Equation-Based Models in
Discrete-Element and Agent-Based Simulations

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ABSTRACT: *There has arisen a significant capability in General Purpose Graphic Processing Unit (GPGPU) computing. This acceleration technology is applicable to the issue of rapid computational speed-up of real-time infrared sensing and analysis. This paper addresses the contributions of the ISI team to an effort to create a scalable thermal analysis tool for IR signatures in real time. Properly modeling or testing multi and hyper-spectral sensor performance requires accurate background and target signature models that capture the detailed physical processes that combine to produce real-world target signatures. Current approaches to real-time signature prediction, using collections of commercial desktop computers, lack the bandwidth, speed, and capacity to simultaneously account for all of the physical processes involved. These include heat transfer, radiation, conduction, and convection. Due to the computational bottleneck inherent in such approaches, convection (the most subtle and computationally demanding to model) is normally accounted for by simple models, and then the results are then uniformly applied to the 3-D target model as a whole. This results in a loss of fidelity in the predicted target signature. The approach under study has a multi-physics capability that simultaneously accounts for all of the physical processes involved in heat transfer. It will provide real-time, high-fidelity, hyper-spectral target signature data required for presenting scenes to hyper-spectral sensors. The problem is laid out, the design issues are discussed and progress toward the final solution is set forth. Bench-mark and any preliminary performance data will be given, comparing bench-marking with homogeneous computing with parallel instantiations on a homogeneous cluster and then with a heterogeneous cluster, using GPGPU programming to achieve virtual homogeneity.*