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A locally refined rectangular grid finite element method: Application to computational fluid dynamics and computational physics. (English) Zbl 0709.76078

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Summary: A new finite element method for solving important linear and nonlinear boundary value problems arising in computational physics is described in this paper. The method is designed to handle general three-dimensional regions, boundary conditions, and material properties. The boundaries are described by piecewise planar surfaces on which boundary conditions are imposed. The method uses box finite elements defined by a Cartesian grid that is independent of the boundary definition. Local refinements are performed by dividing a box element into eight similar box elements. The discretization uses trilinear approximations on the box elements with special element stiffness matrices for boxes cut by any boundary surface. This discretization process is automated and does not require the generation of a boundary conforming grid. The resulting (possibly nonlinear) discrete system is solved using a preconditioned GMRES algorithm. The primary preconditioner is a sparse matrix solver using a dynamic drop tolerance in the decomposition phase. Results are presented for aerodynamics problems with up to 400,000 elements, demonstrating the accuracy and efficiency of the method.

MSC:

76M10 Finite element methods applied to problems in fluid mechanics

Keywords:

finite element method; nonlinear boundary value problems; box finite elements; Cartesian grid; preconditioned GMRES algorithm

Software:

symrcm

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