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A novel state-space based method for direct numerical simulation of particle-laden turbulent flows REETESH RANJAN, CARLOS PANTANO, University of Illinois at Urbana-Champaign — We present a novel state-space-based numerical method for transport of the particle density function, which can be used to investigate particle-laden turbulent flows. Here, the problem can be stated purely in a deterministic Eulerian framework. The method is coupled to an incompressible three-dimensional flow solver. We consider a dilute suspension where the volume fraction and mass loading of the particles in the flow are low enough so that the approximation of one-way coupling remains valid. The particle transport equation is derived from the governing equation of the particle dynamics described in a Lagrangian frame, by treating position and velocity of the particle as state-space variables. Application and features of this method will be demonstrated by simulating a particle-laden decaying isotropic turbulent flow. It is well known that even in an isotropic turbulent flow, the distribution of particles is not uniform. For example, heavier-than-fluid particles tend to accumulate in regions of low vorticity and high strain rate. This lead to large regions in the flow where particles remain sparsely distributed. The new approach can capture the statistics of the particle in such sparsely distributed regions in an accurate manner compared to other numerical methods.

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