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A parallel Local-Adaptive-Mesh-Refinement-enabled Immersed Boundary Method for biological flows[1] WEI ZHANG, JUNSHI WANG, HAIBO DONG, Univ of Virginia — A fast parallel implementation of projection method for the time-dependent incompressible Navier-Stokes equation is presented on a patch-based local refined mesh on a hierarchy of rectangular blocks. A sharp immersed boundary method compatible with the coarse-fine interface interpolation was implemented on the non-conforming Cartesian grids for flows with immersed bodies. A two-dimensional Taylor-Green vortex example shows that a multi-dimensional at least second-order Lagrange interpolation is critical to achieving second-order accuracy in space. An intra-layer communication was identified for overlapping multi-blocks which enables a flexible refinement strategy and better load balance among computing nodes. The newly developed algorithm was benchmarked using flow passing fixed sphere and the results matched well with literature. The numerical simulation shows the parallel code is comparable in execution time to serial execution with the same dense mesh. It decreases slightly with an increased level of refinement. The newly developed algorithm is efficient for the bio-inspired flows where the refined region is predeterminable. Fish swimming and free-flying dragonfly cases are computed by the multi-block and moving block strategies, respectively. Applications to biomedical flow problems including human snoring and animal phonation are also demonstrated in this presentation.

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