Proceedings of CHT-15
ICHMT International Symposium on Advances in Computational Heat Transfer

May 25-29, 2015, Rutgers University, Piscataway, USA

CHT-15-262

A ROBUST AND EFFICIENT INVERSE MESHLESS METHOD FOR NON-DESTRUCTIVE THERMOGRAPHIC EVALUATION

Divo, E.[*,§], Boetcher, S.[*], Brown, J.[**], and Kassab, A.J.[***]
[*]Department of Mechanical Engineering
[**]Department of Civil Engineering
Embry-Riddle Aeronautical University, Daytona Beach, FL, USA
[***]Department of Mechanical and Aerospace Engineering
University of Central Florida, Orlando, FL, USA
[§]Corresponding author. Fax: 1-386-226-6011 Email: divoe@erau.edu

ABSTRACT A novel computational tool based on the Localized Radial-basis Function (RBF) Collocation (LRC) Meshless method, capable of accurately and efficiently solving transient multi-dimensional heat conduction problems in composite and heterogeneous media is formulated and implemented. The LRC Meshless method is coupled with a Volume-of-Fluid (VoF) scheme for the purpose of modeling heterogeneities in the conducting media. While the LRC Meshless method lends its inherent advantages of spectral convergence and ease of automation, the VoF scheme allows to effectively and efficiently simulate the location, size, and shape of cavities, voids, inclusions, defects, or de-attachments in the conducting media without the need to regenerate point distributions, boundaries, or interpolation matrices. To this end, the Inverse Geometric problem of Cavity Detection is formulated as an optimization problem that minimizes an objective function that computes the deviation of measured temperatures at accessible locations to those generated by the LRC-VoF Meshless method. The LRC-VoF Meshless algorithms is driven by an optimization code based on the Genetic Algorithms (GA) technique which can effectively search for the optimal set of design parameters (location, size, shape, etc.) within a predefined design space. Initial guesses to the search algorithm are provided by the classical 1D semi-infinite composite analytical solution which can predict the approximate location of the cavity. The LRC-VoF formulation is tested and validated through a series of controlled numerical experiments. This approach allows solving the onerous computational inverse geometric problem in a very efficient and robust manner while affording its implementation in modest computational platforms, thereby realizing the disruptive potential of this multi-dimensional high-fidelity non-destructive evaluation (NDE) method.

REFERENCES

Divo, E. and Kassab, A.J. [2007], An Efficient Localized RBF Meshless Method for Fluid Flow and Conjugate Heat Transfer, *ASME Journal of Heat Transfer*, Vol. 129, pp. 124-136.

Divo, E. and Kassab, A.J. [2008], Localized Meshless Modeling of Natural Convective Viscous Flows, *Numerical Heat Transfer, Part A: Fundamentals*, Vol. 53, No. 6, pp. 487-509.

Divo, E., Kassab, A.J. and Rodriguez, F. [2004], An Efficient Singular Superposition Technique for Cavity Detection and Shape Optimization, *Numerical Heat Transfer B*, Vol. 46, pp. 1-30.

Pepper, D.W, Kassab, A.J., and Divo, E. [2014], *Introduction to Finite Element, Boundary Element, and Meshless Methods: with applications to heat transfer and fluid flow*. ASME Press.