FOCUSING SYNTHETIC APERTURE SONAR (SAS) DATA WITH THE OMEGA-K TECHNIQUE

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ABSTRACT

Synthetic Aperture Radar (SAR) provides high resolution micro-wave reflectivity maps of the earth surface by coherently combining echoes along a large virtual antennas array formed by a short real antenna mounted on a space-borne or air-borne platform moving along an almost rectilinear trajectory. The Omega-K technique is a computationally efficient phase preserving focusing technique for interferometric application that has been successfully “imported” from Geophysics to the SAR field more than 20 years ago [1]. Similarly to SAR, a Synthetic Aperture Sonar (SAS) system provides high resolution acoustic reflectivity maps of underwater areas by coherently combining echoes along a large hydrophones virtual array. The Omega-K technique can be then modified and integrated with dedicated processing steps to provide a precise phase preserving SAS focusing technique for testing repeat pass interferometric applications.

The main difference of SAS with respect to SAR as far as focusing is concerned, is its peculiar bi-static nature. Typical operational SAS systems are formed by a single transmitter and a short linear real array of receiving hydrophones both mounted on an underwater platform that can be either towed or autonomously moving along a nominal linear trajectory [2].

The echoes of a single transmitted “ping” collected by the real array can be focused by means of the Omega-K technique using the so called “exploding reflectors” equivalence. In the bi-static SAS configuration, however, the full propagation velocity should be considered instead of the equivalent half propagation velocity adopted in the monostatic SAR case. Moreover, the virtual reflector explosion time depends on the reflector-receiver distance (as in the monostatic SAR case) and also on the along-track relative reflector-transmitter position.

Sub-aperture focused images carried out independently for each transmitted ping should be then coherently combined to get the full aperture resolution image.

The key step that allows the correct coherent combination of multiple sub-aperture images is the platform motion estimation and compensation passing from one ping to another. This step can be accomplished by exploiting both the available navigation data and by inverting the inter-ping interferometric phase pattern when the imaged spectra of consecutive pings partially overlap.

In this paper the modifications of the Omega-K technique that are necessary to focus bi-static SAS data will be discussed in detail. Results achieved by means of the proposed SAS focusing technique will be analyzed by showing simulated and real data available in the framework of a cooperation project with the Nato Underwater Research Center of La Spezia (Italy). Software for sonar data deformatting has been provided by Thales.

REFERENCES

[1] C. Cafforio, C.Prati, F. Rocca, “SAR Data Focusing Using Seismic Migration Techniques”, IEEE Transactions on Aerospace and Electronic Systems, Vol. 27, N. 2, March 1991, pp. 194-207

[2] Andrea Bellettini, Marc Pinto, Benjamin Evans, “Experimental results of a 300 kHz shallow water synthetic aperture sonar”, Proceedings of the 2nd International Conference and Exhibition on Underwater Acoustic Measurements: Technologies and Results, 25-29 June 2007, IACM – FORTH, Heraklion, Greece.