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An optimization-based approach for interfaces with gaps and overlaps via virtual controls

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Partitioned approaches are popular for solving coupled problems with possibly different physics in each of one or more subdomains sharing an interface. Particularly when the physics differ, it may be advantageous or simply unavoidable to mesh the subdomains independently. In the case of refining a straight or flat interface, this may result in multiple discretizations that are coincident but have mismatched vertices. In the case of refining a curved surface, the resulting discretizations will likely be noncoincident and mismatched, having gaps and overlaps.

We present an optimization-based approach, which deals with the coupling between subdomains by introducing a virtual control as a natural boundary condition on each of the subdomains. Providing boundary conditions to the physics on each subdomain permits using separate solvers simultaneously. We introduce terms in the objective of our optimization that penalize any violation of global flux conservation or violation of continuity between states. Since the solvers each return a solution on their respective subdomain, it adds complication to comparing the continuity of states. In order to measure violations of continuity, we extend solutions between subdomains by means of extrapolation in a way that makes use of the gradient. We iteratively update the control until the objective is minimized. Computational results will be presented that demonstrate convergence to a manufactured solution, and also that the method can pass a linear consistency test.