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Characterization of Backscattering Signal of 300 kHz Multibeam Echo Sounder

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1. Introduction

Seabed characterization is the main goal of ocean mapping, especially in Rapid Environment Assessment of Navy. Digitized geological information provides boundary conditions for sound propagation model, offshore development and benthic habitat protection. Detailed geological information can be extracted from Multibeam echo sounder data: backscatter amplitude signal and bathymetric profile. Multibeam Echo Sounder send out a large number of sharp & narrow sound pulses. Fan-shaped sounds make a wide profile of the seafloor underneath the surveying vessel. [1]. In recent Multibeam echo sounder records two way travel time of slant range, backscatter amplitude, water column intensity of each beam. Many researchers try to classify seabed with Multibeam data. Dartnell provide empirical techniques and supervised classification with composed images [2]. Fonsenca and David Calder developed “GeoCoder” based on angular range analysis and implemented in commercial post processing software packages (CARIS, Hypack, etc.)[3]. The advantage of hull mounted Multibeam echo sounder compared with a towed side scan sonar system is in the fact that the correlation between backscatter data and bathymetric data is exact. Also, we can use bottom roughness and shape from bathymetric model [4]. We try to characterize surficial geological seabed with Multibeam data (angular curve response of backscatter data and bathymetric feature, etc.) in specific survey area. High frequency backscatter data was shown to penetrate only a couple of centimeter down into the sediments [5]. But because absolute source level, pulse length, absolute and time varying receiver gain, seawater attenuation coefficients and sonar transmission and reception sensitivities have uncertainties, Backscatter image can’t be presented absolute backscatter level of sediments [6].

2. Materials and Methods

In 2009 May, we archived the Kongsberg EM3002 (300 kHz) Multibeam data around Kyeong Sang province, East Sea of Korea. For in-situ calibration of sound speed of water mass, we logged surface sound speed at transducer and profile of sound speed every single day. Based on sound speed profile, EM3002 apply absorption loss effect and ray tracing of each beams. EM3002 system normalized beam intensity to enhance bottom detection and find imagery with real time. But real time algorithm will fail when seafloor is not really flat as system flat bottom assumption [7, 8]. Then, we have to recover raw amplitude and reprocessing to enhance backscatter imagery. Extracted Angular Response Curve uses two ways, first is normalization of backscatter strength, and another is feature of characterization. Pattern of ARC can be changed by sediment type and seabed morphology. To extract ARC, we sampled the backscatter series in the specific region A, B, C as **Fig. 1**.

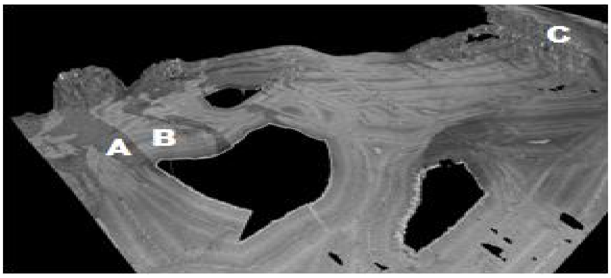

Fig. 1 Draped backscattered amplitude mosaic imagery on 3D bathymetric model. A area is high intensity than B area. C Area is rock.

To extract angular response curve of pre-processing, we gain recover based on sonar parameter in the logged files using in-house SW as **Fig. 2** Logged file records pulse length, slant range of each beams, sound speed, forward & side beam angle and critical incidence angle, etc. Each raw backscatter sample is then corrected for the removal of variable acquisition gains, power levels and pulse widths, according to manufacturer’s specifications. The backscatter strength is calculated per unit of area and per unit of solid angle, so that the actual footprint area of the incident beam should be taken into consideration account for proper radiometric reduction. To check the availability of characterization with Angular Response Curve (ARC), Sonar operation parameter was extracted from logged file. For Examples, Nadir average depth of Area A is 27.2m, and Std. is 0.95m, Pulse length is 149 microseconds. Surface Sound Speed is 1506.9 m/s, and absorption of 300 kHz freq. is 70dB/km that slightly changed according to sound speed & depth. The acoustic backscatter signal sampled at the transducer head is subject to stochastic fluctuations that produce a speckle noise in the registered backscatter data. Canceling of stochastic errors on ARC, we compute average of amplitude at each step angle (1°). In Shallow water, average ping rate is 115milliseconds, and ship speed is 2.5m/s, then 10 ping samples represents 2.8m distance by along track direction. Then we assume 10 ping samples on the same area.

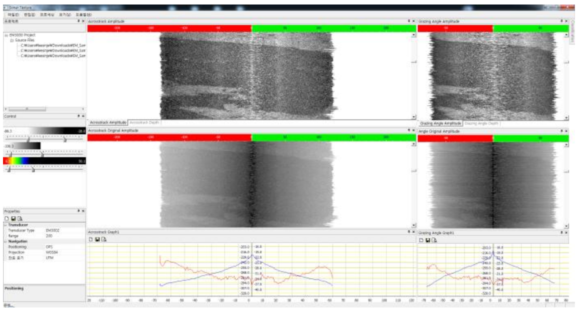

Fig. 2 Developed SW to review the Angular Response Curve of logged file. Upper panel show seabed imagery with normalized angular response curve by Kongsberg real time processor, Middle panel show seabed imagery with original ARC. The bottom panel display angular response curve. Red line is normalized ARC and Blue line is original ARC. Left panel based on distance (m), Right panel based on angle (degree).

4. Results and Conclusion

Normalized Angular Response Curve (NARC) of logged file is almost flat over the whole angle for enhancing seabed imagery. But it is very difficult to characterize seabed sediment with dismissing angular curve characteristics based on properties of sediment itself. As **Fig 3**, we can characterize the seabed with average amplitude intensity and Curve pattern of Far Field area (> 25 deg.).

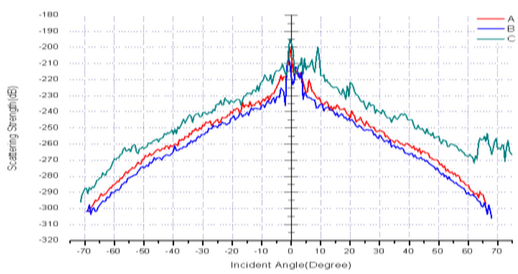

Fig. 3 Angular Response Curve at specific area. A area is red line, B area is blue line and, C area is green line.

Very high intensity curve (green line) represents rocky area (Area C). And low intensity and sharpen curve (blue line) of near nadir angle are assumed to be soft sediment (Area B). These training set be taken a role of indication for automatic classification.

For characterization of seabed with 300kHz Multibeam Echo Sounder data, we review the real time processing method for normalization of angular response of backscatter amplitude, and recover the amplitude response curve to extract curve feature that varied with bottom sediment strength and roughness. For ARC extracting, we implement in-house analysis SW. and In three specific areas (High amplitude, Low amplitude, and Rough bathy), we extract ARC to compare each other. Each ARC has different shape. Especially far field angle can be more characterized. We will characterize seabed with ARC and classify it with ground truth data in the future.

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