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Title: DEVELOPING DISCRETE-EXPANSIONS FOR A ONE-DIMENSIONAL NON-LINEAR RECONSTRUCTION FIELD

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Developing Discrete-Expansions For A One-Dimensional Non-Linear Reconstruction Field

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Background Numerical-solution methods for partial-differential equations (PDE's) that govern continuum fields often combine simple numerical tools. Two tools that are commonly used to both develop and analyze numerical PDE solvers are Taylor series expansions (TSE's) and cell-based interpolation which is discrete-field reconstruction. These tools, however, are incompatible. TSE's are only valid in a region where the function and its derivatives are continuous. In contrast, the continuity of interpolation functions and their derivatives is generally limited to one grid cell. Recently, however, discrete-expansions (DE's), were proposed and demonstrated [1-4] for multi-linear (linear, bi-linear and tri-linear) reconstruction fields that are valid within a computational domain; they properly account for reconstruction-field discontinuities across cell boundaries.

Objective Develop DE's for a one-dimensional (1-D), non-linear reconstruction field.

Milestones Successful completion of the research effort will include the following milestones.

• Select and characterize a commonly used 1-D, non-linear interpolation function. Characterization will include writing the function using various argument lists, and demonstrating the continuity of the function and its derivatives within and across computational cell boundaries.

• Develop and test the TSE and multi-variable expansion (MVE) of the selected function. While TSE's only consider the local, cell-based position vector as an independent variable, MVE's consider this position vector and the constant cell-vertex data as variables for expansion.

• Develop and test DE's for the selected function using the total-differential development method [2-4]. Other development methods may also be explored but only if time permits [1].

• Document the research through a technical report and presentation. The research report and the accompanying presentation material will be submitted for student competition.

References

[1] Brock, J. S., "A Finite-Difference Logical-Coordinate Evaluation Method for Particle Localization," *Progress of Theoretical Physics Supplement*, Vol. 138, pp. 40-42, 2000. (Los Alamos National Laboratory Report LA-UR-99-6493, 1999.)

[2] Brock, J. S., "Integrating a Bilinear Interpolation Function Across Quadrilateral Cell Boundaries," Los Alamos National Laboratory Report, LA-UR-00-3329, 2000.

[3] Brock, J. S. and Wiseman, J. R., "Discrete-Expansions for Linear Interpolation Functions," *Computer Physics Communications*, Vol. 142, pp. 206-213, 2001. (Los Alamos National Laboratory Report LA-UR-01-0216, 2001.)

[4] Dufek, P. D. and Brock, J. S., "Discrete-Expansions for Tri-Linear Reconstruction Fields," Los Alamos National Laboratory Report, LA-UR-03-xxxx, 2003.