Sea Ice SAR Classification Based on Edge Features

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The sea ice information in SAR images over the Baltic Sea is described by the backscattering strength in the uniform areas and by the edges in the deformed areas and between adjacent uniform areas. We at FIMR (Finnish Institute of Marine Research, which was joined to FMI and Finnish Environmental Institute from the beginning 2009) have studied the classification of sea ice SAR data over the Baltic Sea. Our current algorithms are based on segmentation of the SAR images and backscattering combined with simple textural features, such as local autocorrelation, used for discriminating sea ice and open water areas, and local variance or standard deviation as a measure of ice deformedness. These features only include second-order statistics. Our studies have shown that for the data, in the resolutions we use, second order statistics is sufficient in the uniform areas [1, 2]. We have also studied the use of higher-order statistics in SAR classification [1, 3] earlier. Here we represent a novel method for SAR texture classification, The technique is based on classification of the edges located in the SAR images. The edge detection can be performed by some edge detection algorithm, we have applied the Canny edge detection algorithm [4] here.

The basic features we compute are the directional edge strengths using the MPEG-7 edge filters [5], the amount of edge pixels within a given radius R from each (edge) pixel and the size of each edge segment. We apply the edge filters in multiple resolutions (three in our case) to yield the edge strength and direction at all the resolution levels. The multi-resolution image decomposition is generated by applying a half-band low-pass FIR filter designed for multi-resolution image processing [6]. We then derive some higher-level features from the computed multi-resolution basic features. One such higher-level feature is what we call edge type here. If the edge strength has about equal strenghtness at all the resolution levels, it is a clear sharp edge. On the other hand if the strenghtness increases from the higher resolution to the lower resolution the edge is smoother, and if the edge is strong only at high resolutions it is a small detail implicating smaller scale ice deformation. The edge type is defined by the ordering of the edge strengths at different image resolution levels. Another statistical edge measure is the value indicating how well-directed an edge locally is, i.e the relative amount of edge pixels with the same direction within a given radius R (i.e. the distribution of the direction within window of radius R and at different resolutions has a clear peak). We here call this feature (edge) directness. This statistics indicates how representative for the most common direction within R is.

These new features give us information on the structure of the ice field. In uniform areas edge strength and amount of edges have small, rather uniformly distributed values. In deformed fields the amount of edge pixels and edge strength give the basic information on how deformed the ice is. The local distributions of edge type, edge directness and edge segment sizes give additional information on the type of the deformed sea ice. We can for example distinguish between areas with clearly directed ridges and rubble fields, areas with both open water or new ice and ridged ice, and edges between uniform ice fields.

We show some examples of sea ice classification based on this novel method using Envisat ASAR data and Radarsat-2 ScanSAR data over the Arctic and the Baltic Sea. The classifications are performed in 100 m resolution, which is the resolution we use in deriving our operational sea ice products at FIS. Also the geophysical interpretation of the edge features for the test data is discussed.

References

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