SAND2001-0761A

DISTRETIZATION CHARACTERISTICS OF STABILISED GALERKIN MESHFREE METHOD

Y. You[1], J. S. Chen[1], T. Voth[2]
[1]Department of Mechanical Engineering
The University of Iowa
3322 Seamans Center
Iowa City, IA 52242-1527
jschen@icaen.uiowa.edu

[2]Thermal and Reactive Processes Department
Sandia National Laboratories
MS 0836, P.O. Box 5800
Albuquerque, NM 87185-0836
e-mail: tevoth@sandia.gov

Conventional Galerkin meshfree methods employ Gauss quadrature in the integration of the weak form. The intrinsic feature of the meshfree approximation theory, however, is not consistent with this integration technique. Higher order Gauss quadrature rules are required to minimize the error due to mismatching between shape function supports and the integration cells. In addition, Gauss integration does not satisfy linear exactness in the Galerkin approximation with arbitrary discretization. A stabilized conforming nodal integration (SCNI) [1] has been developed to address the efficiency issue in meshfree methods. In this approach, a strain smoothing stabilization has been proposed to provide a stabilization of nodal integration. The gradient matrix associated with the strain smoothing stabilization also satisfies integration constraints and therefore meets linear exactness in the Galerkin method. Studies have shown that SCNI significantly reduces computational effort with almost no loss of accuracy.

The aforementioned studies were limited to static boundary value problems. This paper focuses on the assessment of the numerical performance of SCNI meshfree methods in transient problems. This paper employs von Neumann analysis to investigate SCNI effects on the characteristics of meshfree semi-discretization in space. The combined effects of spatial and temporal discretizations are also investigated with respect to transient analysis. Two model problems were presented with respect to the normalized phase speed and group speed for the wave equation, and normalized diffusivity for the heat equation. Both consistent and lumped mass (capacity) discretizations are considered in the study. The transient properties in the full discretization of the two model problems are also analyzed. The results show superior dispersion behavior in meshfree methods integrated by SCNI compared to the Gauss integration when consistent mass (capacity) matrix is employed in the discretization. For the lumped mass case, SCNI performance is comparable to that of the Gauss integration, but exhibits considerable reduction of computational time.

Reference

[1] Chen, J. S., Wu, C. T., Yoon, S., and You, Y., "Stabilized Conforming Nodal Integration for Galerkin Meshfree Methods," *Int. J. Numer. Meth. Eng.*, v. 50, pp. 435-466, 2001.

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.