Development and Experiment of Bio-Tracking System in Deep Sea

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1. Introduction

In order to track time-series positions of benthic lives in deep sea of off-Tohoku area continuously, bio-tracking system (BTS) has been developed in JAMSTEC. The scientific purpose is research on ecosystem of aquatic resources. The main targets are snow crab and Kitchiji rockfish.

The BTS consists of small acoustic pinger, which is attached to the target and transmit coded acoustic signal periodically, and base station, which receives and records the acoustic signal. In this paper, the design and configuration of BTS, and ocean experiments are introduced.

2. Specifications of Bio-Tracking System

Table I shows the specifications of the BTS. The main systems, the pinger and the receiver, are developed by AquaSound Inc., a Japanese company. There are two types of small pinger, the differences are the size and the source level. Figs. 1 show pictures pingers attached on snow crabs. The acoustic signal is codec by Gold codes of 32 patterns. A pressure sensor and a temperature sensor are equipped with the pingers. One transmission of acoustic signal is consist of three pulses. The sensor data is informed as interval time of the three pulses. Receiver system on the base station receives the acoustic signal with four hydrophones, detects the signal, and records detecting results. Direction of arrival of the acoustic signal can be calculated with the difference between the detected times by four receivers.

3. Estimation of Performance

The acoustic signal is correlated with replica signal in the receiver system. In order to save power consumption, the signal is A/D converted with 1-bit ADC, and correlated as 1-bit digital signal in an ASIC. Figs. 2 (a) and (b) are results of 1000 times simulation, in which AWGN was added and correlation process was simulated. (a) shows peak level of correlation output, and dotted lines represents ± standard deviation. (b) shows standard deviation of error of peak detection time.

4. Experiments

Here detectable range are considered with experimental results. Fig. 3 shows a picture of the base station. Hydrophones were set at corners of the upper face of triangle pole and center. The height of the hydrophones were about 1 meter. Figs. 4 show experimental result in shallow water, depth was 80 m, in Suruga Bay. (a) is time-series
detection result of five pingers hanged from a boat which is moving away from the base station. The plot level in this figure represents summation of peak levels of four hydrophones. (b) shows distance between the pingers and the base station. Detectable range in this case seems about 300 - 400 meters. (c) shows detection result of a pinger which stayed stably at 480 meters off the base station, and the height was about 1 meter. The pinger is detectable, however, it seems to depend ambient environment.

Figs. 5 show experimental result in deep water, depth was 440 m, off Tohoku. (a) is detection result of ten pingers attached on snow crabs. The targets were stocked at about 200 meters off the base station. It seems to be difficult to have stable detection. It could be due to that the snow crabs hag the bottom. On the other hand, (b) shows detection result of pinger which stayed stably at 300 meters off the base station and the height was about 1 meter. And it is detected well. Detectable condition is need to be considered.

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