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DETERMINE THE TIME-DEPENDENT INTERFERENCE BETWEEN STATIONARY AND MOVING BOUNDARIES (Old Dominion Univ.) 2 p
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ABSTRACT

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A new methodology is developed to simulate unsteady flows about prescribed and aerodynamically determined moving boundary problems. The method couples the fluid dynamics and rigid-body dynamics equations to capture the time-dependent interference between stationary and moving boundaries. The unsteady, compressible, inviscid (Euler) equations are solved on dynamic, unstructured grids by an explicit, finite-volume, upwind method. For efficiency, the grid adaptation is performed within a window around the moving object. The Eulerian equations of the rigid-body dynamics are solved by a Runge-Kutta method in a non-inertial frame of reference. The two-dimensional flow solver is validated by computing the flow past a sinusoidally-pitching airfoil and comparing these results with the experimental data. The overall methodology is used for two two-dimensional examples: the flow past an airfoil which is performing a three-degrees-of-freedom motion in a transonic freestream, and the free-fall of a store after separation from a wing-section. Then the unstructured mesh methodology is extended to three-dimensions to simulate unsteady flow past bodies in relative motion, where the trajectory is determined from the instantaneous aerodynamics. The flow solver and the adaptation scheme in three-dimensions are validated by simulating the transonic, unsteady flow around a wing undergoing a forced, periodic, pitching motion, and comparing the results with the experimental data. To validate the trajectory code, the six-degrees-of-freedom motion of a

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store separating from a wing was computed using the experimentally determined force and moment fields, then comparing with an independently generated trajectory. Finally, the overall methodology was demonstrated by simulating the unsteady flowfield and the trajectory of a store dropped from a wing. The methodology, its computational cost notwithstanding, has proven to be accurate, automated, easy for dynamic gridding, and relatively efficient for the required man-hours.