3P6-1

Fundamental Study of an Automatic Discrimination Method for Clams in Sedimentary Layers Using an Acoustic Coring System

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1. Introduction

Clams play a major role as a fishery resource and water purification agent, but in recent years, their catch has been decreasing significantly due to multiple factors such as global warming[1)]. In order to elucidate the causes of this decline and to manage resources in a stable manner, we focused on ecological surveys using acoustic instruments, which can conduct ecological surveys nondestructively and efficiently. In this study, we conducted a detection test of clams, created an acoustic image of the sedimentary layer from the measured waveforms of the detection test, and tried to find a method for automatic identification of clams in the acoustic image, to explore the possibility of ecological survey of clams using acoustic instruments.

2. Clams detection test

Clam detection tests using an acoustic coring system were conducted at the Hamanako Branch of the Shizuoka Prefectural Fisheries and Marine Technology Research Institute in 2022. In addition, a water tank experiment was conducted at Kisarazu National College of Technology in 2024.

2.1 Acoustic equipment

The acoustic coring system shown in Figure 1 is used for the test. This system consists of a waterproof 2-axis driving unit and an acoustic measurement unit, which is a single probe as shown in Figure 2, and it is a 3-dimensional acoustic visualization system that acquires waveform data while the acoustic measurement unit automatically scans within the measurement area in a 2-dimensional plane. [2)]

2.2 Test Subjects

Clams in Figure 3 and other shellfish were buried in planters filled with tidal flat sand and seawater, respectively, for the purpose of determining whether different conditions within the sedimentary layer affect the visibility of the acoustic image.; in July 2022, four types of planters were measured with clams and spiral shell: A (clams only), AM (clams + spiral shell), M (spiral shell only) and C (nothing).as shown in Figure4 and in July 2024, other bivalve (e.g. Meretrix lusoria, Mercenaria mercenaria) were also measured in the same way.

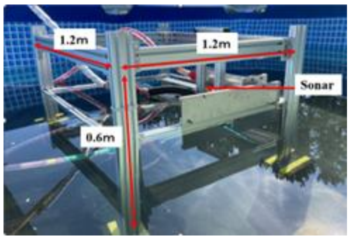

Fig. 1 Acoustic coring system

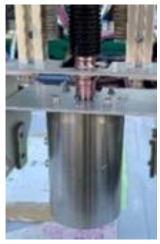

Fig.2 Measurement unit

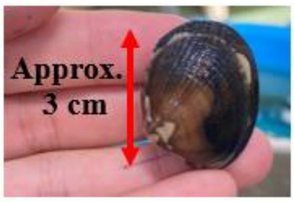

Fig. 3 Measuring clams

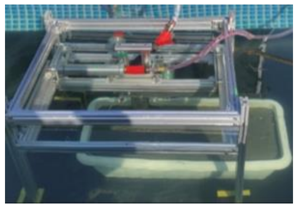

Fig. 4 Measurement scene

2.3 Measurement method

In the measurement, the acoustic measuring section moves 100 cm in the longitudinal direction of the planter and then moves 2 mm in the lateral direction, repeated 125 times. During the scanning, measurements were taken at a pitch of 1 cm when the acoustic measurement unit was moving along the scan axis, and a total of 12,500 waveform data points were acquired for one planter. The distance from the sonar to the depth of the clam habitat is set at 7 cm, which is the convergence point, for the measurement.

3. Data Analysis

The measured reflected waves are detected and denised, and one row of reflected waves is aligned vertically to create an acoustic image. When clams are successfully displayed in the acoustic image, a soil surface parallel to the horizontal axis is seen in the upper part of the image, and two reflection waves (clams) with a distance of about 20 mm between the top and bottom are seen in the middle of the image , as shown in Figure 5.The distance and shape of the reflected waves are used to distinguish the clams

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from other organisms. In Figure 5 of the 2022 measurement, clams and spiral shell(snail) could be discriminated, and in the acoustic image of Figure 6, measured in 2024, clams and Meretrix lusoria could be discriminated.

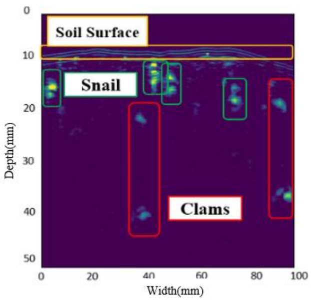

Fig. 5 Acoustic image (2022)

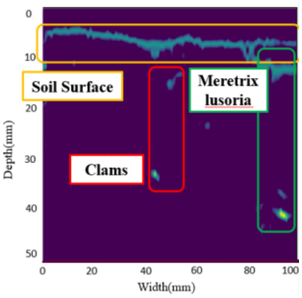

Fig. 6 Acoustic image(2024)

4. Study of automatic identification method

In order to efficiently discriminate clams in the compost pile from other organisms, the following three automatic discrimination methods are tested on all acoustic images, and the method with the highest utility is considered.

4.1 Template matching

This method uses OpenCV to calculate the degree of approximation based on the shape and color of the template image and performs matching. In this study, one clearly recognizable clam is cut out from the acoustic image and matched to all acoustic images as a template image.

4.2 Feature point matching

This method uses OpenCV to calculate the degree of approximation between the feature points of two images, and matches the points with the highest degree of approximation. In this case, the acoustic image of a clear clam is matched with the whole acoustic image.

4.3 Discrimination method considering size and distance

Based on the acoustic image of a clear clam, this method extracts coordinates that approximate the circularity and size of the object in the image, specifies the distance range from the coordinates in the X-axis direction (reflected waves located above and below) and in the Y-axis direction (reflected waves about 20 mm apart), and discriminates the two coordinates that match the conditions as clams.

4.4 Matching Results

Clam matching results generated from the waveforms of the July 2022 clam detection test with the addition of spiral shell were as follows.

Table.1 Matching result

	A	AM
Template matching	67%	38%
Feature point matching	38%	9%
Discrimination method considering size and distance	86%	81%

Matching that took size and distance into account had the highest probability of successful matching; it is thought that the high probability was due to the fact that specifying the coordinate distance of the two reflected waves in both the X and Y coordinates reduced the number of false matches to the spiral shell as shown in Figure 5.

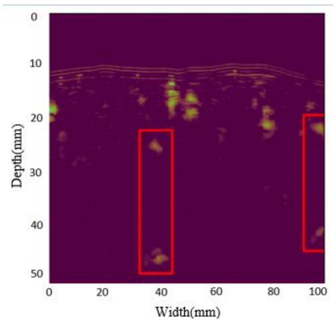

Fig. 5 Results images of Discrimination Methods Considering Magnitude and Distance

5. Summary

In this paper, we conducted a test to detect clams using acoustic equipment and examined the creation of acoustic images and a discrimination method. We succeeded in creating an acoustic image with sufficient visibility, and produced an original discrimination method that is easy to use for discriminating clams, and obtained a sufficient probability of success. In the future, we will also discriminate clams in acoustic images from the detection test conducted in July 2024.

Acknowledgment

We would like to thank Mr. Sakamoto and Mr. Sugimoto of Windy Network, Inc. for their great cooperation in the experiments. This research was also supported by Grant-in-Aid for Scientific Research (20H02362) and by Grant-in-Aid for Strengthening International Collaboration B (20KK0238). We express our sincere gratitude.

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