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A Basic Study of Relationship between Spatial Distribution of Noise Sources and Target Scatterings Observed in the Sea Trial of Ambient Noise Imaging

周囲雑音イメージング実験における雑音位置とターゲット散乱波の関係に対する基礎研究

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1. Introduction

Buckingham *et al.* developed a radical idea, which views ambient noise as a sound source rather than a hindrance, and which is neither a passive nor an active sonar. [1] This method is often called ambient noise imaging (ANI), and an acoustic lens system would be a powerful choice for realizing ANI, because such a system would not require a large receiver array and a complex signal processing unit for two-dimensional beam forming, which could reduce the size and cost of the system. In our past studies, we analyzed a sound pressure field focused by an acoustic lens constructed for an ANI system with a single spherical biconcave lens or a single aplanatic lens. [2-4] We already designed and made an aspherical lens with an aperture diameter of 1.0 m for ANI. It was verified that this acoustic lens realizes directional resolution, which is a beam width of 1° at the center frequency of 120 kHz over the field of view from -7 to +7°. [5] And, the silent target was successfully detected under only ocean natural ambient noise, which is mainly generated by snapping shrimps. [6]

In this report, we estimated the spatioal distribution of noise sources using a pair of tetrahedron arrays, and some preliminary results and discussions of relationship between noise source positions and target scatterings were described.

2. Experimental Setup

The equipment was deployed through the barge “OKI SEATEC II”, which was moored at Uchiura Bay. The water depth at this location is a nominal 30 m. The experimental setup conducted on November of 2010 is shown in **Fig. 1**. The prototype imaging system constructed with the acoustic lens and hydrophone array were suspended from the end of the barge. The aluminum panels of Target A and B were also suspended. The distance between the lens and each target was about 30 and 15 m, respectively. To observe the spatial distribution of noise sources, a pair of tetrahedral arrays was suspended near the prototype ANI system. Four hydrophones were mounted on tops with a separation of 1 m on each array. The distance between the two tetrahedral arrays was about 10 m. The hydrophones had perfect omni-directionality over 360 degrees in the horizontal plane and 270 degrees in the vertical plane.

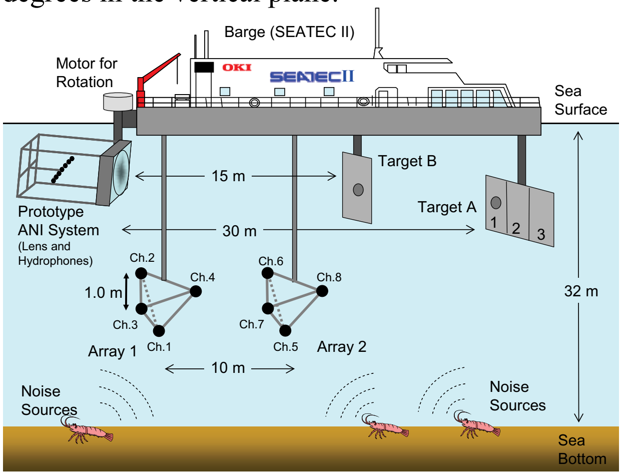

Fig. 1 Experimental Setup for Estimating Noise Source Positions with Two Tetrahedron Arrays

3. Preliminary Results and Discussions

Figure 2 shows the estimated source positions for the horizontal plane in the afternoon of Nov. 8, 2010. In the cases in which the source positions were estimated above the arrays, they are plotted in Fig. 2(a). We can see that the source positions were coincident with the barge when the noises arrived from the sea surface. Figure 2(b) is the plot of the cases in which the source positions were estimated under the arrays. The source positions were spread when the noises arrived from the sea bottom. Some of the sources were around the barge, and other sources were around fish

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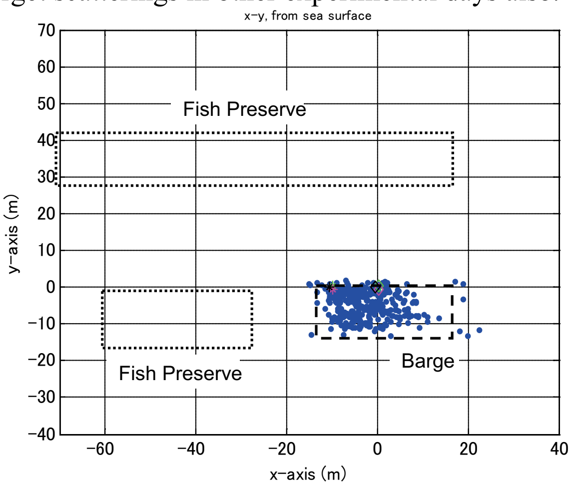
preserves in the area.

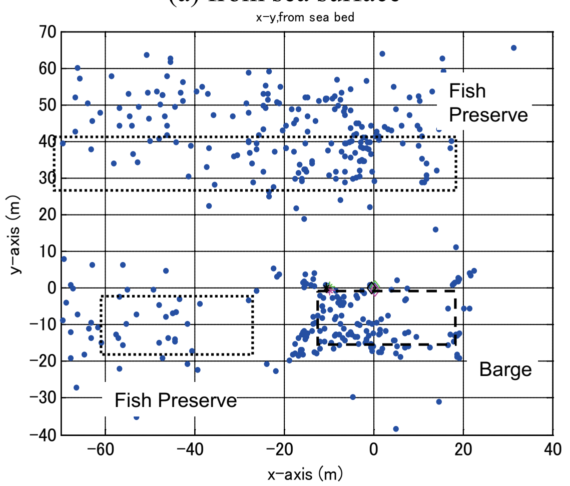
Figure 3 shows the estimated source positions for the vertical plane in the same day. Again, we can see that a portion of the noise sources is concentrated at the bottom of the barge around the sea surface, and the other part of the noise sources is spread around the sea bottom.

Figure 4 shows examples of the bistatic target strength of the rigid rectangle plate (height of 1 m, width of 3 m) which simulates the directivity of target strength of Target A at normal incidence. This shows that the target scattering from Target A has a narrow directivity. It is suggested that some receiver beams of the ANI system can capture target scatterings having high intensities if the noises are generated in the limited area around the center axis close to the ANI system in Fig. 3.

Therefore, the noise sources at the bottom of the barge around the sea surface are considered to be strong possibilities as the projectors to generate the target scatterings received by the ANI system. We will survey the detailed positions of noise sources in which the ANI system can detect strong target scatterings in other experimental days also.



(a) from sea surface



(b) from sea bed

Fig. 2 Estimated Source Positions on Horizontal Plane in the afternoon of Nov. 8, 2010.

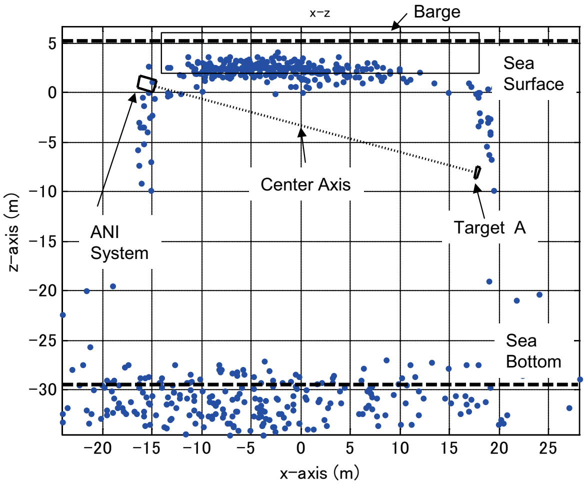


Fig. 3 Estimated Source Positions on Vertical Plane in the afternoon of Nov. 8, 2010.

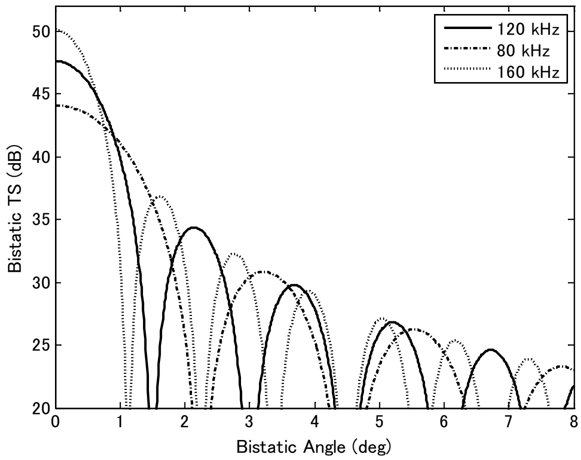


Fig. 4 Bistatic Target Strength of Rigid Rectangle Plate (height of 1 m, width of 3 m) at Normal Incidence.

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