SAND2011-1060C

# A MASSIVELY PARALLEL TIME-DOMAIN INFINITE ELEMENT APPROACH FOR FAR-FIELD ACOUSTIC CALCULATIONS

Manoj Bhardwaj[1], Clark Dohrmann, Garth Reese, Timothy Walsh, and Riley Wilson

[1] Sandia National Laboratories[i] and Presenting Author, Albuquerque, NM. Email: mkbhard@sandia.gov

Finite element analysis of transient acoustic phenomena on unbounded exterior domains is very common in engineering analysis. In these problems there is a common need to compute the acoustic pressure at points outside of the acoustic mesh, since meshing to points of interest would be impractical. In aeroacoustic calculations, for example, the acoustic pressure may be required at tens or hundreds of meters from the structure. In these cases, a method is needed for postprocessing the acoustic results to compute the response at far-field points. Due to the large extent of exterior domains it is common for these problems to involve large numbers of unknowns, thus necessitating a parallel implementation of the element assembly, solution, and post-processing phases. We describe a parallel domain decomposition solver based on GMRES for solving the nonsymmetric system of linear equations, and we discuss the stability of the transient equations of motion. Also, since the variable-order infinite elements are much more costly than the acoustic elements when the order is increased, we describe a weighting procedure to help achieve a balanced domain decomposition.

We will also compare two methods for computing far-field acoustic pressures, one derived directly from the infinite element solution, and the other from the transient version of the Kirchoff integral. For the infinite element solution, we describe a nonlinear iteration method for locating far-field points within a specific infinite element, and then we use the infinite element shape functions to interpolate the solution. We compare the accuracy, implementation and parallel efficiency of the infinite element and Kirchoff integral methods.

## References

[1] R. J. Astley, J.P. Coyette and L. Cremers, "Three dimensional Wave Envelope Elements of Variable Order for Acoustic Radiation and Scattering. Part II. Formulation in the Time Domain.", *JASA*, Vol. 103, No. 1, 1998.

[2] R. J. Astley and J.A. Hamilton, "The Stability of Infinite Element Schemes for Transient Wave Problems", *CMAME*, Vol. 195, 2006.

---

[i] Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under contract DE-AC04-94AL85000.