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Preface

On behalf of the conference organizing committee, we are happy to present the Proceedings of the Third International Conference on Mathematics and Natural Sciences (ICMNS 2010). The organizing committee of the ICMNS 2010 is highly pleased to have nearly two hundreds full papers submitted to the Conference. The ICMNS's biannual event is organized jointly by the Faculty of Mathematics and Natural Sciences (FMIPA), the School of Life Sciences and Technology (SITH), and the School of Pharmacy (SF), Institut Teknologi Bandung. We are highly honored to host the event here in Bandung.

The aim of the ICMNS 2010 is to promote interdiciplinary researches in science and technology, to encourage the development of sciences and technologies for sustainable development, and to disseminate research in various fields of mathematics and natural sciences. The main theme of the ICMNS 2010 is "Science for Sustainable Development". The conference deals with mathematics and natural sciences to fundamental and applied researches, including nine scopes and topics that are health sciences, biosciences and biotechnology, environmental science, pharmaceutical science, physical sciences, material science, mathematics, computer and computational science, and earth and space sciences.

Finally, we would like to express our gratitude to Dean of FMIPA, Dean of SF, Dean of SITH, PT Chevron, PT Biofarma, and Indonesian Journal of Physics (IJP) for the financial support and thank the invited speakers as well as participants for their contribution in making the conference a success. As general chairperson, I highly appreciate the great efforts of the members of the organizing committee whose hard work really made it possible to have this conference.

Bandung, April 30, 2011

Roberd Saragih
Chairperson, ICMNS 2010

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Addendum

MEASURING ECHO STRENGTH OF FISH AND SEA BOTTOM USING UNDERWATER ACOUSTIC INSTRUMENT

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Abstract. Underwater acoustic technology is indispensable method to receive underwater information. For this purpose, we used an underwater acoustic instrument with operating frequency of 200 kHz to detect and measure the echo strength of fish and sea bottom. The value of echo strength is important to be obtained not only in estimating fish stock, but also in designing and constructing of sonar instrument. By this research, the application of underwater acoustic technology is obtained to detect and quantify fish and sea bottom. Results showed the echo strength of fish depends on the orientation of fish to transducer. The echo strength of sand bottom is higher (8 dB) than fish target.

Keywords: Echo Strength, Underwater Acoustic Instrument

1 Introduction

Underwater acoustic research of fishery and seabed resources using scientific sonar system are used worldwide. To obtain the fish distribution density or volume backscattering strength (SV), it is important to quantify the target strength (TS) of fish.

However, the acoustic research has several problems. There is no definitive method for fish and sea bottom classification. Besides, the difficulties arise in quantifying TS to SV. These problems must be solved to improve the reliability of the underwater acoustic research.

Some work on comparison of different systems and frequencies has been already done: Rudstam, *et al* [1] compared the performance of single and split beam acoustic instruments. However up to now no systematic work on comparison of acquisition and analysis parameter settings within a single system have been performed. In situ target strength (TS) is the optimal quantity to scale echo integration values to fish density [2], so the precise knowledge of TS distributions is the primary importance for the proper fish biomass estimation. The relationships between target strength and fish size are not well enough known to permit accurate sizing and reliable identification to be done as routine work at sea.

The aim of this paper was to simultaneously quantification of fish and seabed using underwater acoustic instrument.

2 Methodology

Data Acquisition

Underwater acoustic transmitting and receiving systems were constructed in this research (Fig. 1). In the transmitting system, the signal from a signal generator was amplified by a power amplifier and the signal was sent to the transducer. In the receiving system, the reflected and backscattered wave were sent by the receive transducer. The output signals were observed, measured, and transformed into digital data by Digital Signal Processing (DSP), and the acoustic data were transferred to a personal computer via a developed interface.

The transmit and receive transducers were designed as a monostatic system. The operating frequency was 200 kHz with the beam width of the transducer is 8°. The acoustic instrument was calibrated with standard copper sphere [3]. Calibration of standard target for this frequency showed no change from the manufacturer calibration and theoretical value.

Field acoustic data were collected in around Seribu Island, Indonesia. Global Positioning System (GPS) was used for the positioning of the acoustic transect, bottom and fish sampling. Underwater acoustic data, water depth, water temperature and GPS data were stored in a computer and later processed by the Matlab software.

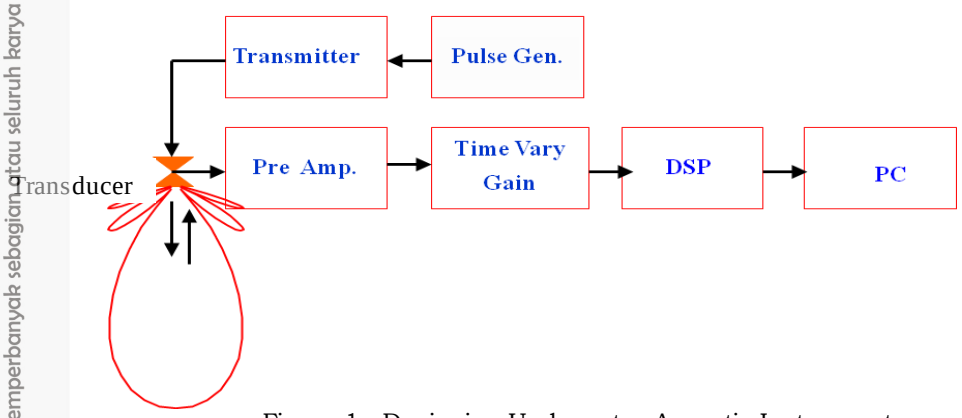

Figure 1. Designing Underwater Acoustic Instrument

Data Processing

Underwater acoustic data were processed and analyzed using MATLAB software. This program uses the sonar equations algorithm to quantify a target strength distribution from the measured distribution of peak voltage response from single fish and seabed echoes. All analysis is performed using data collected with 40 log R TVG for single target and 20 log R TVG for multiple target, where R is the range between transducer face to the target and TVG is Time Varied Gain. TVG was designed to compensate the acoustic wave propagation losses in sea water [3].

Data Analysis

The echo strength or target strength (TS) of fish or sea bottom is defined as

$$TS\,(\mathrm{dB}) = 10 \log (I_r / I_i) \qquad (1)$$

where I_r is reflected intensity from the target, I_i is incident intensity to the target.

The developed algorithm for Target Strength (*TS*) or Bottom Backscattering Strength (SS) measurement as follows :

$$TS\,(\mathrm{dB}) = \mathrm{SS}\,(\mathrm{dB}) = 10 \log (EA / DN) \qquad (2)$$

where *EA* is echo amplitude and *DN* is 8 bit digital number ranges from 0 to 255.

The Echo Strength (ES) or Echo Level (EL) is obtained using sonar equation below

$$ES = EL = SL - 2\,TL + TS \qquad (3)$$

where *SL* is Source Level, *TL* is Transmission Loss and *TS* is Target Strength.

3 Results and Discussion

Underwater Acoustic Calibration

Calibration is fundamental work for underwater acoustic instrument. The sphere was installed at the beam axis position and in far field range. From the measurement, the sphere was detected at 1.4 m below the transducer (Fig.2). The target strength of sphere is -36.0 dB. This value is similar with the TS obtained using the theoretical value.

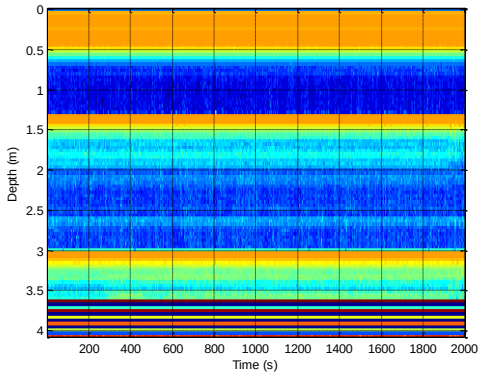

Figure 2. Sphere calibration detected at 1.4 m

Target Strength distributions

Target strength distribution obtained with the developed method using acoustic transmitting and receiving instrument was shown in Fig. 3. Average target strengths (TS) calculated with acoustic method on backscattering cross section unit. All averaging were done in the linear domain and back transformed to dB units. Figure 3 shows the Target Strength varies on fish orientation. The highest target strength is near 0°. This is caused in this position (0°) the response of acoustic energy is maximum to reflect the acoustic energy from the fish. This result is correlated to the maximum response axis of the transducer [4],[5].

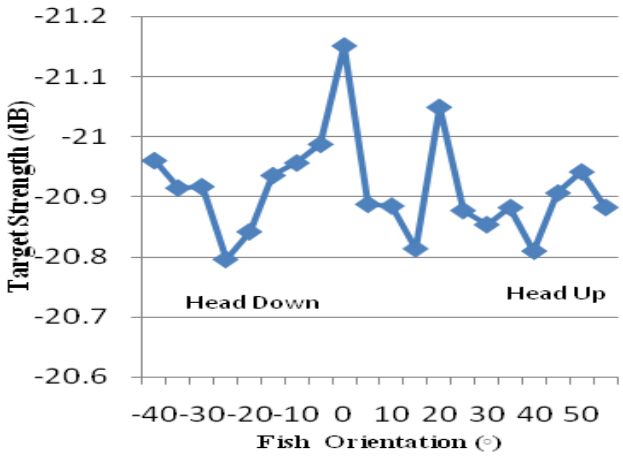

Figure 3. Target strength against fish orientation.

Figure 4 shows the acoustic reflection from seabed. The depth of seabed was measured around 10 to 16 meter. The echo strength of seabed (or bottom backscattering strength, SS) is around -8.0 dB shown in color bar scale.

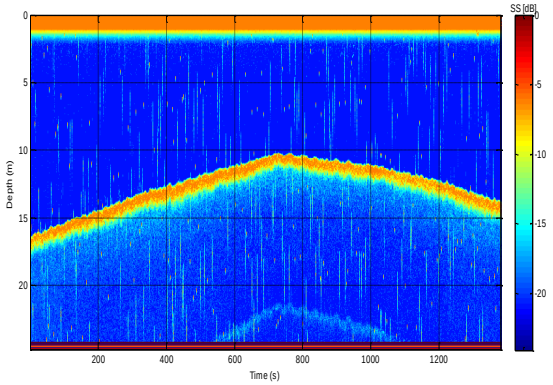

Figure 4. Underwater images obtained by underwater acoustic system.

Medwin and Clay [3] presented their result that sand bottom with echo strength was around -12.6 to -6.0 dB. The echo strength of fish was around -22.5 to -20.5 dB (Fig. 5). This result is agreed with the result of the previous measurements using sonar [5],[6]. Figure 6 shows the echo strength (SS) of sand bottom varies on time ranged between -12.5 to -13.0 dB. This is agreed to the former study the echo strength of sand bottom is around -12.7 dB using 200 kHz frequency of echo sounder [3].

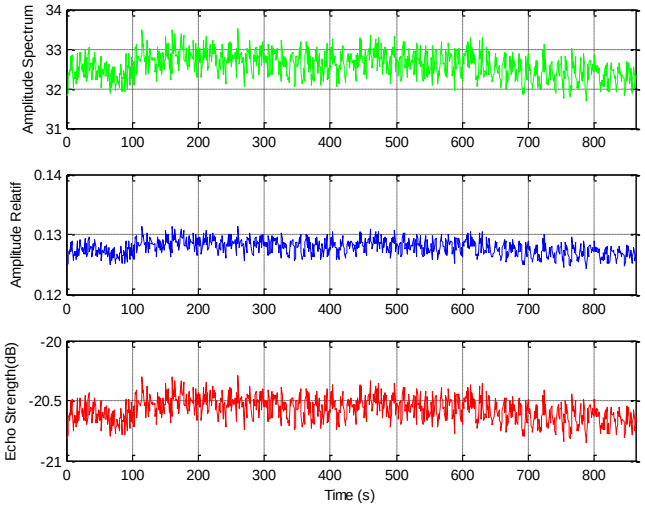

Figure 5. Echo strength of fish.

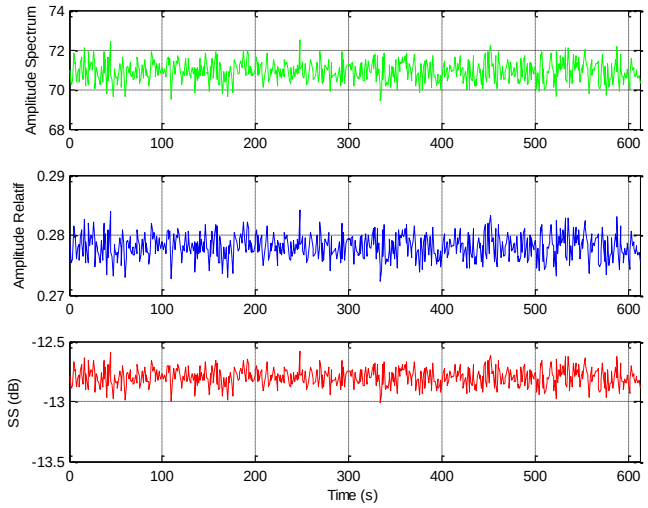

Figure 6. The echo strength of sand bottom.

4 Conclusion

We conclude our study as follows:
1. Underwater acoustic technology is a reliable tool to detect, quantify and identify sonar target such as fish and sea bottom.
2. The echo strength of sand bottom is higher (8 dB) than fish echo.

The following topics are suggested for future work :
1. A research aimed at improving the signal to noise ratio to gain better quantitative information.
2. A research of echo strength spectra for underwater target identification and quantification.

Acknowledgments

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