3Pa6-4

Proceedings of Symposium on Ultrasonic Electronics, Vol. 32 (2011) pp. 437-438
8-10 November, 2011

Developments of a New Discrimination Method between Japanese Jack Mackerel and Chub Mackerel by Using the relation between incident angle and reflect ratio

入射角度と音響反射強度の関係を用いたアジ･サバの判別方法

Yong Wang[1†], Shinji Ogawa[1] , Yasushi Nishimori[1], Masahiko Furusawa[2], Masanori Ito[3], Ikuo Matsuo[3], Tomohito Imaizumi[4] and Tomonari Akamatsu[4] ([1]Furuno Electric Co., Ltd.; [2]Tokyo Univ. Mar. Sci. Tech; [3]Tohoku Gakuin Univ.; [4]Nat. Res. Inst. Fish. Engin., FRA) (11 points)

王 勇[1‡], 小河 慎二[1], 西森 靖[1], 古澤 昌彦[2], 伊藤 雅紀[3], 松尾 行雄[3], 今泉 智人[4], 赤松 友成[4] ([1]古野電気 研究部; [2]東京海洋大, [3]東北学院大, [4]水工研)

1. Introduction

At present, the Japanese Jack mackerel (*Trachurus japonicus*) and Chub mackerel (*Scomber japonicus*) are one of the most important stock economically in Japan. Becouse of the high market prices in consumers' season, fishermen wish to know fish size and fish species within a fish school before catching.

In the last decade, species discrimination by single-beam echosounder was performed based on the echo amplitudes and the aggregation morphologies. In these days, features measured by multifrequency echosounder have also been used to discriminate species. However, those method are low reliability when discriminating between Japanese Jack Mackerel and Chub Mackerel, becouse they have similar acoustic properties.

In our researches, broadband split-beam echo-sunder can provide the high-precise measurements of the reflect ratio and fish position of individual fish within the beam. Using the fish position information, the incident angle can be estimated.[1-4)]

In this report, the relation between the incident angle and the reflect ratio is introduced as a new method to discriminate fish species. Using the data collected in aquarium cage, Japanese Jack Mackerel and Chub Macherel are efficiently discriminated.

2. Method and discussion

Broadband split-beam echo-sunder can transmitted the signal from 70 kHz to 130 kHz @-3 dB with the source level at 223 dB re 1 uPa@1 m and receive echoes using four channels. Signal processing is performed in real-time software in PXI system (National Instruments, Texas, USA). All of the channels were combined to form the narrow beam (8 degree).

Mail to: yong.wang.mx@furuno.co.jp

As shown in **Fig.1**, the fish position vector $v_u[n]$ and the fish swimming vector $v_f[n]$ were obtained separately by the four received signals. The incidence angle $\theta_{inc}[n]$ was also estimated from the fish swimming vector and the fish position vector using

$$\theta_{inc}[n] = \frac{\pi}{2} - \arccos\left(\frac{v_f[n]\cdot v_u[n]}{|v_f[n]||v_u[n]|}\right) .$$

The plus values of $\theta_{inc}[n]$ indicates "head-up" position of the fish relative to the transducer. And minus values indicate "head-down". The reflect ratio *e* was the linear value of target strength (TS) shown as

$$e = 10^{TS/20}$$
.

Typical echograms of Chub mackerel and Japanese Jack mackerel obtained in breading cage were displayed in **Fig.2** and **Fig.3**, respectively. From those figures, the change of Chub Mackerel's reflect ratios relative to incident angle are remarkable than Japanese Jack Mackerel. **Figure 4** and **Fig. 5** show the relation of the reflect ratio *e* and the incident angle θ_{inc} from Chub Mackerel's and Japanese Jack Mackerel's echogram, respectively. To estimate the variance of each distribution, the Gaussian curve were fitted from the contour points using the method of least-squares. The Chub Mackerel's variance is sharper than Japanese Jack Mackerel. To quantitatively discriminate between Japanese Jack Mackerel and Chub Mackerel, the variance of Gaussian distribution σ is used, shown as **Table 1**.

3. Conclusion

We proposed a new discrimination method

between Japanese Jack Mackerel and Chub Mackerel using the relation of incident angle and reflect ratio. It is useful tool to discriminate the echoes from the fish in the breading cage. In the future, Nature fish echoes will be tested.

Acknowledgment

We are grateful to Prof. O. Murada and Prof. T. Yamane, Kinki University, for providing aquarium space. This work is supported by the Research and Development Program for New Bio-industry Initiatives of the Bio-oriented Technology Research Advancement Institution, Japan.

References

1. I. Matsuo, T. Imaizumi, T. Akamatsu, M. Furusawa, and Y. Nishimori: J. Acoust. Soc. Am. **125** (2009) 444.

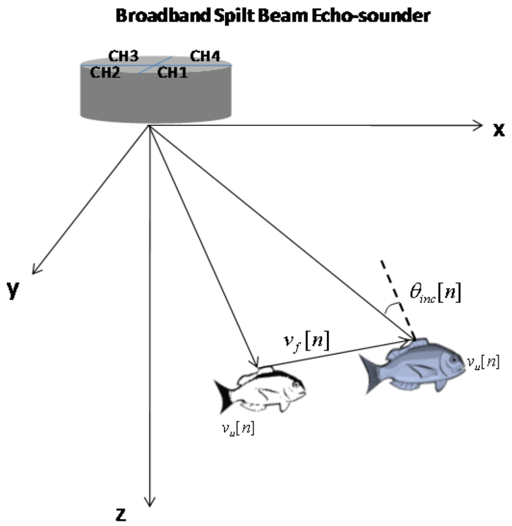

Fig. 1 The measurement of incident angle using the broadband split beam echo-sounder.

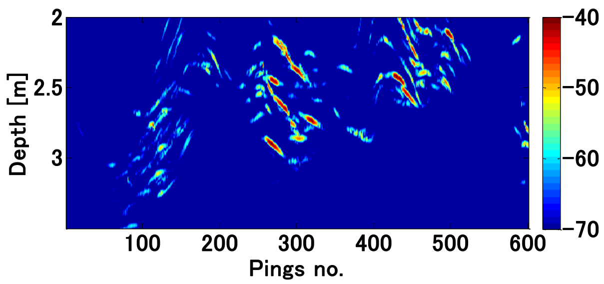

Fig. 2 A sample echogram of Chub Mackerel.

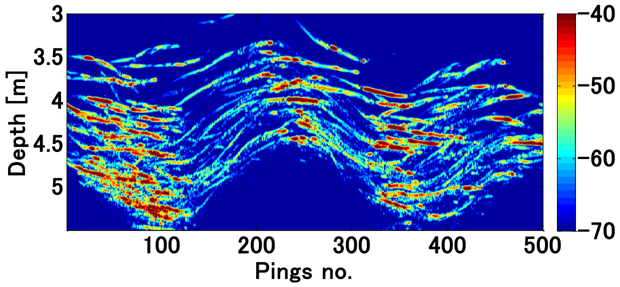

Fig. 3 A sample echogram of Japanese Jack Mackerel.

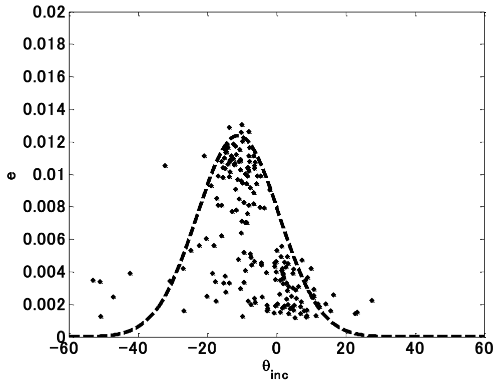

Fig. 4 The relation of reflect ratio and incident angle from Chub Mackerel's echogram.

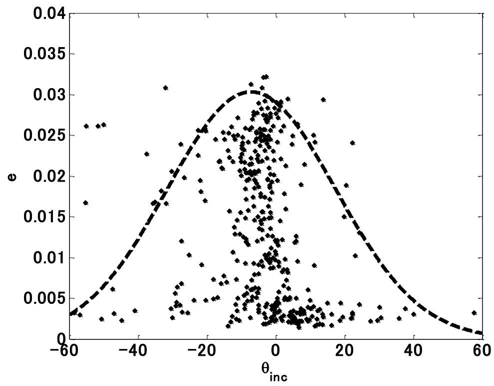

Fig. 5 The relation of reflect ratio and incident angle from Japanese Jack Mackerel's echogram.

Table 1 Comparison of σ between Japanese Jack Mackerel and Chub Mackerel

No.	Japanese Jack Mackerel	Chub Mackerel
1	20.6138	12.0558
2	16.9441	13.9694
3	18.3637	13.8226
4	23.0205	12.6402
5	18.8466	11.9788
6	17.1696	11.8975
7	17.7009	11.6064
8	17.4976	11.2502
9	19.4494	
10	18.3395	
11	23.924	
12	22.9708	
13	20.3629	