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Adjoint-based control of a surfactant-free drop suspended in an axisymmetric straining flow SHREYAS BIDADI, DANIEL BODONY, Univ of Illinois - Urbana — Optimal control theory has been remarkably successful in controlling a wide variety of single-phase flows. However, to date there has been no fundamental study on its application to multiphase problems. In this study, the continuous adjoint method is employed for the first time to control a clean, neutrally buoyant droplet of viscosity $\mu_I$suspended in a low Reynolds number axisymmetric straining flow of viscosity μ_E. The control variable is the non-dimensional Capillary number C. For the forward problem, each C generates a distinct steady-state droplet. This information is utilized by the inverse problem to compute the adjoint velocities and the corresponding control gradient at the drop interface. The resultant gradient is subsequently used to update C. The algorithm is repeated until the desired shape is realized. To reduce computational cost, both the forward and adjoint velocities are obtained by solving Fredholm integral equations of the second kind. The theory is tested for three viscosity ratios; $\lambda = \mu_I/\mu_E = 0.1$, 1 and 10. For all three cases, the cost functional is successfully minimized. The adjoint gradient is shown to be in good agreement with the corresponding finite-difference approximation of it.

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