Sea ice drift from SAR using feature tracking

Stefan Muckenhuber, Anton Korosov and Stein Sandven

contact: stefan.muckenhuber@nersc.no Nansen Environmental and Remote Sensing Center, Norway

Abstract A computationally efficient, open source feature tracking algorithm, called ORB (Oriented FAST and Rotated BRIEF), is adopted and tuned for sea ice drift retrieval from Sentinel-1 SAR images. The best suitable setting and parameter values have been found using four Sentinel-1 image pairs representative of sea ice conditions between Greenland and Severnaya Zemlya during winter/spring. The performance of the algorithm is compared to two other feature tracking algorithms (SIFT and SURF). Applied on a test image pair acquired over Fram Strait, the tuned ORB algorithm produces the highest number of vectors (6920, SIFT: 1585 and SURF: 518) while being computationally most efficient (66 s, SIFT: 182 s and SURF: 99 s using a 2.7 GHz processor with 8 GB memory). For validation purpose, 314 manually drawn vectors have been compared with the closest calculated vectors, and the resulting root mean square error of ice drift is 563 m. All test image pairs show significantly better performance of the HV channel. On average, around four times more vectors have been found using HV polarisation. All software requirements necessary for applying the presented feature tracking algorithm are open source to ensure a free and easy implementation.

Manuscript: http://www.the-cryosphere-discuss.net/tc-2015-215/ Sea ice drift algorithm: https://github.com/nansencenter/sea_ice_drift

ORB algorithm (Rublee et al. 2011)

Keypoint (red) detection: \geq 9 contiguous pixels of the surrounding circle (blue) have much lower intensity values than the centre

Orientation θ (green): direction to intensity weighted centroid

Patch (34x34 pixels): displayed area used for feature description

Feature: binary vector from 256 tests e.g. (yellow) $p(X) < p(Y) \rightarrow \tau(p; X, Y) = 1$



Algorithm tuning



Brute Force matching using Hamming distance e.g. $\vec{b_1} = 1011101$ and $\vec{b_2} = 1001001 \rightarrow d = 2$ Lowe ratio test: match is accepted, if $\frac{d_1}{d_2}$ < threshold

Validation

Manually drawn vectors (white)



Brightness boundaries for HH channel Brightness boundaries for HV channel Threshold for Lowe ratio test

[0,0.08] [0,0.013] 0.75

Comparison to SIFT and SURF





Tuned ORB (first column, 6920 vectors), SIFT (second column, 1585 vectors) and SURF (third column, 518 vectors) Panels: drift vectors (red, first row), number of vectors per grid cell (green, second row) and root mean square distance in km (red, third row).

Acknowledgement: IceMotion (RCN 239998/F50)