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Efficient Multigrid Method Based on Adaptive Weighted Jacobi in Isogeometric Analysis

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ABSTRACT

The isogeometric analysis Method (IGA) is an efficient and accurate engineering analysis method. However, in order to obtain accurate analysis results, the grid must be refined, and the increase of the number of refinements will lead to large-scale equations, which will increase the computational cost. Compared with the traditional equation solvers such as preconditioned conjugate gradient method (PCG), generalized minimal residual (GMRES), the advantage of multigrid method is that the convergence rate is independent of grid scale when solving large-scale equations. This paper presents an adaptive weighted Jacobi method to improve the convergence of geometric multigrid method to efficiently solve the equations of IGA. Geometric multigrid constructs a series of coarse grids by using the refinement of IGA. By coarsening and refining the grid, the low-frequency part of the residual can be effectively suppressed. In order to choose the best parament of weighted Jacobi to improve the convergence speed, the adaptive weighted Jacobi is proposed. The adaptive weighted Jacobi method can effectively reduce the high-frequency part by minimizing the residual principle to change the weight. Thus, the convergence condition and convergence speed of geometric multigrid can be improved. The numerical examples demonstrate that the proposed method has the advantages of fast convergence speed and high efficiency in solving topology optimization models, and the weighted Jacobi has superior parallel performance, which has a great application potential in solving large-scale problems.

KEYWORDS

Isogeometric analysis; geometric multigrid; adaptive weighted Jacobi; convergence acceleration

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