3P-44

Proceedings of Symposium on Ultrasonic Electronics, Vol. 31 (2010) pp. 543-544
6-8 December, 2010

Modified Sound Source Detection Technique with Zero Padding

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1. Introduction

To detect the insulator in the fault state on the electric poles, we first measured radiation sounds from the normal state insulators and the error state insulators in the anechoic chamber. We found two apparent results from their frequency spectrums – one is 120Hz harmonic components, the other is high average noise level than normal state ones[1]. Then we also applied a technique for the direction detection of fault state insulator using the cross correlation from the three dimensional array microphones. But the source from out of source image plane, it occurred the wrong direction estimations. For the preveting wrong estimation, we introduce a modified source localization technique with zero padding.

2. A Source Localization Technique

For the estimation of the direction of the insulator in fault state, we applied the technique using the time delay between received signals in the pair of array sensors and to map it as the corresponding source position[2-3]. **Figure 1** shows a pair of sensors and source arrangement. From the cross correlation function between the reference sensor and the *i*th sensor, the time delay is given by .[7)]

$$\tau_i = \frac{d_i \cos\theta_i}{c_0} \tag{1}$$

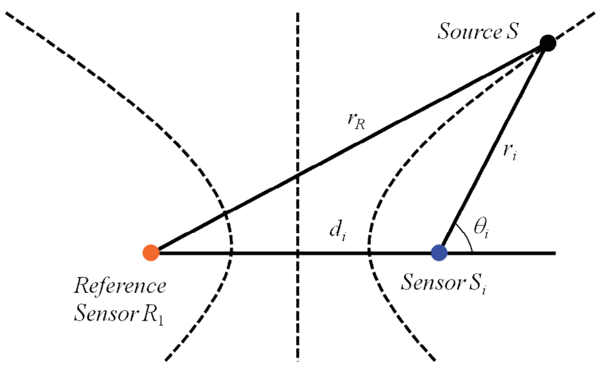

Fig. 1 A pair of sensors, sound source and path length difference.

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For the estimation of the source direction on 3D space, we designed the 4 microphones' position - one reference sensor and three sensors - as shown **Fig. 2**. The source image plane is regarded as the location of insulators on the electric pole.

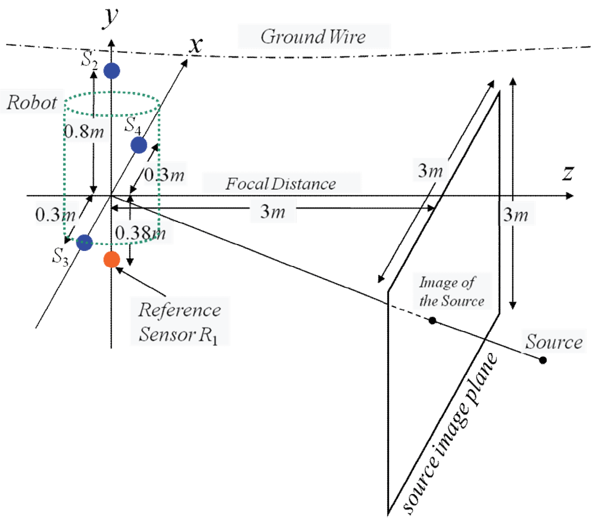


Fig. 2 An array geometry, coordinate and source image plan.

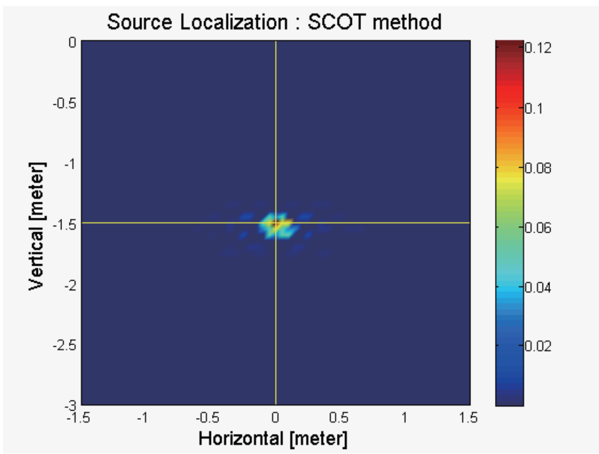


Fig. 3 A simulation result of the estimation of a source at (0, -1.5, 3)*m*.

Figure 3 shows an simulation example of the estimation when the source is located at (x, y, z)=(0, -1.5, 3)*m*. In **Fig. 4** (a) shows another example when the source is located at (x, y, z)=(0, 0, 10)*m*.

This source is out of range for this system and regarded as other noises, but it shows on the image plane. To solve this problem, we calculated the maximum and minimum time delays on boundary points using Euclidean distance. The zeros were replaced out of the each limit as shown **Fig. 5**, and then we could get the region limited result.

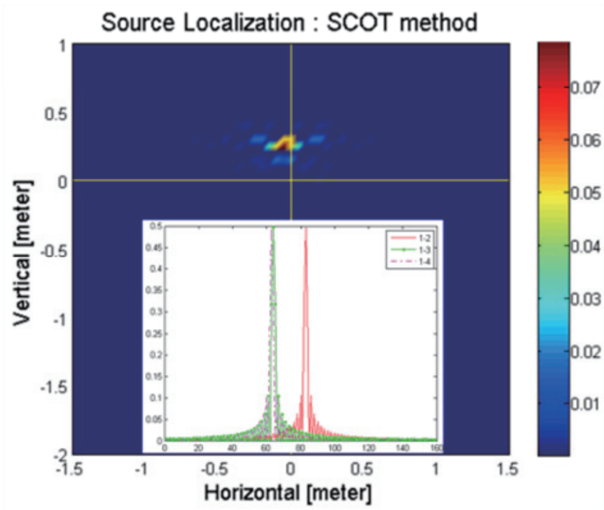
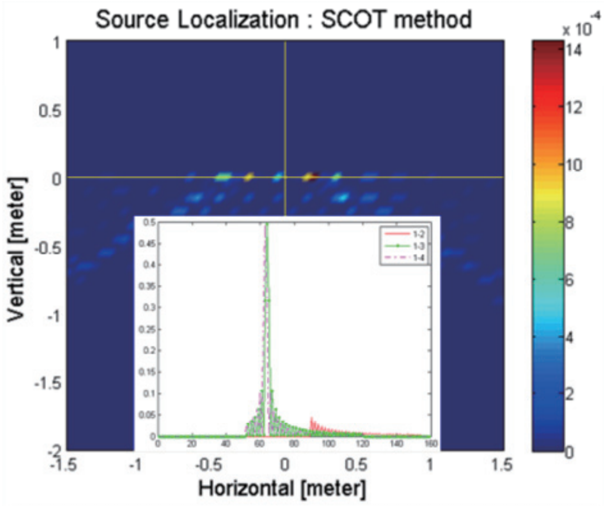


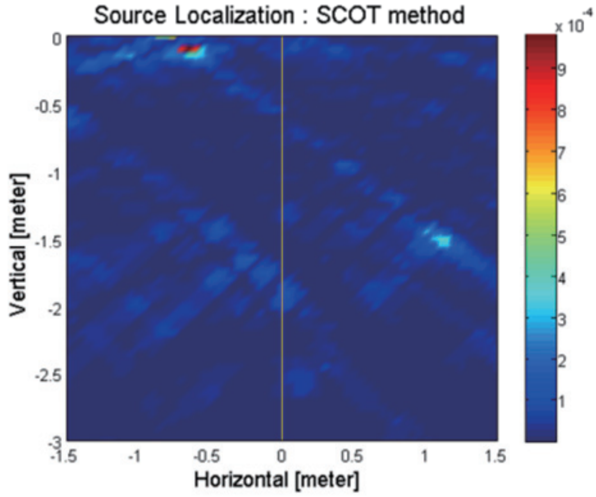
Fig. 4 Another example when the source is located at (x, y, z)=(0,0,10)m.



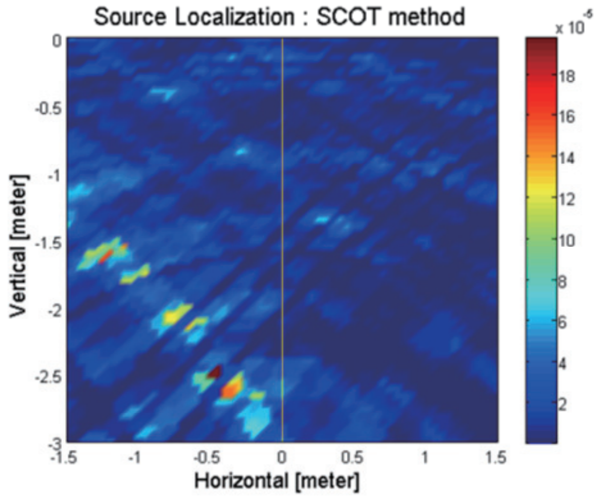
(b)

Fig. 5 Another simulation result of the estimation of a source at (0, 0, 10)m with zero padding.

Figure 6 shows real source estimated results in outside:(a) the real source was located at (x, y, z)=(-0.6, -0.1, 3)m and (b) the source was located out of the image plane. In (b), it looks as there are two or three sources in the image plane, but the values are 50 times low than (a).



(a)



(b)

Fig. 6 Results of the estimation of real source with zero padding, (a) at (-0.6, -0.1, 3)m, (b) at out of the image plane.

References

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