A Moving Mesh Method Based on the Geometric Conservation Law

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We present a new adaptive mesh movement strategy based on the geometric conservation law and the specification of the Jacobian determinant of the coordinate transformation. By specifying the Jacobian, we are able to directly control the mesh concentration. The geometrical conservation law, an identity satisfied by any coordinate transformation, is an important tool which has been used for many years in the engineering community to develop cell-volume preserving finite volume schemes. The conservation law is used here to transform the algebraic expression specifying the Jacobian into an equivalent differential relation which is the key formula for the new mesh movement strategy. We will show that the resulting method bears a close relation with the Lagrangian method and shares common features with several existing moving mesh methods. Advantages of the new approach include an ease of controlling the cell volumes (and therefore mesh adaption) and theoretically guaranteed existence and non-singularity of the coordinate transformation. It is also shown that the method may suffer from the mesh skewness, a consequence directly related to its close relation with the Lagrangian method. Numerical results are presented to demonstrate various features of the new method.