Johns Hopkins Whiting School of Engineering

Department of Civil and Systems Engineering

High Order Sensitivity and Uncertainty Analysis Using the Hypercomplex Finite Element Method

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Abstract

The use of hypercomplex variables and algebra within a finite element code provides a convenient method to obtain highly accurate, high order sensitivities of the degrees of freedom with respect to arbitrary shape, material and loading parameters. Subsequent post processing leads to sensitivities of the strains, stresses, strain energy, etc. The attraction of the method is that no new equations or finite element formulation is required – the method augments current formulations. The University of Texas at San Antonio (UTSA) has developed the hypercomplex finite element code ZFEM using a user-element within the Abaqus commercial finite element software. ZFEM has been applied successfully in a number of disciplines such as fracture mechanics, plasticity, heat transfer, and structural dynamics, among others. A highly efficient non-intrusive version has also been developed. ZFEM has recently been coupled with a moment-based uncertainty quantification method such that estimates of the mean, variance, skewness, and kurtosis can be obtained using only the ZFEM outputs. Applications to a number of disciplines will be presented.

About Our Speaker

Dr. Harry Millwater is the Samuel G. Dawson Professor of Mechanical Engineering at the University of Texas at San Antonio. His area of interest includes probabilistic mechanics and sensitivity methods as applied to structures subject to fatigue and fracture. He is the originator of the hypercomplex finite element method ZFEM. His grants include funding from Air Force Office of Scientific Research (AFOSR), Air Force Research Laboratory (AFRL), Army Research Office (ARO), Department of Defense (DoD), Federal Aviation Administration (FAA), National Institutes of Health (NIH), National Nuclear Security Administration (NNSA), Nuclear Regulatory Commission (NRC), Office of Naval Research (ONR), and Pacific Northwest National Laboratory (PNNL). He is the Principal Investigator for the development of the Smart suite of probabilistic fatigue codes for the FAA, and a past developer of the Nessus and Darwin probabilistic software codes.

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