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A MESHLESS METHOD FOR THERMAL PROBLEMS: FROM THEORETICAL DEVELOPMENTS TO INDUSTRIAL APPLICATIONS

Božidar Šarler, Agnieszka Zuzanna Lorbiecka, Gregor Kosec, Robert Vertnik
University of Nova Gorica, Vipavska 13, SI-5000 Nova Gorica, Slovenia, bozidar.sarler@ung.si, agnieszka.zuzanna.lorbiecka@ung.si, gregor.kosec@ung.si, robert.vertnik@ung.si

ABSTRACT

Structure of a new meshless solution procedure for calculation of one-domain coupled macroscopic heat, mass, momentum and species transfer problems as well as phase field concepted models and cellular automata models of microstructure evolution is represented. The solution procedure is defined on a set of nodes which can be non-uniformly distributed. The domain and boundary of interest are divided into overlapping influence areas. On each of them, the fields are represented by the multiquadrics radial basis functions collocation or least squares approximation on a related sub-set of nodes. The transition rules are defined for a set of nodes on the influence area in case of cellular automata modelling. The timestepping is performed in an explicit way. All governing equations are solved in their strong form, i.e. no integrations are performed. The polygonisation is not present. The possible growth of the domain (like in the problems of die casting or continous casting) is described by activation of additional nodes and by the movement of the boundary nodes through the computational domain, respectively. The solution can be easily and efficiently adapted in node redistribution and/or refinement sense, which is of utmost importance when coping with fields exhibiting sharp gradients (phase field variable or enthaply, for example). Step by step theoretical developments and benchmarking of the method is represented, followed by industrial examples such as the dendritic growth, grain structure formation in continuous casting of steel and turbulence modelling with solidification. The results of the new approach are compared with the analytical solutions, recent well documented bench-mark solutions, and commercial packages. The method turns out to be extremly simple to code, accurate, inclusion of the complicated physics can easily be looked over. The coding in 2D or 3D is almost identical.

Key Words: *Thermal Problems, Multiphysics and Multiscale Modelling, Meshless Methods.*

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