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Source Localization of Biological Transient Noise Using a Pair of Tetrahedron Hydrophone Array

1 対の正四面体ハイドロフォンアレイを用いた生物突発性雑音の音源測位

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1. Introduction

It is common knowledge that one of the most pervasive sources of biological noise in shallow warm waters is snapping shrimp. This noise is pervasive and is constantly present at latitudes less than 40°.[1-3] A snapping shrimp has one enlarged claw that produces a short acoustic transient signal when snapped closed. A typical waveform of snap has a low intensity positive excursion (precursor) and a short time pulse with high intensity (main pulse).[4] In a previous ocean acoustic observation, it had been estimated that the principal habitat of snapping shrimp population is the subsurface structure of wharves.[5]

In this study, we observed biological transient noises with a pair of tetrahedron hydrophone array in October 2009 and May 2010. Our aim was to estimate the source positions of those noises and the peak-to-peak source levels. The observation site was Hashirimizu port in Yokosuka.

2. Experimental measurements.

The observation place was the maritime training harbor of National Defense Academy in Hashirimizu**.** This harbor faces Tokyo bay, the breakwater suppresses the surface wave in the harbor. It also shuts out the ship sounds of the marine traffic from Uraga Channel. Therefore this site was suitable to observe only snapping noises. The observation was conducted on Oct. 20, 2009 and May 12, 2010.

Fig. 1 shows the experimental setup for estimating source positions of biological transient noises using a pair of tetrahedron hydrophone array. Four hydrophones were mounted onto tops with separation of 1 m on each array. The separation of the two arrays was about 10 m. Each hydrophone (B&K, Type 8105) took absolute sound measurements over the frequency range of 0.1 Hz to 160 kHz with a receiving sensitivity of -205 dB re 1 V/μPa. The hydrophones had perfect omni-directionality over 360° in the horizontal plane and 270° in the vertical plane. Each received signals were amplified with the gain of 40 (50) dB and those bands are limited from 200 Hz to 200 kHz (System Intech, Aquafeeler SEQ-1001C). Finally, all signals were digitized by the A/D converter (National Instruments, PXI-1036, PXI-6133, PXI-8360). The sampling frequency was 1MHz and the quantization bit rate is 14 bits.

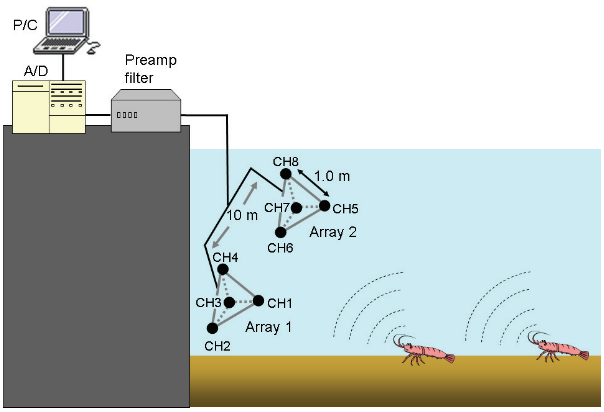


Fig. 1 Experimental setup for estimating source positions of biological transient noises.

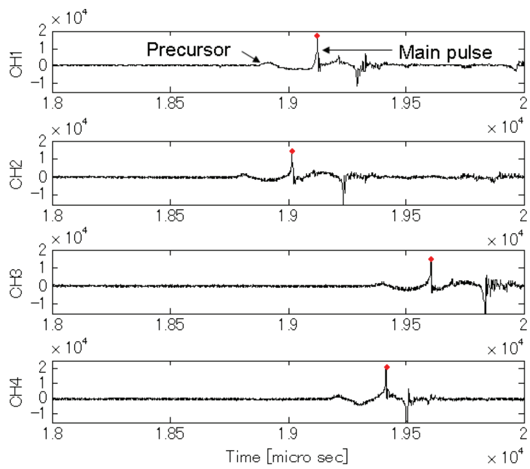
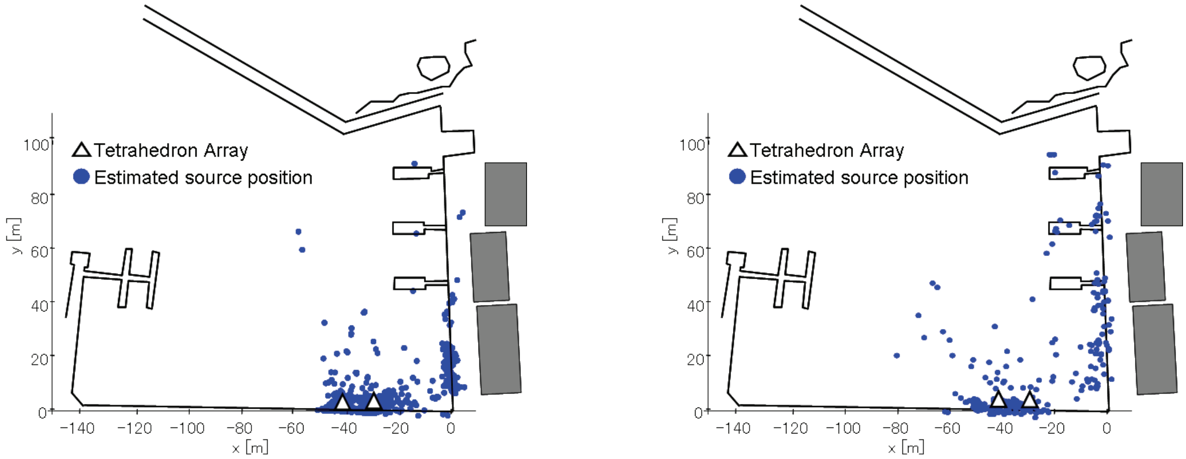


Fig. 2 Examples of observation signals of snapping sound on May 12, 2010.



(a) Oct. 20, 2009 (b) May 12, 2010

Fig. 3 Estimated source positions.

3. Results

Fig. 2 shows the examples of the observation signals. It can be seen that each signal has a precursor and a main pulse. These waveforms agree with those of the sound radiated by snapping shrimp. As the similar waveforms shifted on the time axis corresponding to the distances between the source and hydrophones, it is possible to obtain the relative time of arrival of the pulse at each hydrophone. The source positions were estimated by the passive localization technique with these time differences.

The estimated source positions are shown in **Fig. 3**. Here**,** we collected individual pulses, where the received amplitude was over 145.0 dB re 1μPa, with the typical waveform on Oct. 20, 2009 and 711 pulses were extracted from the recorded data of 10 minutes. We also collected 322 pulses from the recorded date of 5 minutes, where the received amplitude was over 135.0 dB re 1μPa on May 12, 2010. Most of the source positions of the snapping sounds were coincident with the position of the wharf edge near the arrays. This result is similar to the previous observation in Sydney Harbour.[5]

We calculated the received peak-to-peak level (*PL*) and the peak-to-peak source level (*SPL*) of each pulse as follows:

$$PL = 20 \log v - S_R - G_R \text{ (dB re 1 } \mu\text{Pa)},$$
$$SPL = PL + 20 \log r \text{ (dB re 1 } \mu\text{Pa at 1m)},$$

where v (V) is the voltage of the preamplifier output, S_R (dB re 1 V/μPa) is the sensitivity of the hydrophone, G_R (dB) is the gain of preamplifier, and r (m) is the distance between the source and the hydrophone. Here, the absorption loss is neglected because the distance r is shorter than 100 m. The average *SPL* was 180.9 dB and its standard deviation was 6.3 dB on Oct. 20, 2009 and the *SPL* is the average of 169.8 dB and its standard deviation of 7.8 dB on May 12, 2010. In a previous study, the source level ranged from 183 to 190 dB re 1 μPa at 1 m in a tank experiment in which the source levels were averaged over ten snaps from each of 40 snapping shrimp specimens gathered in Kaneohe Bay.[4] The mean value of the source levels of 1000 pulses *in situ* measured in Sydney Harbour was 187 dB re 1 μPa at 1 m.[5] The mean source level of our measurements was smaller than the values of the previous studies.

4. Summary

In this study, biological transient noises were measured at Hashirimizu Port in Tokyo Bay. The source positions of individual pulses were also estimated using a pair of a tetrahedron arrays. The estimated source positions were concentrated near the wharf edge. The remarkable difference of the estimated source positions was not observed between spring and autumn. However, the peak-to-peak source level was lower than those of the previous studies.

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References

1. V. O. Knudsen, R. S. Alford and J. W. Emling: J. Mar. Res. **7** (1948) 410.
2. F. A. Everest, R. W. Yound and M. W. Johnson: J.Acoust. Soc. Am. **20** (1948) 137.
3. D. Cato: Acoust. Australia. **20** (1993) 76.
4. W. W. L. Au and K. Banks: J. Acoust. Soc. Am. **103** (1998) 41.
5. B. G Ferguson and J. L. Cleary: J. Acoust. Soc. Am. **109** (2001) 303