Leads Detection Using Mixture Statistical Distribution Based CRF Algorithm from Sentinel-1 Dual Polarization SAR Imagery

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Synthetic Aperture Radar (SAR) is significantly important for polar remote sensing since it can provide continuous observations in all days and all weather. SAR can be used for extracting the surface roughness information characterized by the variance of dielectric properties and different polarization channels, which make it possible to observe different ice types and surface structure for deformation analysis. In November, 2016, Chinese National Antarctic Research Expedition (CHINARE) 33rd cruise has set sails in sea ice zone in Antarctic. Accurate leads spatial distribution in sea ice zone for routine planning of ship navigation is essential. In this study, the semantic relationship between leads and sea ice categories has been described by the Conditional Random Fields (CRF) model, and leads characteristics have been modeled by statistical distributions in SAR imagery. In the proposed algorithm, a mixture statistical distribution based CRF is developed by considering the contexture information and the statistical characteristics of sea ice for improving leads detection in Sentinel-1A dual polarization SAR imagery. The unary potential and pairwise potential in CRF model is constructed by integrating the posteriori probability estimated from statistical distributions. For mixture statistical distribution parameter estimation, Method of Logarithmic Cumulants (MoLC) is exploited for single statistical distribution parameters estimation. The iteration based Expectation Maximal (EM) algorithm is investigated to calculate the parameters in mixture statistical distribution based CRF model. In the posteriori probability inference, graph-cut energy minimization method is adopted in the initial leads detection. The post-processing procedures including aspect ratio constrain and spatial smoothing approaches are utilized to improve the visual result. The proposed method is validated on Sentinel-1A SAR C-band Extra Wide Swath (EW) Ground Range Detected (GRD) imagery with a pixel spacing of 40 meters near Prydz Bay area, East Antarctica. Main work is listed as follows:

1) A mixture statistical distribution based CRF algorithm has been developed for leads detection from Sentinel-1A dual polarization images.

2) The assessment of the proposed mixture statistical distribution based CRF method and single distribution based CRF algorithm has been presented.

3) The preferable parameters sets including statistical distributions, the aspect ratio threshold and spatial smoothing window size have been provided.

In the future, the proposed algorithm will be developed for the operational Sentinel series data sets processing due to its less time consuming cost and high accuracy in leads detection.