A new multiscale method for geometrically nonlinear shape morphing of fluid actuated cellular structures

***J.Lv[1], H.Liu[2], and H. W. Zhang[3]**

[1] School of Aeronautics and Astronautics, Dalian University of Technology, Dalian 116024, P. R. China
[2] Department of Engineering Mechanics, School of Civil Engineering, Wuhan University, Hubei 430072, P.R. China
[3] Department of Engineering Mechanics, Dalian University of Technology, Dalian 116024, P. R. China

*Corresponding author: lvjun@dlut.edu.cn

Geometrically nonlinear shape morphing behaviors of the adaptive bio-inspired fluid actuated cellular structures are investigated in current research. A multiscale co-rotational formulation based on the multiscale finite element framework is proposed for the geometrically nonlinear analysis of the fluidic cellular structures with periodical microscopic fluid inclusions. The multiscale base functions are constructed to establish the relationship between the small-scale fluctuations of the microstructures and the macroscopic deformation on the coarse scale mesh. The co-rotational formulation is integrated to the multiscale method to decompose the geometrically nonlinear motion of the coarse-grid element into rigid-body motion and pure deformational displacements. Then, the large displacement-small strain nonlinear problems of the fluid actuated cellular structures are resolved on the multiscale co-rotational coarse-grid elements. The numerical results indicate that the present multiscale algorithm is simple, accurate and highly efficient and can provide an alternative to model the fluid actuated actuators for morphing wings.

Keywords: Fluid actuated, Cellular structures, Geometrically nonlinear analysis, Multiscale finite element method, Co-rotational formulation