Optimizing Lagrangian particle tracking in parallel environment

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In this paper, we present the adaptive parallel approach to Lagrange particle tracking, where particles possess various lifetime values. Lagrange particle method is very suitable for a distributed programming model because the particle trajectories are entirely independent, but static domain decomposition where each processor is responsible for a certain amount of particles will cause the reduced efficiency of the distributed algorithm. The presented algorithm removes defects of the static domain decomposition and brings a novel approach to the discrete particle tracking. The algorithm introduces the master/slave model with partial trajectory optimization, where a certain number of processors produce partial trajectories and put them to the distributed queue while remaining processors simulate particle motion using generated partial paths. The whole system is adaptive to the total number of processors, while optimal job configuration, partial trajectory length, and the number of producers/consumers, is selected using ML model and evolutionary approach. The paper presents speedup improvement in the use case of Radon progeny behavior in the diffusion chamber, where particles posses exponential distribution of lifetime values and Maxwell speed distribution. The algorithm is implemented in C language, using MPI, and archives speedup close to ideal.

References

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