Mesh free Technique in Finite-Difference Formulations

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Abstract:

The Mesh free approach for solutions of the Navier-Stokes equations has been advancing well towards becoming one of the classical numerical techniques. However, two issues remain to be examined in details by mesh free methods; the first is the consistency of the numerical approach and the second is application to compressible flows with shock waves. In the present study, we developed a Mesh free method based on a second order polynomial fitting arbitrary set of grid points (at least 9-points in two-dimensions). The governing equations are coupled to the polynomial through Lagrange multiplier and the polynomial coefficients are determined from the least square method. The resulting algebraic set of equations can be solved either explicitly or implicitly. Due to the enlarged stencil as compared to the classical 5-point finite-difference methods, the explicit solutions converge faster. In addition, our method has several other advantages over existing Mesh free methods. First, our method leads to a set of algebraic equations very much similar to the classical finite-difference equations that can be analyzed using Taylor's expansion for consistency in Mesh free environment. Second, the method is equally applicable for solutions of compressible and incompressible flow equations. Several test problems are solved to validate the method. These include the driven cavity, flow over a cylinder and compressible flow over a thin airfoil with shock wave.

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