Velocity Estimation of Moving Ships using C-band SLC SAR Data

Andrea Radius (aradius@deetc.isel.ipl.pt) , Paulo Marques (pmarques@isel.pt)

ISEL – Instituto de Telecomunicações – IT, Lisbon, Portugal

Abstract

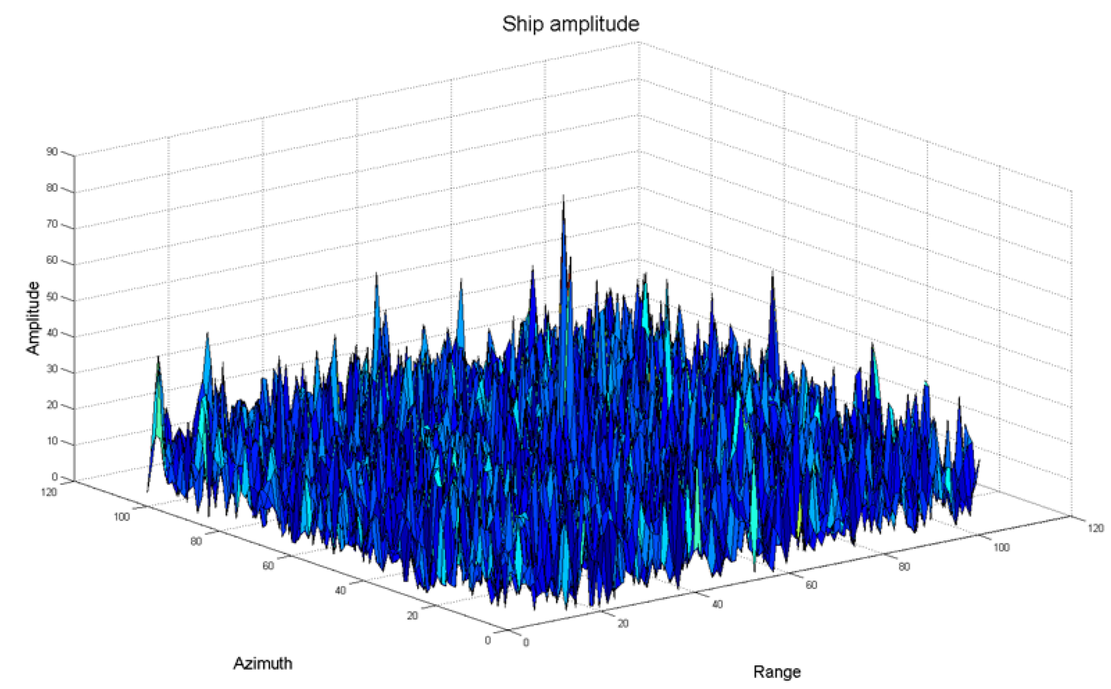
- A novel methodology, based on Spectral Signature analysis and orientation for ship velocity estimation

- Advantages:
  - Uses easily available Single Look Complex SAR data
  - Light from the computational point of view
  - Does not require *a priori* information
- Limitations:
  - Bad accuracy with small boats – orientation is difficult to estimate
  - Low accuracy for small relative range velocity

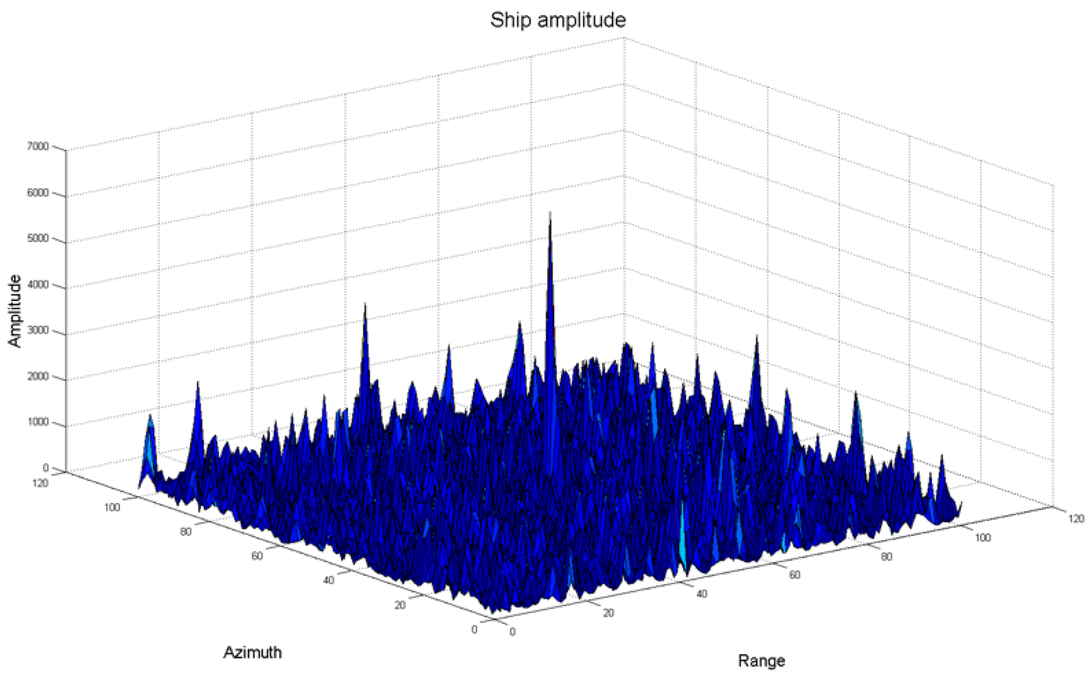
Pre-filtering and Ship Detection

- Pre-filtering is performed using a dedicated azimuth sub-aperture combination, in which three partially overlapped sub-apertures are combined through interferometric processing

Original SLC image containing a boat on rough sea

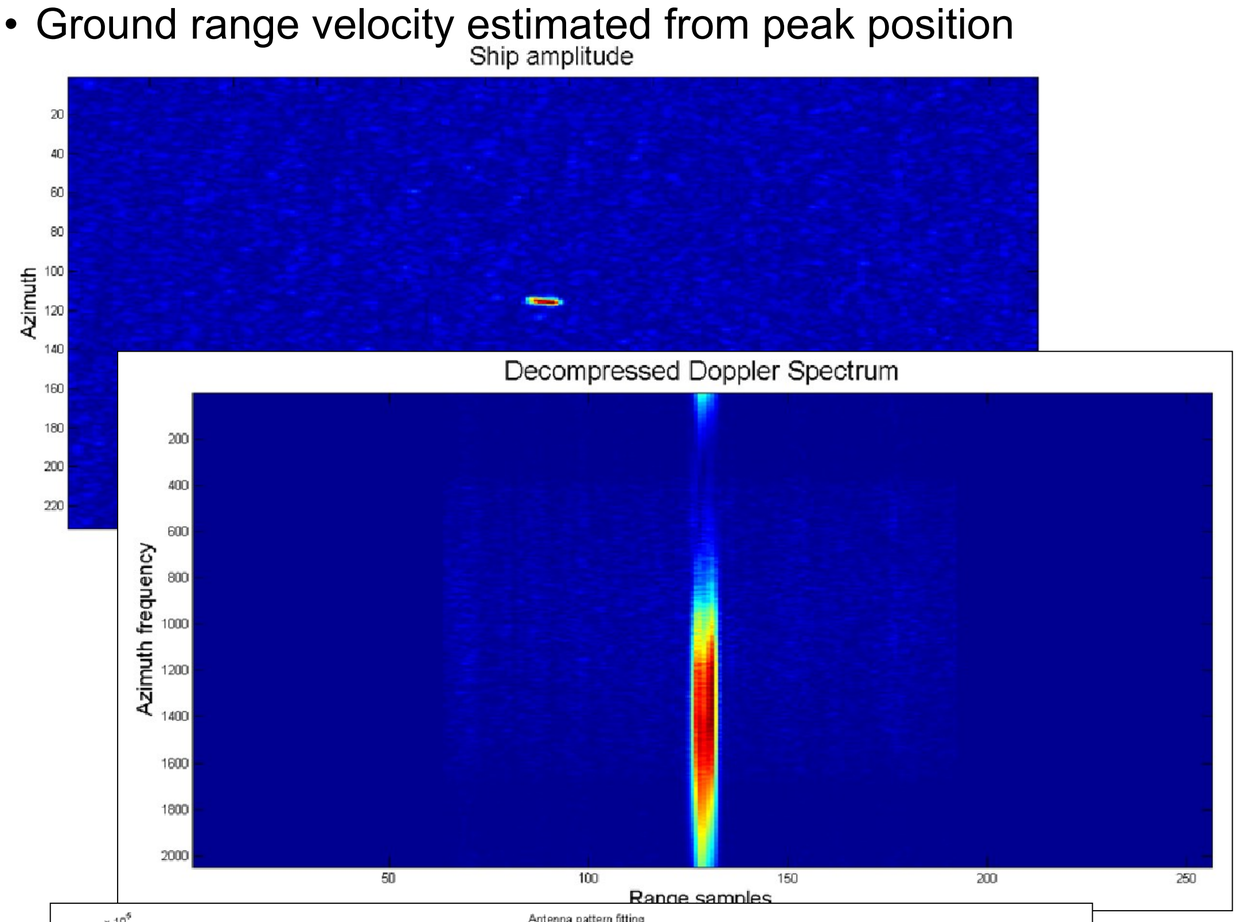


Filtered SLC image containing a boat on rough sea



Velocity Estimation

- Range velocity estimation from amplitude of the target Doppler spectrum
- Spectral signal energy is obtained by calculating the mean of two sub-sampled sub-apertures in range direction such that the spectral energy is concentrated along the same azimuth line, overpassing the residual range migration of the moving target.
- Spectral peak position estimation by fitting the spectrum with the sinc squared function.
- Ground range velocity estimated from peak position



- Azimuth velocity is estimated using the range velocity and ship orientation estimation

Simulation Results

TABLE I. PRELIMINARY RESULTS OF THE VELOCITY ESTIMATION

L (m)	SCR (dB)	Φ (°)	V_{rg} (m/s)	V_{az} (m/s)	$\bar{\Phi}$ (°)	$\bar{V}_{rg}$ (m/s)	$\bar{V}_{az}$ (m/s)
30	31.6	90	10	0	90	10.3	0
30	24.8	49.1	7.6	6.5	45	6.7	6.7
50	33.7	67.3	7.4	3.1	72.3	6.2	3.8
50	28.3	67.3	11.1	4.6	60.6	10.7	6
50	28.7	112.7	10.1	-4.3	120.8	8.8	-5.3
50	29.8	117.7	10.3	-7.9	116.7	7.9	-5.9
35	21.9	112.5	12.7	-8.1	130.8	10.6	-12.3
45	30.7	124.3	12.4	-8.4	112.7	11.1	-7.1

- Mean square error of range velocity, azimuth velocity and orientation estimation are, respectively 11.5%, 11.3%, 16.3%