Accepted Manuscript

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PII: S1270-9638(16)30988-9
DOI: https://doi.org/10.1016/j.ast.2018.06.007
Reference: AESCTE 4621

To appear in: *Aerospace Science and Technology*

Received date: 2 November 2016
Revised date: 21 April 2018
Accepted date: 4 June 2018

Please cite this article in press as: A.T. Nguyen, J.-H. Han, Wing flexibility effects on the flight performance of an insect-like flapping-wing micro-air vehicle, *Aerosp. Sci. Technol.* (2018), https://doi.org/10.1016/j.ast.2018.06.007

Revised for Aerospace Science and Technology

Wing Flexibility Effects on the Flight Performance of an Insect-like Flapping-wing Micro-Air Vehicle

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Abstract

This study explores the effects of wing flexibility on several characteristics of flight, in this case the trim conditions, power requirements and dynamic stability of an insect-like flapping-wing micro-air vehicle (FWMAV) based on the hawkmoth *Manduca sexta*. The wing structure is analyzed by the finite-element method. A potential-based aerodynamic model which encompasses the unsteady panel method and the extended unsteady vortex-lattice method is employed to compute the aerodynamic forces. The motions of the FWMAV are obtained using a flexible multibody dynamics program coupled with the potential-based aerodynamic model. The results of this study show that the trim conditions of insect-like flexible and rigid FWMAVs may differ significantly from each other. When the flight speed is less than 3.0 m/s, using flexible wings is favorable, as they help the FWMAV reduce the power requirement and stabilize the lateral dynamics. However, at 3.0 m/s, these advantages are almost unnoticeable, while at 4.0 m/s, the flexible insect-like FWMAV requires even more mechanical power than its rigid counterpart.

Keywords: Insect-like flapping-wing MAV, Wing flexibility, Panel method, Unsteady vortex-lattice method, Flexible multibody dynamics

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