A Reduced Order Model of Synthetic Jet Actuators

Nail K. Yamaleev[a] and **Mark H. Carpenter**[b]

[a]Center for Aerospace Research
North Carolina A&T State University
Greensboro, NC 27411
nkyamale@ncat.edu

[b]NASA Langley Research Center
Mail Stop 128
Hampton, VA 23689
m.h.carpenter@larc.nasa.gov

A new reduced order model of multidimensional synthetic jet actuators, that combines the accuracy and conservation properties of full numerical simulation methods with the efficiency of simplified zero order models, is proposed. The multidimensional actuator is simulated by solving the time-dependent compressible 1-D Euler equations, whereas the diaphragm is modeled as a moving boundary. The governing equations are approximated with a 4th-order finite difference scheme on a moving mesh such that one of the mesh boundaries coincides with the diaphragm. The new reduced order model of synthetic jet actuators has several advantages. In contrast to the 0-D models, this approach provides conservation of mass, momentum, and energy. Furthermore, the new method is computationally much more efficient compared with the 2-D Navier-Stokes simulation of the actuator cavity flow, while providing practically the same accuracy in the exterior flowfield. The most distinctive feature of this model is its ability to predict the resonance characteristics of synthetic jet actuators, which is not practical using the 3-D models because of the computational cost involved. Numerical results demonstrating the accuracy of the new reduced order model and its limitations will be presented.