18th International Conference of
Adaptive Structures and Technologies
October 3rd, 4th, 5th, 2007
Ottawa, Ontario, Canada

Analytic Modeling of the Aerodynamics of Shape Changing Wings

E. Cuji[1]*, and E. Garcia[1]
[1] Department of Mechanical and Aerospace Engineering, Cornell University, Ithaca, NY, USA
* Corresponding author: 226 Upson Hall, Cornell University, Ithaca, NY 14853
Tel: 1 (607) 255-5457, Fax: 1 (607) 255-1222, E-mail: eac47@cornell.edu

ABSTRACT

This paper will present the aerodynamic modeling using an adaptation of the Prandtl's lifting-line method for analyzing change shaping wings. This method can be use to find the aerodynamic properties for wings with arbitrary camber, sweep and dihedral. This method is show to be ideal for preliminary analysis of morphing wings for its speed and adaptability of varying geometries and flight conditions.

This method is compared to the closed form solution for an elliptical wing to examine its accuracy and limitations. One particular wing configuration examined is the wing configuration that has general shapes, including wing asymmetries.

Keywords: Aerodynamic, Morphing, Prandtl's Lifting-line

1. INTRODUCTION

Presently, most aircraft are designed and optimized for a certain mission. Increasingly it has been considered desirably for an aircraft to perform multiple missions and in different flight regimes. For example, an aircraft that could perform efficiently, have long endurance and be maneuverable, and would enable new missions. As seen in nature, birds morph their bodies in different flight regimes to increase performance. Using birds as an inspiration, research toward the development of a morphing aircraft has been undertaken. A morphing aircraft is defined as an aircraft vehicle that could perform gross shape changes in-flight to increasing efficiency, adaptability and/or mission performance [1, 2]. Recent advances in smart materials and actuators have enable shape changing structures and, eventually, the development of a morphing aircraft structures without the addition of extra weight [3].

The new capabilities of a morphing aircraft can be reached by manipulating the aerodynamics forces and moments that act upon the aircraft. To determine the forces, an aerodynamic analysis for both varying geometries and flight condition are required. The purpose of this research is to develop