Optimal design for acoustic unobservability in water

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Until now, it was only possible to optimize an acoustic cloaking structure for the air environment. However, with this latest research, "Acoustic cloak designed by topology optimization for acoustic-elastic coupled

systems," published in the latest *Applied Physics Letters,* it is possible to design an acoustic cloak for underwater environments.

In the conventional topology optimization of acoustic cloaking, the design method was based on an analysis that approximated an elastic body in the air as a rigid body. However, since the approximation holds only for materials that are sufficiently stiff and dense such as metal in the air, there were few material options other than metal. Moreover, it was impossible to design an acoustic cloak in water by the approximation method.

In this study led by Garuda Fujii of Shinshu University, the group developed topology optimization based on the finite element analysis of coupled acoustic-elastic wave propagation. By considering the interaction between the vibration of the elastic body and the sound wave in the optimization calculation, it is now possible to select the material that constitutes the acoustic cloak from light ABS and other materials and to design the acoustic cloak for use in air and water. Furthermore, the group successfully designed wide frequency band acoustic cloaks optimized respectively for each environment, aerial and underwater.

This novel research has made it possible to select the constituent materials of the acoustic cloak and the surrounding acoustic medium environment (air or underwater) with a high degree of functionality. It is expected that the functions of acoustic cloaking will be greatly expanded.

More information: Garuda Fujii et al, Acoustic cloak designed by topology optimization for acoustic–elastic coupled systems, *Applied Physics Letters* (2021). DOI: 10.1063/5.0040911

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