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A Massively Parallel Finite Element Capability for Forward and Inverse Structural Acoustics Simulations

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Implicit, three-dimensional structural acoustic simulations on highly complex structural models that are immersed in infinite and semi-infinite acoustic domains typically leads to large numbers of degrees of freedom that cannot be solved with commercial software packages. Typical applications include underwater acoustic simulation of submerged structures, reverberation testing of aerospace structures, and aeroacoustic radiation from complex, three-dimensional structures. Many of these applications of interest involve large acoustic domains and high frequency ranges, thus making a finite element solution an attractive option for the forward and inverse problems. This has motivated the development of Sierra-SD, which provides a scalable finite element simulation package for large-scale, complex structural acoustic models.

In this talk we will present the current state of Sierra-SD in the area of structural acoustic modeling. We will discuss recent research efforts in Sierra-SD in the area of structural acoustics, including infinite elements, perfectly matched layers (PML), nonlinear acoustics, and mismatched structural/acoustic meshes, and the corresponding capabilities that have emerged from those efforts. We will also present a partial differential equation (PDE) constrained optimization approach for solving inverse problems in structural acoustics that uses Sierra-SD for solving the forward and adjoint problems. Inverse problems are commonly encountered in structural acoustics, where accelerometer and/or microphone pressures are measured experimentally, and it is desired to characterize the acoustic sources and/or material parameters that produced the measurements. With a PDE-constrained optimization approach, the scalability of Sierra-SD can be leveraged for solving inverse problems.

We will present results on the application of Sierra-SD on several large-scale structural acoustic applications examples of interest.

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