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Numerical Simulations of Acoustic Imaging in Hydrodynamic Tunnel with Model Adaptation and Boundary Layer Noise Reduction

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Abstract : The noise requirements for naval and research vessels have seen an increasing demand for quieter ships in order to fulfil current regulations and to reduce the effects on marine life. Hence, new methods dedicated to the characterization of propeller noise, which is the main source of noise in the far-field, are needed. The study of cavitating propellers in closed-section is interesting for analyzing hydrodynamic performance but could involve significant difficulties for hydroacoustic study, especially due to reverberation and boundary layer noise in the tunnel. The aim of this paper is to present a numerical methodology for the identification of hydroacoustic sources on marine propellers using hydrophone arrays in a large hydrodynamic tunnel. The main difficulties are linked to the reverberation of the tunnel and the boundary layer noise that strongly reduce the signal-to-noise ratio. In this paper it is proposed to estimate the reflection coefficients using an inverse method and some reference transfer functions measured in the tunnel. This approach allows to reduce the uncertainties of the propagation model used in the inverse problem. In order to reduce the boundary layer noise, a cleaning algorithm taking advantage of the low rank and sparse structure of the cross-spectrum matrices of the acoustic and the boundary layer noise is presented. This approach allows to recover the acoustic signal even well under the boundary layer noise. The improvement brought by this method is visible on acoustic maps resulting from beamforming and DAMAS algorithms.

Keywords : acoustic imaging, boundary layer noise denoising, inverse problems, model adaptation
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