Coupling algorithm for finite volume and smoothed particles methods

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To expand the range of solvable problems, it is proposed to use an algorithm that combines the Finite Volume Method (FVM) and Smoothed Particle Hydrodynamics (SPH) [1], allowing simultaneous calculations with different methods in different spatial regions. For the FVM, a Riemann solver is used that takes into account the speed of the contact discontinuity [2], as is the case for SPH. The time step is chosen based on the Courant criterion for each method, and integration is performed with a common minimum time step. Virtual cells and particles are created near the interface, with data recalculated from the real particles and cells, respectively. To ensure a smoother and more accurate transition of material from the cell region to the particle region, as well as to maintain the continuity of the SPH medium, an algorithm for generating virtual particles has been developed and implemented. This algorithm uses a combined approach, integrating the Particle Shifting Technique (PST) [3] and free-surface detection [4] methods. This comprehensive algorithm generates particles and then shifts them at a small, computed speed relative to the material boundary, which allows for an even distribution of particles across the problem domain and ensures the continuity of the density field. The results of applying the algorithm are demonstrated through a series of test cases that show sufficient accuracy in preserving mass, momentum, and energy flux as the material transitions through the interface region.

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[3] Michel J e a 2022 *Journal of Computational Physics* **459** 110999
[4] Marrone S e a 2010 *Journal of Computational Physics* **229** 3652–3663