SPACE-TIME RESIDUAL DISTRIBUTION SCHEMES AND APPLICATION TO UNSTEADY TWO-PHASE FLOW COMPUTATIONS ON UNSTRUCTURED MESHES

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The extension of Residual Distribution Schemes to general *unsteady* and *complex inhomogeneous* systems of conservation laws poses several technical difficulties, which have made efforts unsuccessful until now. First, the schemes in their original formulation cannot be more than first order accurate in *space* in *unsteady* computations due to an inconsistent treatment of the time derivative in the discretization. Furthermore, the conservation property strongly relies on the existence of a Roe-type linearization of the Jacobians of the system, which is not available in general. Finally, including forcing terms in the discretization in a consistent way had not been achieved until now.

The goal of this project is therefore to cure the above problems and to demonstrate the application towards complex hyperbolic systems on a two-fluid two-phase flow model.

Second order of accuracy in time and space was obtained by using a space-time approach for which general boundary conditions, based on characteristic eigenvector decomposition, were implemented. A new source-term discretization, consistent with the Residual Distribution method, has been proposed and tested. This new treatment of the forcing terms has been shown to be robust and extendable to second order of accuracy. The same idea at the basis of the source term discretization allowed rewriting the schemes in a way that does not require any Roe-type linearization of the Jacobians to guarantee discrete conservation. Comparison with the classical formulation has shown the robustness and reliability of the approach. Finally, the space-time schemes, combined with the new treatment of the source terms, have been applied to a simple two-phase flow model. Some well known two-phase problems involving separated flow have been solved. As an example, the figures show the solution for the sloshing of a liquid column in a tank.

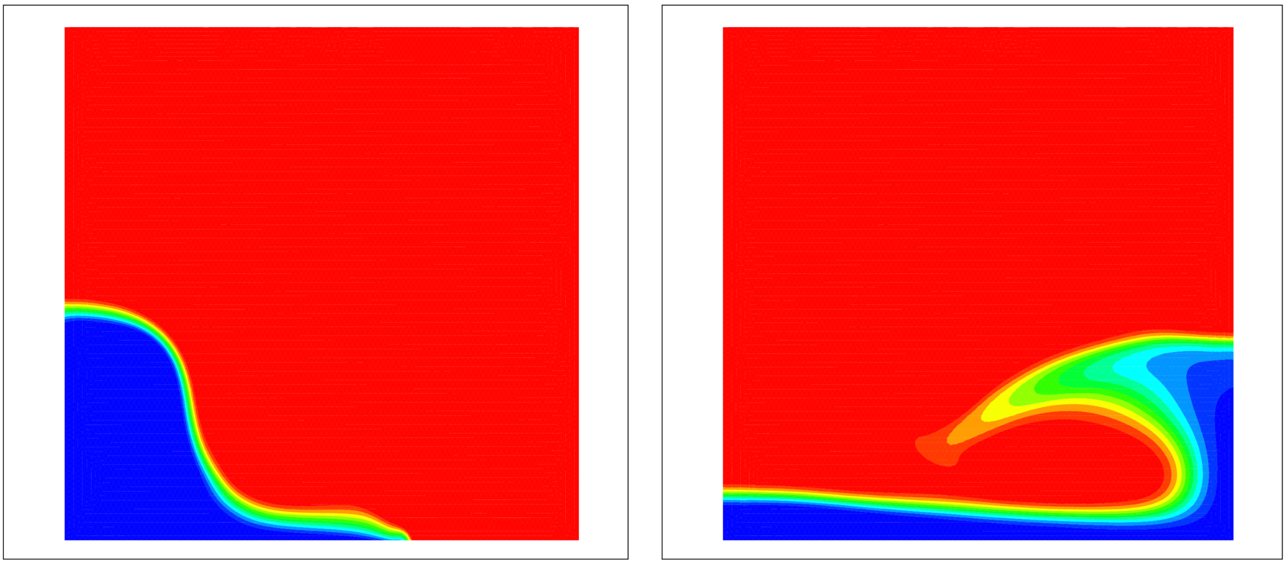

Figure 1: Sloshing of a liquid column in a tank: gas void fraction contours.
Results obtained with a second order space-time scheme and the new treatment of the source terms.
***The liquid is in blue and the gas in red. Left: $t \approx 0.2$* s*, Right: $t \approx 0.8$* s**