AUV Exterior Acoustic Scattering Case Study

FastBEM Acoustics®

Large AUV model | FastBEM Acoustics V9.0 | up to 20 kHz full-space analysis

Boundary elements	Boundary nodes	Field points	Frequency	Iterations	Wall time
362,542	181,269	1,782,225	20 kHz	104	971.93 s

Study method and numerical setup

Objective: Evaluate plane-wave scattering from a detailed 1.0 m long autonomous underwater vehicle (AUV) in water and solve both the surface acoustic pressure and the surrounding scattered-pressure field.

Key steps:

1. Prepare and repair the CAD model so the surface is closed, consistently oriented (inward normal), and free of gaps or duplicate faces.

2. Build a nearly uniform triangular boundary mesh. Uniform sizing is preferred because abrupt element-size changes can increase BEM equation conditioning.

3. Set the boundary condition. This rigid-scattering case uses zero normal surface velocity and one unit-amplitude plane wave propagating in -Z direction.

4. Create the field surface and sampling points around the AUV before the solve so the scattered wave pattern can be evaluated directly.

5. Maintain at least 10 elements per wavelength at the highest frequency. At 20 kHz in water, the wavelength is 75 mm and the guideline size is 7.5 mm or smaller; the 2 mm mesh used here is substantially smaller.

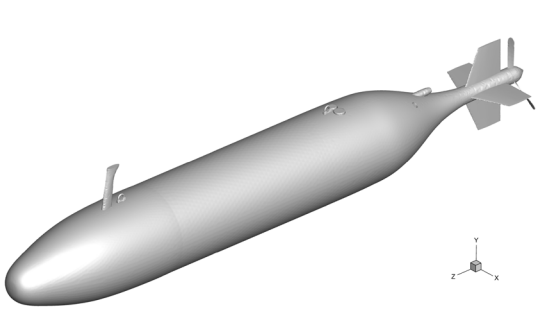
6. Use FMM for large models to reduce the memory and computational cost of the dense boundary-element system, then check convergence and visualize boundary and field results.

FastBEM setup:

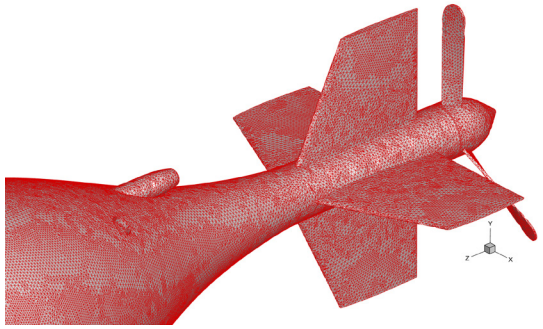
Medium c = 1500 m/s and density = 1000 kg/m3

FMM parameters nexp = 28; 100 elements per leaf; 1.0E-4 convergence tolerance; 10 CPU threads

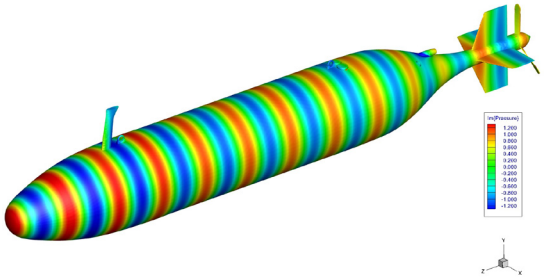
Model and computed response



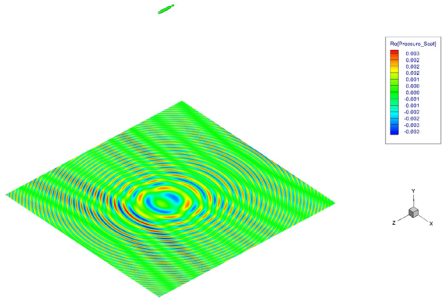
CAD model



Uniform 2 mm triangular boundary mesh



Computed boundary total acoustic pressure



Scattered acoustic pressure on the field surface

Result. The FMM solution converged normally in 104 iterations to a residual of 9.954E-5. The complete run used 971.93 s wall-clock time on a laptop PC, including field evaluation. The sound pressure contours show the total-wave variation over the AUV and the interference pattern on the field surface (10 m below the AUV).