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On particle distribution in High-Order Smoothed Particle Hydrodynamics schemes

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Smoothed particle hydrodynamics (SPH) numerical schemes are becoming very popular in CFD due to their Lagrangian and meshless nature. Nevertheless, many arising numerical issues still remain to be investigated. One of the major drawback of such meshless schemes is the low order convergence rate due to particle spatial anisotropy. To overcome this, considerable work has been done towards introducing kernel corrections. Nevertheless, these might lead to instabilities and break the conservation properties of the numerical scheme. Recently, it was demonstrated that schemes such as diffusion-based particle shifting are able to improve the accuracy of the approximations however, they do not conserve linear and angular momentum. In the present work, an arbitrary Lagrangian-Eulerian scheme (ALE-SPH) has been developed where the transport velocity is computed by means of an iterative particle shifting scheme which ensures a near isotropic particle distribution spatially. Moreover, a new class of kernels have been adopted that can guarantee an arbitrary order of convergence (at the continuous level of spatial interpolation). In this way, we have been able to attain the theoretical order of convergence of the adopted kernel (for example 4th or 6th order) preserving the conservation properties.