Sea Ice SAR Data and Segmentwise Edge Features

Juha Karvonen (1)

(1) ***Finnish Meteorological Institute (FMI)***
PB 503, FI-00101 Helsinki, Finland, Email: Juha.Karvonen@fmi.fi

Sea ice types in SAR images are best described by the edges present in the images. The type and amount of edges give us information on the ice types, in addition to backscattering statistics. Here we present a classification scheme for sea ice SAR data, based on edge detection and edge-based features.

We first perform a speckle filtering, which is based on a simplified version of an anisotropic diffusion filtering. Then an intensity-based segmentation is applied in full image resolution (high resolution segmentation). Also lower resolution segmentations are produced. Two lower resolutions are used, we here call them the medium and the low resolutions, respectively. The two lower resolution segmentations are derived from the high-resolution segmentation by iteratively joining smaller segments to their neighboring larger segments. The condition for joining segments is based on a (dynamic) threshold for the contrast at the segment edge. This approach is different from the generally used down-sampling approach (multi-resolution pyramid), which leads to blurring of the segment boundaries at the lower resolutions.

Some segments in the full-resolution are actually small ice features or small uniform ice field details, the medium and low resolutions are more suitable for statistical classification of the segments. The classification resolution depends on the size of the elementary features. Three resolutions are necessary: the high resolution includes small ice details or features as single segments in addition to larger uniform ice segments, in the lower resolutions these small features are incorporated as parts of the segments, i.e. are features describing the segment contents. The medium resolution can be used for statistical classification based on pixel-wise edge features, and the low resolution can be used for classification based on larger-scale segment (edge) features (areal ice statistics).

The edges are located using the Canny edge detection algorithm.The edges can be divided into structured edges and random, structureless edges. Also the corner points detected by the Harris corner detection algorithm are used as pixel-wise elementary features. The amounts of corners and structured vs structureless edges given information of the local ice structure. Also the local amount of detected edges gives information on the local ice deformation. We also show that open water areas can be located based on these edge features.

The segment shape also gives information on the segment, e.g. ice floes typically can have polygonal or round shape, and ice ridges and cracks or leads typically are narrow but long segments, often they are not straight lines, however. The segment shape can be described by shape features based on the segment edges. The segment shape features in our approach are computed from the ordered edge points sampled along the edge. Then the object shape can roughly be characterized by the polygon defined by the sampled set of the edge points and multiple useful features based on this representation can be computed for the ice type classification.

We have collected C-band SAR data, both Radarsat and Envisat ASAR data over the Baltic Sea and also over the Arctic Sea areas for our studies. The data are Radarsat ScanSAR wide mode data and Envisat ASAR wide swath mode data. These data have a resolution of about 100 m and each image covers an area of about 500 km wide, thus suitable for operational sea ice monitoring. We show classification results over the Baltic Sea and over Kara sea, using our data sets, and compare the results with ice analyst interpretations.