Takizawa, Kenji; **Kostov, Nikolay**; **Puntel, Anthony**; **Henicke, Bradley**; **Tezduyar, Tayfun E.**
Space-time computational analysis of bio-inspired flapping-wing aerodynamics of a micro aerial vehicle. (English) Zbl 1286.76180
Comput. Mech. 50, No. 6, 761-778 (2012).

Summary: We present a detailed computational analysis of bio-inspired flapping-wing aerodynamics of a micro aerial vehicle (MAV). The computational techniques used include the Deforming-Spatial-Domain/Stabilized Space-Time (DSD/SST) formulation, which serves as the core computational technique. The DSD/SST formulation is a moving-mesh technique, and in the computations reported here we use the space-time version of the residual-based variational multiscale (VMS) method, which is called "DSD/ SST-VMST." The motion and deformation of the wings are based on data extracted from the high-speed, multi-camera video recordings of a locust in a wind tunnel. A set of special space-time techniques are also used in the computations in conjunction with the DSD/SST method. The special techniques are based on using, in the space-time flow computations, NURBS basis functions for the temporal representation of the motion and deformation of the wings and for the mesh moving and remeshing. The computational analysis starts with the computation of the base case, and includes computations with increased temporal and spatial resolutions compared to the base case. In increasing the temporal resolution, we separately test increasing the temporal order, the number of temporal subdivisions, and the frequency of remeshing. In terms of the spatial resolution, we separately test increasing the wing-mesh refinement in the normal and tangential directions and changing the way node connectivities are handled at the wingtips. The computational analysis also includes using different combinations of wing configurations for the MAV and investigating the beneficial and disruptive interactions between the wings and the role of wing camber and twist.

MSC:

76Z10 Biopropulsion in water and in air
92C10 Biomechanics

Keywords:

micro aerial vehicle; bio-inspired flapping; locust; aerodynamics; space-time techniques; NURBS

Full Text: DOI

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