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Towards Automated Landing of a Morphing UAV

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ABSTRACT

As unmanned aerial vehicles (UAVs) acquire new abilities through advancements in technology, new sensing and control strategies will be required to enable these vehicles to perform robustly in a safe manner. This paper discusses a sensing system for the task of automated landing of a morphing UAV. This bio-inspired vehicle has the ability to perform a perching maneuver, similar to a bird, to land on the edges of structures such as buildings or bridges. The morphing maneuver allows for many new capabilities; however, it must be accurately controlled in a safe and effective manner - and doing so requires good estimates of the vehicle states. A system for the gathering and fusion of information from various sensors is tested and data is presented from flight simulations. Augmenting the standard suite of GPS and inertial sensors with visual information will enhance operation and provide a multi-sensory approach that enables the UAV to perform through periods of sensor dropout. Such dropouts are commonly encountered with GPS signals in urban environments. Sensors returning visual data are also required to identify a passive landing target - which GPS and inertial measures alone cannot provide. Effectiveness of other sensors, such as a forward-looking range finder, is also discussed. Relying on visual information for the landing sequence removes integrated errors that often build throughout the duration of a mission, allowing for more precise estimates. The directed flight goal of the UAV requires that the uncertainty at the landing site must vanish as the vehicle approaches to allow for a safe landing.

Keywords: automated flight control, morphing vehicle, unmanned aerial vehicle

1. INTRODUCTION

Many strategies exist for vehicle state estimation for autonomous navigation and often several sensor types are utilized to take advantage of different measurement characteristics. Sensors measure specific parameters often making direct measurements of the complete set of state variables impossible. Instead these measurements are used to estimate the vehicle states and often also relevant environmental features. The challenge is to choose a set of sensors that yields enough information to generate accurate estimates.

The vehicle considered in this paper will be a morphing unmanned aerial vehicle (UAV) [1]. This bio-inspired vehicle has a small thrust-to-weight ratio and is capable of changing its configuration to generate additional lift at high angles of attack and postpone stall on control surfaces, thereby maintaining controllability. This new configuration morphing characteristic enables the vehicle to perform a perching maneuver using aerodynamics, a concept similar to landing techniques employed by some birds. Landing through this method would also allow the UAV to operate and land