AUTOMATIC SHIP DETECTION IN SAR IMAGES USING AEGIR

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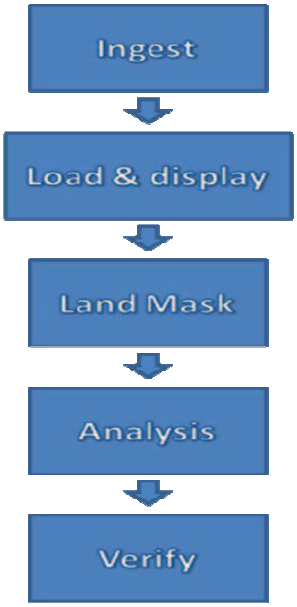
Norway has large economic and fisheries protection zones stretching from 56°N to 82°N, and has used SAR satellite images operationally for ship detection since 1998. SAR satelitte images ease the Coast Guard's task of maritime monitoring. A good automatic ship detection tool is desirable to do this task.

The paper presents the SAR marine imagery analysis tool Aegir, developed at the Norwegian Defence Research Establishment (FFI), and results of analysing SAR images using the tool. Aegir is written in the IDL language, and the name comes from Aegir who was the god of the sea in Norse mythology. The program is configured to run analysis on ENVISAT, RADARSAT-1, RADARSAT-2 and TerraSAR-X images. The general work flow of the program is shown below.



The data must be ingested before being analyzed further. The data is loaded and displayed onto the screen. A land mask is applied to the image data to generate possible land masks, and a masked file is produced.

Each of the major steps in figure 1 is carried out by corresponding modules. All the steps can either be done fully automatic or the user can choose to control it through a configuration menu.

The analysis includes a ship detection module, which has a

configuration menu. It contains a general section, a section for each of the target detection algorithms and a section for wake analysis. The operator can also enable or disable the wake analysis and confidence estimate procedures.

Two different threshold algorithms are used to do the automatic ship detection [3], N-sigma and K-distribution. The N-sigma algorithm is a very simple method to do ship detection. Each polarisation band is divided into squares of size M x M, which can be defined by the user. Each frame is used to extract standard deviation (σ) and mean value (μ). The threshold is N standard deviations above the mean value. The K-distribution algorithm is more sophisticated. A threshold value is here estimated based on the Probability Density Function (PDF), which is adapted to the data [2].

The output data is polarisation, size (number of pixels), peak value, target position, estimated ship length, estimated ship beam, estimated heading and detection confidence. The detected targets are plotted as symbols in the SAR image. If AIS data are available, the AIS position is also plotted as symbols overlaid the SAR image [4].

The two algorithms have been tested on a series of ENVISAT ASAR AP images [1], [2]. The research indicates that the N-sigma method performs better for cross-polarised data than for co-polarised data, both in terms of successful detections and false alarms. The false alarm ratio and the successful detection rate are both lower using the K distribution algorithm. The paper presents test results from a large data set using RADARSAT-2 ScanSAR Narrow and Wide images that have been acquired over the Malangen and Tromsøflaket areas outside the northern Norwegian coast.

Fusion of the different polarisation channels are also done to see how the different information can be used to best being able to detect ships and to suppress the ocean clutter.

[1] Arnesen, T. og R. Olsen (2004). *Vurdering av ENVISAT ASAR for skipsdeteksjon. FFI-rapport 2004/02121.* Norwegian Defence Research Establishment.

[2] Brekke, C. (2009). *Automatic ship detection based on satelitte SAR. FFI-rapport 2008/00847.* Norwegian Defence Research Establishment.

[3] Rey et al (1996). *A search procedur for ships in RADARSAT imagery (U).* Defence Research Establishment Ottawa, Report No. 1305.

[4] Weydahl et al. (2007). *Ship traffic monitoring using satellite SAR images in combination with AIS reports.* Proceedings of SPIE 2007, Firence, Italy, vol. 6749, 7 pages.