On a GRP solver for a hyperbolic model governing two-layer thin film flow

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This work is concerned with developing a second-order generalized Riemann solver for a simplified two-phase thin film flow model under the influence of a perfectly soluble anti-surfactant solute. The generalized Riemann problems (GRP) for nonlinear hyperbolic systems of balance laws in one space dimension are now well-known finite volume methods that generalize the first-order Godunov schemes. In fact, the $(n+1)$th order GRP scheme is based on an analytical evaluation of time derivatives up to nth order, which turns out to be dependent only on the spatial derivatives up to nth order. It is a well-known fact that the classical Riemann problem serves as a "building block" to develop many numerical schemes; in particular, the Godunov scheme is based on the solution of the Riemann problem. Similarly, the analytic study of generalized Riemann problems leads to a variety of GRP-based numerical schemes, which naturally extend the Godunov scheme. To develop a second-order GRP scheme for the concerned system, we use the Riemann invariant decomposition of the system and obtain the first-order time derivatives using the spatial derivatives only. Finally, the accuracy of the derived GRP solvers is justified with several numerical examples.