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# The 2nd Sea Trial for Ambient Noise Imaging with Acoustic Lens

音響レンズを用いた周囲雑音イメージングの第 2 回実海域試験

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## 1. Introduction

Buckingham *et al.* developed a revolutionary 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 suitable choice for realizing ANI. 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 (FOV) from -7 to +7°.[2] Using the 1st prototype system with the lens and a 1-D receiver array on a part of the image surface, the silent target was successfully detected under only ocean natural ambient noise, which is mainly generated by snapping shrimps on the 2010 sea trial conducted at Uchiura Bay.[3] We also estimated the spatial distribution of noise sources using a pair of tetrahedron arrays, and some results and discussions of relationship between noise source positions and target scatterings were reported.[4] Our final goal is to create a pictorial image of a target under ocean natural ambient noise. It is necessary to arrange a 2-D receiver array to cover onto the image surface fully. Recently, we rebuilt the 2nd prototype ANI system with the 2-D receiver array.[5] To evaluate this system, we conducted the 2nd sea trial in November of 2014. The main objective is to verify whether the target can be successfully imaged under various conditions involving the direction of the imaging system and the noise distributions. In this report, the outline of the 2nd sea trial is presented.

## 2. The 2nd Sea Trial and Some Results

In the 2nd sea trial on November 10-14, 2014, we investigated the influence of the spatial noise distribution on the target image obtained by the ambient noise imaging (ANI). The experimental arrangement is shown in Fig. 1. Here, the noise sources in front of the target are called ‘front-light’ as shown in Fig. 1(a), and those in rear of the target are called ‘back light’ as shown in Fig. 1(b). We then considered two conditions for the directions of the imaging system. The first condition (front-light) was nearly horizontal, and the FOV included an area where the noise sources were not present. The second condition (back-light) was nearly vertical, and the FOV included an area where the noise sources were present. As in the 1st sea trial, the equipment was deployed through the barge “OKI SEATEC II”, which is moored at Uchiura Bay. The water depth at this location is a nominal 30 m. The 2nd prototype imaging system was suspended from the end of the barge. In the case of front-light, two panel targets were suspended from the barge so that those targets might be in the FOV. The targets were created by arranging multiple 1-m × 1-m square panels for “Target A” and 0.5-m × 0.5-m panels for “Target B”. In the case of back-light, a panel target was also suspended from the barge at a depth of about 15 m. The target was created by arranging multiple 0.5-m × 0.5-m panels for “Target C”. Several pingers were attached to the targets for alignment in FOV.

Fig. 2 shows an image of ‘Target B’ in front-light. An illustration of the target arrangement in the FOV is shown in Fig. 2(a). Many transients of target scatterings were extracted from the recorded sound. Figure 4(b) shows the combination of the 30 images of transients. We can see that the reconstructed target image agrees well with the shape of “Target B” in FOV.

Fig. 3 shows an image of ‘Target C’ in back-light. An illustration of the target arrangement in the FOV is shown in Fig. 3(a). Many transients of directly received noises from the sea bottom were extracted from the recorded sound. Figure 3(b) shows the combination of the 200 images of transients. We can see that the reconstructed target image silhouetted against the noises from the sea bottom agrees well with the shape of “Target C” in FOV.

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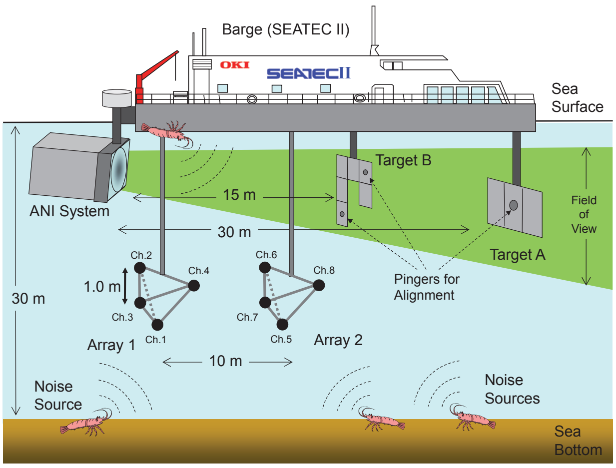
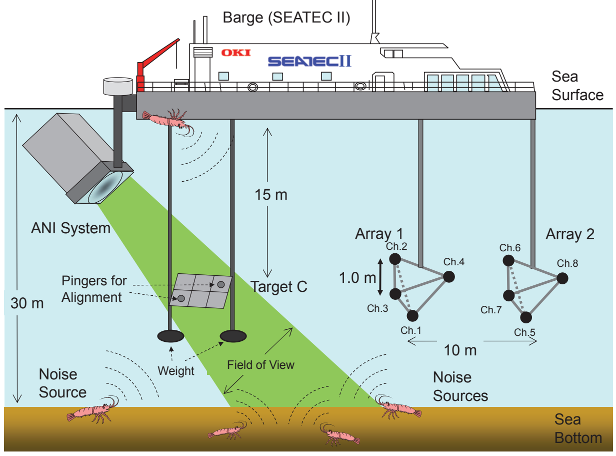
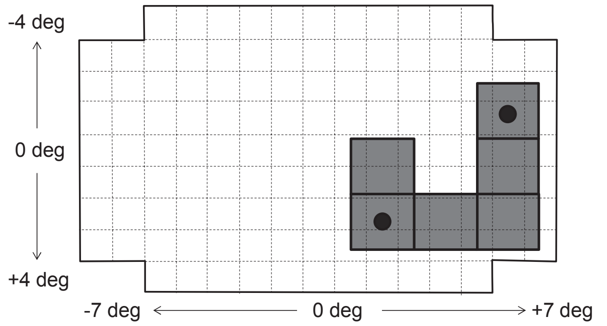



(a) Front-light

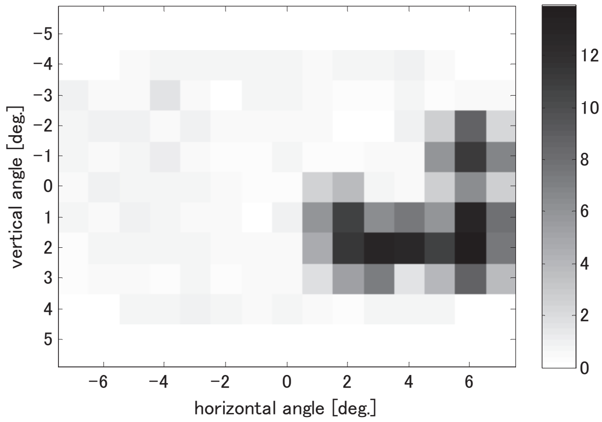



(b) Back-light

Fig. 1 Experimental Arrangement.

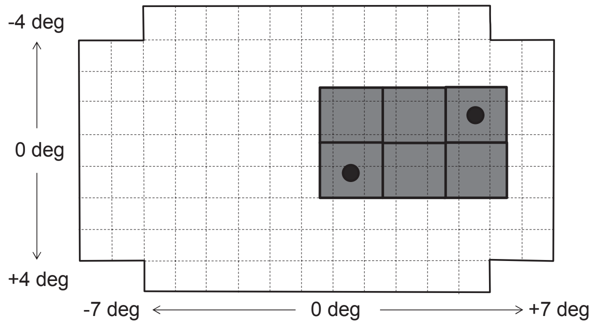



(a) Target arrangement in FOV

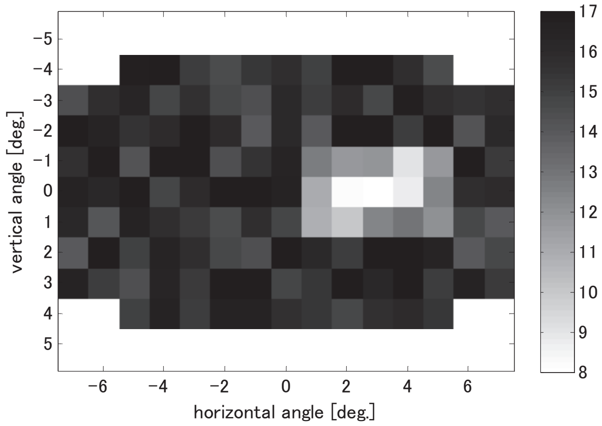



(b) Combination of 30 images of target scatterings

Fig. 2 An ANI result in a case of front-light (Target B).




(a) Target arrangement in FOV




(b) Combination of 200 images of target scatterings

Fig. 3 An ANI result in a case of back-light (Target C)