# Experimental Analysis of a Perching Aircraft Using Dynamic Testing

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**This paper presents the results of wind tunnel experimentation on a novel morphing aircraft design whose purpose is to perch using aerodynamic forces. The purpose of these experiments is to verify pre-existing analytic and computational models of perching maneuver aerodynamics through quasi-static and dynamic wind tunnel testing that capture force and moment data. The unique design of this wind tunnel model is presented, as well as the data acquisition system that controls the various degrees of freedom of the aircraft while recording aerodynamic data. The distinctiveness of this model is that both the conventional control surfaces and morphing degrees of freedom can be controlled real-time during experimentation, so that transient aerodynamic data may be taken during shape reconfiguration. Additionally, the perching aircraft flies in both stalled and un-stalled regimes; therefore, the time-varying, oscillatory nature of the flow is also recorded and modeled. The aerodynamic effects of stalled and un-stalled flows are presented for various shape configurations, as well as a discussion of the effects of partially stalled flows over parts of the aircraft. The effectiveness of the control surfaces is discussed with regard to the controllability of the aircraft throughout various stages of the perching maneuver. Future work on this system, concerning closed-loop flight stabilization in the wind tunnel, is also briefly suggested.**

## Nomenclature

| | | |
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| $A$ | = | lift area |
| $b$ | = | wing span |
| c | = | mean aerodynamic cord |
| $C_L$ | = | lift force coefficient |
| $C_D$ | = | drag force coefficient |
| $C_{\mathscr{L}}$ | = | wing roll moment coefficient |
| $C_{\mathscr{M}}$ | = | wing pitch moment coefficient |
| $C_{\mathscr{N}}$ | = | wing yaw moment coefficient |
| $\alpha$ | = | angle of attack of the plane body |
| $\theta_b$ | = | tail boom angle with respect to plane body |
| $\theta_t$ | = | tail angle with respect to plane body |
| $\delta_a$ | = | aileron deflection |
| $\delta_e$ | = | ruddervator deflection |
| $\rho$ | = | air density |

## I. Introduction

RECENTLY in aviation research, morphing aircraft has been a popular topic. Current fixed wing aircraft are either designed for efficient flight at a very small subset of operational parameters, such as speed and altitude, for aircraft such as commercial jets or for acceptable performance at a wide range of operational parameters, as with

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