ABSTRACT

FLOW SIMULATIONS ABOUT STEADY-COMPLEX AND UNSTEADY MOVING CONFIGURATIONS USING STRUCTURED-OVERLAPPED AND UNSTRUCTURED GRIDS

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The limiting factor in simulating flows past realistic configurations of interest has been the discretization of the physical domain on which the governing equations of fluid flow may be solved. In an attempt to circumvent this problem, many Computational Fluid Dynamic (CFD) methodologies that are based on different grid generation and domain decomposition techniques have been developed. However, due to the costs involved and expertise required, very few comparative studies between these methods have been performed. In the present work, the two CFD methodologies which show the most promise for treating complex three-dimensional configurations as well as unsteady moving boundary problems are evaluated. These are namely the structured-overlapped and the unstructured grid schemes. Both methods use a cell centered, finite volume, upwind approach. The structured-overlapped algorithm uses an approximately factored, alternating direction implicit scheme to perform the time integration, whereas, the unstructured algorithm uses an explicit Runge-Kutta method. To examine the accuracy, efficiency, and limitations of each scheme, they are applied to the same steady complex multicomponent configurations and unsteady moving boundary problems. The steady complex cases

consist of computing the subsonic flow about a two-dimensional high-lift multielement airfoil and the transonic flow about a three-dimensional wing/pylon/finned store assembly. The unsteady moving boundary problems are a forced pitching oscillation of an airfoil in a transonic freestream and a two-dimensional, subsonic airfoil/store separation sequence. Accuracy was accessed through the comparison of computed and experimentally measured pressure coefficient data on several of the wing/pylon/finned store assembly's components and at numerous angles-of-attack for the pitching airfoil. From this study, it was found that both the structured-overlapped and the unstructured grid schemes yielded flow solutions of comparable accuracy for these simulations. This study also indicated that, overall, the structured-overlapped scheme was slightly more CPU efficient than the unstructured approach.