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Discussion

Reply to the comments on "Reply to the comments on 'The boundary point method for the calculation of exterior acoustic radiation' (by S.Y. Zhang, X.Z. Chen, *Journal of Sound and Vibration* 228(4) (1999) 761–772)"

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At first, I think I should tell the commenter that the idea in our original paper to replace the sound field generated by an arbitrary object by that produced by point sources distributed inside the surface of a real object is right. It is just like the equivalent source method (ESM) appeared in Ref. [1]. The commenter should know that the Eq. (6) in his comments on our first reply is approximately but not really equal and is the same as that in the ESM. The difference between the ESM and our method is the way to obtain the equation.

In the ESM, the equation is obtained by solving the source strengths at first, which has been discussed in our first reply and is given again in the following.

The source strength W is determined by the normal derivative of the velocity potential on the surface as

$$W = \left(\frac{\partial \Phi_T^*}{\partial \mathbf{n}}\right)^{-1} \frac{\partial \Phi}{\partial \mathbf{n}}, \tag{1}$$

where $\partial \Phi_T^* / \partial \mathbf{n}$ is created by the point sources, and $\partial \Phi / \partial \mathbf{n}$ is given by the measured surface normal velocity. The velocity potential Φ on the surface can be obtained by

$$\Phi = \Phi_T^* W = \Phi_T^* \left(\frac{\partial \Phi_T^*}{\partial \mathbf{n}}\right)^{-1} \frac{\partial \Phi}{\partial \mathbf{n}}. \tag{2}$$

In our method, the same equation can be obtained. Every point source distributed inside the vibrating object can create a set of particular solutions Φ_{Ti}^* and $\partial \Phi_{Ti}^* / \partial \mathbf{n}$ of velocity potential and its normal derivative on the surface, respectively. If the surface of the vibrating object is vibrating with Φ_{Ti}^* and $\partial \Phi_{Ti}^* / \partial \mathbf{n}$, i.e., Φ_{Ti}^* and $\partial \Phi_{Ti}^* / \partial \mathbf{n}$ are regard as the boundary conditions of the vibrating object, then its radiating field can be described by the well-known Kirchhoff–Helmholtz integral equation and its matrix forms. Here, the matrix form on the

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surface of the vibrating object is as follows:

$$\mathbf{A}\Phi^*_{Ti} = \mathbf{B}\frac{\partial \Phi^*_{Ti}}{\partial \mathbf{n}}. \tag{3}$$

If N point sources are distributed inside the vibrating object, then N equations like Eq. (3) can be established and combined as

$$\mathbf{A}\Phi^*_{T} = \mathbf{B}\frac{\partial \Phi^*_{T}}{\partial \mathbf{n}}. \tag{4}$$

Here, the number and the positions of the point sources are the same as those in the ESM.

Then, by performing the inversion of the matrices $\mathbf{A}$ and $\partial\Phi^*_T/\partial\mathbf{n}$, Eq. (4) can be rewritten as

$$(\mathbf{A})^{-1}\mathbf{B} = \Phi^*_T\left(\frac{\partial \Phi^*_{T}}{\partial \mathbf{n}}\right)^{-1}. \tag{5}$$

Then, the velocity potential Φ on the surface can be obtained by

$$\Phi = (\mathbf{A})^{-1}\mathbf{B}\frac{\partial \Phi}{\partial \mathbf{n}} = \Phi^*_T\left(\frac{\partial \Phi^*_{T}}{\partial \mathbf{n}}\right)^{-1}\frac{\partial \Phi}{\partial \mathbf{n}}. \tag{6}$$

It is obvious that Eq. (6) is the same as Eq. (2). I don't know why the commenter said that our method was wrong and our following work was wrong.

In fact, the similar equation can be found in Ref. [2]. The transfer matrix $\mathbf{G}_v(\mathbf{x}^\Gamma|\mathbf{x}_S;\omega)$ in Eq. (14) and on page 557 is constructed by the particular solution sources inside the vibrating object as

$$\mathbf{G}_v(\mathbf{x}^\Gamma|\mathbf{x}_S;\omega) = \boldsymbol{\Psi}(\mathbf{x}^\Gamma;\omega)\boldsymbol{\Phi}(\mathbf{x}_S;\omega)^+, \tag{7}$$

where $\boldsymbol{\Psi}(\mathbf{x}^\Gamma;\omega)$ and $\boldsymbol{\Phi}(\mathbf{x}_S;\omega)$ are the particular solutions to the Helmholtz equation.

If the distributed sources in our method are the same as the particular solution sources and they are located in the same positions, Eq. (7) is the same as the Eq. (10) in our original paper.

References

[1] L. Song, G.H. Koopmann, J. Fahnline, A method for computing acoustic fields based on the principle of wave superposition, *Journal of the Acoustic Society of America* 86 (5) (1989) 2433–2438.

[2] X. Zhao, S.F. Wu, Reconstruction of vibroacoustic fields in half-space by using hybrid near-field acoustical holography, *Journal of the Acoustic Society of America* 117 (2) (2005) 555–565.