel-level accurate ice map in an operational setting due to the workload involved.

1.1 Image Segmentation

Image segmentation is the process of partitioning the images into different types of regions. A region is collection of pixels of similar properties. The properties of the images include its gray level, texture, motion etc. There are two regions of image segmentation are as follow:

- Region Segmentation
- Edge Segmentation

- **Region Segmentation:** In region segmentation, the pixels of the same objects are grouped and marked to indicate the formation of the region. The pixels may be assigned to the same regions if they have same intensity values and close to one another. Edge canary operators are used in it.
- **Edge Segmentation:** In edge segmentation, it analyzes the gray value level of distribution and gives value them according to the level of gray scales.

1.2 Synthetic aperture radar (SAR)

SAR is capable of day-night and all weather atmospheric penetration in practically all conditions using active microwave sensing. SAR aerial and satellite platforms are able for regularly capturing information at satisfactorily sufficient resolutions for the purposes of sea ice discrimination resolution. SAR sea ice images are interpreted using unsupervised segmentation. SAR imaging is the one of the most important source of the sea ice mapping. TO understand the concept of SAR knowledge of R2 is necessary.

The system consists of a spacecraft with the SAR apparatus moving along an orbital track, which traces out the orbital ground track along the Earth's surface. The SAR system emits microwave pulses at the Earth's surface. The antenna lengths required to build high resolution images that are too large to begin into orbit for traditional RADAR. SAR solves this problem by using signal processing techniques and the activity of the spacecraft to generate the effect of a larger antenna, giving rise to the synthetic aperture. The motion of the spacecraft also allow the field of view to be advanced in the direction of motion so that two dimensional SAR images of the surface can be generated. SAR systems can transmit and receive EM energy in different polarizations. Polarization refers to the orientation of the electric field component of the electromagnetic wave. Different ice types have unusual backscatter characteristics that can be measured by SAR, since each ice type differs in factors such as surface roughness, volumetric structure and salinity.

1.3 RADAR 2 Capabilities and data

The most important development provided by R2 for operational sea ice mapping is the dual-polarization Scan SAR Wide mode. This mode combines the same 500 km swath width as R1's single polarization. Scan SAR mode with the supplementary information provided by dual-polarization imaging. The European Space Agency's ENVISAT Advanced SAR (ASAR) also provides dual-polarization data but only has a swath width of 100 km. Scan SAR Wide has a pixel resolution of 100 m x 100 m, with a pixel spacing of 50 m x 50 m. A full SAR scene is hence approximately 10000 x10000 pixels. Recently we will focus on investigating the use of R2 dual-polarization data from its Scan SAR Wide mode since it will be the model used for sea ice monitoring. The HH channel provides the same data as R1, but there is the addition of the HV channel is expected to improve the unfairness of ice and water, particularly water that has been wind roughened, which looks very similar to some types of ice in the HH channel at small incidence angles. The dual-polarization mode of R2 provides additional features unavailable from R1 to distinguish the different ice types. It should therefore be able to improve the image segmentation results obtained with automated algorithms.

2. Review of Literature

Gui Gao, Gongtao Shi and Shilin Zhou, "Ship Detection in High-Resolution Dual-Polarization SAR Amplitude Images" IJAP, 2013

In this paper they introduced [1] a CFAR detecting method which aiming adaptive detection of a ship only when high resolution dual polarization SAR amplitude is available. First of all they design a novel PMA detector, which can improve the signal-to-clutter ratio and make the discrimination of a ship from clutter more easily. Meanwhile, the PMA detector's statistical model has been described by the well-known G0 distribution when facing complex sea background.

Yuliya Tarabalka et.al "Shape-Constrained Segmentation Approach For Arctic Multiyear Sea Ice Floe Analysis" IEEE, 2012

In this paper they designed [2] a new TempoSeg method for multi temporal segmentation of multiyear sea ice floes from the MODIS data. The proposed technique is based on shape-constrained best merge region growing, and it segments each image from a time series into Floe and Background regions. They have applied this method to a set of MODIS images acquired in August-October 2008 and successfully estimated both an area and a perimeter of the floe of interest over the given time period.

Pham, Tuan D. "Image texture analysis using geostatistical information entropy" in IEEE 2012

In this paper author studied [3] and proved that the extraction of effective features of objects is an important area of research in the intelligent processing of image data. A well-known feature in images is texture which can be used for image description, segmentation and classification. A novel texture extraction method using the principles of geostatistics and the concept of entropy in information theory. Experimental results on medical image data have shown the superior performance of the proposed approach over some popular texture extraction methods.

Ehmann, J. "Structural Texture Similarity Metrics for Image Analysis and Retrieval" in IEEE 2013

In this paper , author developed [4] new metrics for texture similarity that account for human visual perception and the stochastic nature of textures. The metrics rely entirely on local image statistics and allow substantial point-by-point deviations between textures that according to human judgment are essentially identical. The proposed metrics extend the ideas of structural similarity (SSIM) and are guided by research in texture analysis-synthesis. We conducted systematic tests to investigate metric performance in the context of known-item search, the retrieval of textures that are identical to the query texture. This eliminates the need for cumbersome subjective tests, thus enabling comparisons with human performance on a large database.

Bernd Scheuchl et.al, "Potential of RADARSAT-2 data for operational sea ice monitoring", CJRS, 2004

In this paper they introduced [5] Synthetic aperture radar (SAR) data from RADARSAT-1 are an important operational data source for several ice centres around the world. Whereas RADARSAT-1 is only capable of acquiring data at a single polarization, RADARSAT-2 will be capable of acquiring dual-polarization data in many wide-swath modes and fully polarimetric SAR data in a narrow 25-km swath mode. In this paper, we consider the ice information requirements for operational sea ice monitoring at the Canadian Ice Service and the potential for RADARSAT-2 to meet those requirements. Primary parameters are ice-edge location, ice concentration, and stage of development; secondary parameters include leads, ice thickness, ice topography and roughness, ice decay, and snow properties.

3. Problem Formulation

SAR imaging is used for mapping of the ices. SAR sea ice images are interpreted using unsupervised segmentation. For image source RADARSTAT 1 is the main source. But it has some disadvantages that its results were not accurate. So for accuracy automated algorithms were developed for radar 1 for better results. These updations were not satisfied so enhancement in RADARSTAT 1 was required known as RADARSTAT2. Now RADARSTAT 2 provided better results than RADAR 1 in the form of image position, its density etc. The existing algorithms of RADARSTAT1 are not as much compatible with RADARSTAT 2 as expected for better, accurate and efficient results of ice images.

4. Proposed Work

In this proposed work, we are working on pixels based algorithms which will gives précised results for analysis. Our work is based upon region based segmentation which will give better than exiting algorithms in the form of property of ice, color density and geographically position type of the sea ice. Proposed work can be achieved in different steps:

1. By implement automated algorithm based upon region segmentation.
2. Enhancing the accuracy of ice sea segmentation by finding pixel value more accurately and precise results

and then analyze the results of RADARSTAT 2 for analyzing the geographical position type and properties of the sea ice.

5. Research Methodology

Co-occurrence matrices M represent the probability of finding two pixels with a certain gray value and a certain oriented distance between them. An image is divided into many subimages or windows w x w among which the matrices will be computed. The window size depends on the texture itself and has to be sufficiently big as to capture the texture properties. For an image with N gray levels, the associated co-occurrence matrices (for each window) will be of size NxN ranging in each column and row from 0 to N-1. Each of the elements of the matrix will be called mij, where i and j describe the row and column position respectively. Then, a certain "rule" that describes the distance and orientation between two pixels, the selected one and its neighbor, in the window is given. The orientation is usually 0°, 45°, 90° and 135°, as shown in Figure 1. different orientations.

Once the co-occurrence matrix M has been computed, the statistics related to it are obtained. The statistics used in this work were the energy, homogeneity, contrast and entropy, which, using the previous notation.

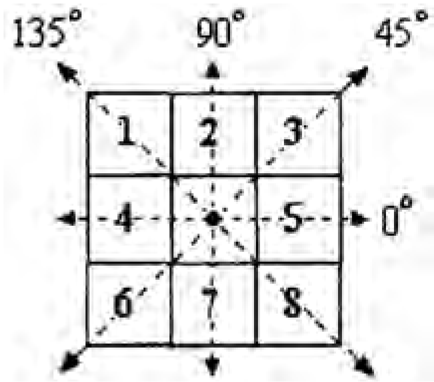

Figure 1: Neighbors of a pixel

6. Multivariate Investigate Growing Region (MIGRS) Algorithm

Multivariate Investigate Growing Region with Semantics (MIGRS) algorithm MIRGS is an automate ice sea mapping algorithm which is used to find out the accurate results. MIRGS was considered to work with one-channel single-polarization SAR imagery from the RADARSAT-1 satellite. After launch of RADARSAT-2, it has made available two-channel dual-polarization SAR imagery for the purpose of sea ice mapping. Dual-polarization imagery provides more information for distinguishing ice types and one of the channels is less sensitive to changes in the backscatter caused by the SAR incidence angle parameter. In the past, this change in backscatter due to the incidence angle was a key limitation that prevented automatic segmentation of full SAR scenes.

An evaluation of MIRGS with RADARSAT-2 data was performed and showed that some feature was lost and that the incidence angle caused errors in segmentation. Several data fusion schemes were investigated to determine if they can improve performance. Gradient generation methods considered to take advantage of dual polarization data, feature space fusion using linear and non-linear transforms as well as image fusion methods which are based on wavelet combination rules were implemented and tested. Tuning of the MIRGS parameters was performed to and the best set of parameters for segmentation of dual-polarization data. Results show that the standard MIRGS algorithm with default parameters provides the highest accuracy, so no changes are necessary for dual-polarization data. A hierarchical segmentation scheme that segments the dual-polarization channels separately was implemented to overcome the incidence angle errors. The technique is effective but requires more user input than the standard MIRGS algorithm.

7. Conclusion

In this paper we have simulated the behavior of various Algorithms on a realistic applications. The objective of this paper was to provide an overview of the architectures and the research activity of sea ice floe analysis. The proposed technique is based on shape-constrained best merge region growing, and it segments each image from a time series into Floe and Background regions. A hierarchical segmentation scheme that segments the dual-polarization channels separately was implemented to overcome the incidence angle errors. The MIRGS technique is effective but requires more user input than the standard MIRGS algorithm.

References

[1] Gui Gao, Gongtao Shi and Shilin Zhou, "Ship Detection in High-Resolution Dual-Polarization SAR Amplitude Images" IJAP, volume 3 issue 5, pp- 213-2-15, 2013
[2] Yuliya Tarabalka et.al "Shape-Constrained Segmentation Approach For Arctic Multiyear Sea Ice Floe Analysis", IEEE, 2012
[3] Pham, Tuan D. "Image texture analysis using geostatistical information entropy" IEEE 2012
[4] Ehmann, J. "Structural Texture Similarity Metrics for Image Analysis and Retrieval", IEEE 2013
[5] Bernd Scheuchl et.al, "Potential of RADARSAT-2 data for operational sea ice monitoring", CJRS, 2004.
[6] Kanchan S. Deshmukh, "Texture Image Segmentation using FCM" 012 IACSIT Hong Kong Conferences IPCSIT vol. 25 2012, IACSIT Press, Singapore.
[7] Waller, Ben M., Mark S. Nixon, and J. N. Carter. "Analysing Micro-and Macro-Structures in Textures." In Signal Image Technology and Internet Based Systems (SITIS), 2012 Eighth International Conference on, pp. 246-253. IEEE, 2012.
[8] Costa, Alceu Ferraz, Gabriel Humpire-Mamani, and Agma Juci Machado Traina. "An Efficient Algorithm for Fractal Analysis of Textures." In Graphics, Patterns and Images (SIBGRAPI), 2012 25th SIBGRAPI Conference on, pp. 39-46. IEEE, 2012.
[9] Marta, Antonio, " Models For Synthetic Aperture Radar Texture Analysis" IEEE, 2009
[10] Zujovic, Jana, Thrasyvoulos N. Pappas, and David L. Neuhoff. "Structural similarity metrics for texture analysis and retrieval." In Image Processing (ICIP), 2009 16th IEEE International Conference on, pp. 2225-

2228. IEEE, 2009

[11] R. Wolfe and M. Nishihama, "Trends in modis geolocation error analysis," in Proc. of SPIE - Earth Observing Syst. XIV, 2009, vol. 7452

[12] B. Scheuchl, R. Caves, D. Flett, R. Abreu, M. Arkett, and I. Cumming "ENVISAT ASAR AP data for operational sea ice monitoring" In Proc. IEEE,International Geoscience and Remote Sensing Symposium, volume 3, Sept. 2004

[13] B. Ramsay, D. Flett, H. S. Andersen, R. Gill, S. Nghiem, and C. Bertoia. Preparation for the operational use of RADARSAT-2 for ice monitoring. Canadian Journal of Remote Sensing, June 2004.

[14] P. Yu, "Segmentation of RADARSAT-2 dual polarization sea ice imagery," Master thesis, University of Waterloo, Ontario, Canada, 2009.

[15] P. Soille, Morphological Image Analysis, Springer-Verlag, Heidelberg, 2nd edition, 2003.

[16] Zhong, Y., Shen, H.H. (1994) "Drift of a Small Floe under Wave Action with and without a Reflecting Wave" Dept. of Civil and Environmental Engineering, Clarkson University