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Hermite-type Meshfree Method with Discontinuous/Discontinuous-Derivative Basis Functions for Solving Hyperbolic-Type Equation by Using Pseudo-particle Method

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ABSTRACT

Hermite-type Moving Least Squares Approximation [1] with Discontinuous / Discontinuous-Derivative Basis Functions (HMLSA-DBF) is proposed for solving hyperbolic-type equations. In order to cure the difficulties for approximating discontinuous functions and functions with discontinuous derivatives, two schemes of Discontinuous / Discontinuous Derivative Basis Functions (DBF) are presented as: (A) the proper expressions of DBF are derived according to the continuity and discontinuity conditions of the functions; (B) a unified form of DBF is proposed according to "numerical discontinuity" in order to simplify the different expressions of DBF in (A). With value of function itself and its derivatives at sampling points, HMLSA-DBF can approximate the functions with various discontinuities more accurately than conventional meshfree method. Furthermore, the essential idea of Pseudo-particle Method in Cubic Interpolated Pseudo-particle Method/Constrained Interpolation Profile [2][3][4] Method (CIP) is employed to solve advection terms of the hyperbolic-type equations by the proposed HMLSA-DBF method. Numerical examples for one- and two-dimensional problems indicate that the proposed method is a stable and less diffusive method for solving hyperbolic-type equations with regularly and irregularly distributed nodes. Using DBF in Scheme (B) avoids selecting the proper expressions according to various continuity and discontinuity features of the problem as DBF in Scheme A. The convergent studies for recovering functions and solving hyperbolic-type equations reveal that the numerical results obtained by both kinds of DBF are identically accurate with superior convergence properties.

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