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Discussion

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

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The original paper attempts to replace the sound field generated by an arbitrary object by that generated by point sources distributed inside the surface of a real object. The basic process can be summarized as follows. First, consider the sound generated by an arbitrary object in a free field. Using the standard Helmholtz integral formulation, one can derive a matrix equation of the form

$$[\mathbf{A}]\{\mathbf{\Phi}\} = [\mathbf{B}]\left\{\frac{\partial \mathbf{\Phi}}{\partial n}\right\}, \tag{1}$$

where $\{\Phi\}$ represents the velocity potential on the surface, $\{\partial\Phi/\partial n\}$ indicates the normal surface velocity, $n$ is the unit surface normal, and $[\mathbf{A}]$ and $[\mathbf{B}]$ are the matrices that relates velocity potential to the normal surface velocity.

Next, the point sources are distributed inside the surface of a real object and the resultant sound field is written in a similar manner as

$$[\mathbf{A}]\{\mathbf{\Phi}^*\} = [\mathbf{B}]\left\{\frac{\partial \mathbf{\Phi}^*}{\partial n}\right\}, \tag{3}$$

where $\{\Phi^*\}$ and $\{\partial\Phi^*/\partial n\}$ are the velocity potential and its normal derivative due to point sources, respectively.

By inverting the matrix $[\mathbf{A}]$ in Eq. (3), one can write the velocity potential $\{\Phi^*\}$ as

$$\{\mathbf{\Phi}^*\} = [\mathbf{A}]^{-1}[\mathbf{B}]\left\{\frac{\partial \mathbf{\Phi}^*}{\partial n}\right\}. \tag{5}$$

Performing the same inversion of matrix $[\mathbf{A}]$ in Eq. (1), one can solve for the velocity potential $\{\Phi\}$ in terms of $\{\partial\Phi/\partial n\}$, $\{\Phi^*\}$, and $\{\partial\Phi^*/\partial n\}$.

$$\{\mathbf{\Phi}\} = [\mathbf{A}]^{-1}[\mathbf{B}]\left\{\frac{\partial \mathbf{\Phi}}{\partial n}\right\} = \{\mathbf{\Phi}^*\}\left\{\frac{\partial \mathbf{\Phi}^*}{\partial n}\right\}^{-1}\left\{\frac{\partial \mathbf{\Phi}}{\partial n}\right\}. \tag{6}$$


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Eq. (6) is the major result of this paper, which is based on an implicit assumption that the matrices [**A**] and [**B**] for an arbitrary vibration object are exactly the same as those of the point sources distributed inside the surface of this object.

I believe this assumption is wrong because the locations of the point sources are different from those of the surface points. Therefore, one will in general obtain two sets of matrices: [**A**] and [**B**] for $\{\Phi\}$ and $\{\partial\Phi/\partial n\}$, and [$\mathbf{A}^*$] and [$\mathbf{B}^*$] for $\{\Phi^*\}$ and $\{\partial\Phi^*/\partial n\}$.

A correct way is to determine the source strengths of point sources first by matching the sound produced by an arbitrary object to that generated by point sources. Once this is done, we can describe sound radiation in the region external to the real object using distributed point sources.

In the original paper, there is no mention of determination of source strength of distributed the point source. In the authors' reply, they gave the relationship, Eq. (6). However, they still made the same mistake as they did in their original paper. Namely, they assumed that the matrices [**A**] and [**B**] are the same for both velocity potential functions represented by $\{\Phi\}$ and $\{\Phi^*\}$. I want to point out this mistake because it has permeated through several follow-up papers by these authors and their colleagues. I hope this comment can alert everyone that this approach is wrong and a correct one should be taken in predicting sound radiation.