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PERCHING TRAJECTORY OPTIMIZATION THROUGH AIRCRAFT MORPHING

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ABSTRACT

Recent advances in materials, actuators, and control architecture have enabled new flight capabilities for aircraft. One new mission capability – perching – is presented and discussed herein. This maneuver, described as a vertical landing with minimal use of thrust, is shown to be practical only through shape reconfiguration. Trajectory optimization using nonlinear programming techniques is employed to show the effects that nonlinear aerodynamics have on the maneuver. These effects are shown to relax the initial conditions, reduce the bounds on the trajectory, and decrease the required thrust for the maneuver. The aerodynamics are modeled using empirical and analytical methods in both attached and separated flow regimes. Unsteady effects such as dynamic stall are also included in this model. The impact of morphing on this new flight capability is discussed, as well as further refinements through the inclusion of pre- and post-stall wind tunnel data.

***Keywords**:* Perching, Morphing, Aircraft, Trajectory, Optimization.

INTRODUCTION

Enabling new missions and new capabilities for aircraft is one of the major goals of the morphing aircraft program [1,2]. Perching is a new capability under development at Cornell University for mesoscale UAV's. Perching can be described as a high angle-of-attack approach, with the purpose of using the air flow for braking, followed by a planted landing. While vertical landings have been accomplished by rotary and VSTOL aircraft, it is desired to perch using aerodynamics alone, with little input from thrust-generating devices. This will alleviate the need for the heavy, inefficient thrust generators required to land vertically, which are not compatible with long endurance aircraft systems. Thus, perching will be