Motion Compensated High Frequency Synthetic Aperture Sonar (SAS)

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Abstract: The performance of a SAS is primarily limited by two things, the changing environment and the motion perturbations by the tow craft. Motion compensation algorithms attempt to correct both of these effects. This SAS uses a MOCOMP algorithm that has proven to be very successful and can produce very high resolution images, on the order of 1 inch at 40 meters. This paper will present results in the form of a point response function and sonar images.

Active SAS Technology

In the mid seventies the Coastal Systems Station (CSS) began to seriously consider the SAS concept as a practical sonar system for underwater imaging and mine classification. Measurements by CSS and others indicated that the environment was stable enough to support SAS and CSS decided to proceed with development of SAS technology. In the late 80's and early 90's modern digital signal processors (DSP) made SAS a practical and affordable technology. The latest DSP technology makes processing, modeling, simulation and implementation of complex SAS algorithms an affordable reality.

SW/VSW SAS

Northrop Grumman (formerly Westinghouse), under contract to CSS, designed and constructed the current MCM SAS. This is a dual frequency SAS, operating simultaneously at 20 and 180 kHz, producing 7.5 and 2.5 centimeter resolution respectively from a 0.5 meter physical aperture. It uses the displaced phase center (DPC) algorithm first described by Sheriff (1) for motion compensation (MOCOMP).

RESULTS

The target field consisted of two target spheres, 15 cm and a 20 cm, and a resolution panel. The resolution panel is an aluminum 1.2 by 2.4 meters plate with gravel rings ranging from 30 cm to 5 cm inside diameter. Figure 1a and 1b are the SAS point response function (PRF) of the 15 cm sphere without and with MOCOMP. The resolution of the sonar is near theoretical of 2.5 cm, with sidelobes of -14 dB. Figure 2a is an image of two spheres and a resolution panel with uncompensated motion. Figure 2b is the same scene with DPC MOCOMP applied.

CONCLUSIONS

A SAS can produce ultra high resolutions from very small physical arrays. We expect that as new MOCOMP algorithms are developed and verified that the operating ranges will grow without sacrificing resolution. These new SAS systems will have resolutions and maximum range capabilities that will far surpass any existing, conventionally designed Navy MCM side scan sonar.

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REFERENCES

Fig. 1a. Point response function without MoComp

Fig. 1b. Point response function with MoComp

Fig. 2a. SAS image without MoComp

Fig. 2b. SAS image with MoComp