Efficient computation of unsteady vortical flow using flow-adaptive time-dependent grids

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Received 06-MAY-92

The objective of this study is to efficiently simulate vortex-dominated highly unsteady flows. In such flows, the locations as well as the extent of the regions requiring fine-mesh resolution vary with time. A technique has been developed to simulate these flows on a temporally adapting grid in which the adaption is based on the evolving flow solution. The flow in an axisymmetric constriction has been selected as an illustrative problem. The multiple and disparate length scales inherent in this complex flow make this problem ideally suited for evaluating the adaptive-grid technique. Adaption is based on the equidistribution of a weight function, through the use of forcing functions. The significance of this is that the method can be implemented into existing flow-analysis systems with minimal changes. The grid-generation equations developed are viewed as grid-transport equations. The time-dependent control functions perform the role of the convective speed in this transport mechanism. The equations provide the efficiency and flow tracking capability of parabolic equations, while maintaining the smoothness of computationally expensive elliptic equations. The efficiency and flow tracking capability of the approach is demonstrated for both steady and unsteady flows.

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