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Efficient methods for optimal feedback control of mixing in a Stokes fluid flow IAN COUCHMAN, ERIC KERRIGAN, JOHN CHRISTOS VASSILICOS, Imperial College London — Many microfluidic applications require the mixing of fluids but the laminar nature of the flow can make this difficult. The advent of laboratory techniques, such as magnetohydrodynamics, make it possible to generate time-varying velocity fields and provide a mechanism by which a flow can be controlled. As such, research into the optimal control of mixing in advection-dominated flows is a highly relevant problem. This work considers the optimal control of a system comprising of a scalar field being advected by a velocity field, which is influenced by a control variable. The cost by which performance is judged is the 'mix-norm' defined in Mathew et al. (2005). The approach involves solving a dynamic optimization problem based on a low-order model with diffusivity several orders of magnitude larger than that of the actual system. This significantly reduces the complexity of the optimization problem. By solving recursively, feeding back the current system state as the initial model state, this work demonstrates that a controller based on a low-order model can provide satisfactory performance. A key benefit of this approach is the explicit incorporation of state and input constraints representative of some physical properties of the system or source.

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