7th African Conference on Non Destructive Testing (ACNDT) & the 5th International Conference on NDT and Materials Industry and Alloys (IC-WNDT-MI)

2016

Investigating Applicability of Discontinuous Galerkin Methods Towards Structural Health Monitoring in Transportation

Salah-Eddine Hebaz, Farouk Benmeddour, Emmanuel Moulin, Jamal Assad

Abstract : Ultrasonic guided waves offer an ef?cient means of rapid non-destructive inspection over long distances. Several researches has been conducted to study and modelise ef?ciently the propagation of these waves in large structures with arbitrary cross-sections like rails, bars, tubes, and plates. Classical numerical methods such as the ?nite element method (FEM), the semi-analytical ?nite element method (SAFE), the hybrid method FEM-SAFE, etc. have proved successful in this regard, but still have a major drawback: the high consumption of resources (memory and CPU time). Recently,the discontinuous Galerkin ?nite element method (DG-FEM) has revolutionised computations in the time domain through its potential in terms of applications and facilities it provides. In this work, the potential bene?ts of a class of discontinuous methods namely the interior penalty discontinuous Galerkin methods (IPDG) in the frequency domain are investigated by performing a modal analysis of a ?nite structure. The natural frequencies and vibration modes are searched via the eigenvalue problem derived from the discretisation of the Helmholtz problem with free boundaries, in one dimension of space. In line with the work of literature, it was foundthat the resulting solutions are correct and free of spurious modes. In addition, the discontinuous formulation provides an interesting algebraic system with a block tridiagonal stiffness matrix and a diagonal block mass matrix. Therefore, the eigenproblem can be reduced from a generalised problem to a standard one. For large size problems, this can lead to a signi?cant gain in computation time. Moreover, it retains its block-tridiagonal form for which effective and well suited for parallel implementation block algorithms are developed. Thus, the DG-FEM allows a double gain strategy in computation time/memory consumption and achieving high order accuracy.

Keywords : Structural health monitoring (SHM), Interior penalty discontinuous Galerkin methods (IPDG), Eigenvalue problem.