NARROW-BEAM MONOPULSE TECHNIQUE FOR BATHYMETRY AND SEAFLOOR ACOUSTIC BACKSCATTER IMAGERY WITH A VOLUME SEARCH SONAR

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ABSTRACT

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The potential to obtain environmental information, specifically seafloor relief and texture, from a volume search sonar designed for mine countermeasure applications is demonstrated. This capability is explored using the volume search sonar of the AQS-20 mine countermeasure system, which transmits a stepped FM pulse over a 243° vertical fan beam centered on nadir and receives with twenty-seven pairs of beams symmetrically steered about nadir in the fore-aft direction and spaced at 7.16° intervals across-track. The receive beam pair geometry allows simultaneous views of the seafloor in forward, vertical, and rear profiles.

Pulse compression, monopulse processing techniques, and temporal and spatial filtering are used prior to the seafloor detection algorithm in order to improve the temporal and spatial resolution of the data. Three monopulse techniques are reviewed: conjugate-product, difference-over-sum, and narrow-beam. These techniques are used on both along-track and across-track pairs of adjacent beams. A seafloor detection algorithm using the data from narrow-beam monopulse processing applied to along-track beam pairs is derived in order to estimate the bathymetry and seafloor acoustic

backscatter imagery. The along-track beam pairs were chosen for this proof of concept because they provide results which are the simplest to represent spatially. Because of the unavailability of phase information in the monopulse results for along-track pairs (resulting from a common phase center for each pair of beams) the narrow-beam monopulse technique was chosen due to its superior magnitude response compared to the other two monopulse techniques reviewed. The detection algorithm employed detects targets within each narrow-beam beam separately while separating signal from noise using a constant threshold following the application of several normalization processes.

Results are presented for data collected in two test areas while surveying at roughly 25 knots, showing the combined effects of acoustic geometry and survey speed on the derived bathymetry and seafloor acoustic backscatter imagery and on bottom coverage over an across-track swath width of roughly 140°.