Thermal Conduction and Local Stress Difference Material Point Methods

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When using the material point method (MPM) to model thermal conduction in geometries with uneven particle distributions, solution noise is observed and is unavoidable using standard MPM. Similarly, measuring the heat flux convergence for a system with a specified velocity field reveals that large amounts of particles per cell are required to obtain the expected linear convergence rate. Both these issues are similarly seen in the dual domain material point (DDMP) method.

We will show that both these issues were fixed when using local stress difference (LSD) methods adapted to the energy equation of MPM/DDMP. The energy implementation of LSD addresses the noise in a 1d bar of unevenly distributed particles, in line with previous results for the momentum equation implementation.

Using a 1D manufactured solution as a benchmark, we will show that LSD generalizations of MPMs greatly reduce the required number of particles to obtain linear heat flux convergence, often from requiring 32-64 particles per cell for MPM/DDMP, to as few as 2-4 for their LSD equivalents.