Soutenance de thèse

Léandro LUSTOSA soutiendra sa thèse de doctorat, préparée au sein des équipes d'accueil doctoral ISAE-ONERA EdyF et ISAE-ONERA CSDV et intitulée « *Un drone multi-tâches convertible pour des missions de reconnaissance complexes*»

Le 14 novembre 2017 à 10h30, salle des thèses ISAE-SUPAERO

devant le jury composé de

Mme Caroline BERARD	Professeur ISAE-SUPAERO	
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Summary

Remote building intrusion missions in complex urban environments call for micro air vehicles (MAVs) capable of switching between long-endurance and hover flight modes. Traditionally, long-endurance missions are performed by fixed-wing architectures which advantage from lift generation due to aerodynamic surfaces. This yields high-speed stable flight even under adverse wind conditions. On the other hand, hovering platforms (e.g., multi-rotor platforms, helicopters) cannot benefit from air to vehicle relative movement and calls for energetically expensive propulsion methods that precludes long-distance missions but allows for sustained low-speed unstable indoor flight. This thesis is built around a hybrid architecture based on the tilt-body tail-sitting concept, called MAVion, that is capable of balancing aerodynamic and propulsion design parameters to deliver a solution to the remote building intrusion problem. Since their debut in the 50s, vertical take-off and landing (VTOL) aircraft would only be flown by the most experienced pilots. Recent advances on low-cost inertial sensors, embedded computing and control technology -- on the other hand -- support stability augmentation systems (SAS) in mitigating unstable dynamic modes and allowing for inexperienced (or even autonomous) flight. Nearly all autopilot design techniques, however, rely on accurate mathematical descriptions of novel and thus unfamiliar architectures (e.g., number and positioning of propellers, number and positioning of fixed/variable aerodynamic surfaces). While a large and growing body of literature has investigated underlying modeling, control and planning issues to specific hybrid vehicles, an unified approach to addressing arbitrary architectures is practically non-existent. The present thesis establishes an unified framework, namely the phi-theory, for assessing hybrid vehicles handling qualities and, moreover, designing appropriate stabilizing control laws. This study sets out to establish a tractable model for tail-sitting vehicles in view of control design and qualitative dynamics analysis. The proposed phi-theory not only yields a numerically advantageous model but also extends our comprehension of tail-sitting vehicles. In sharp

contrast with existent literature, the proposed model is globally non-singular, polynomial-like and bypasses the use of aerodynamic angles of attack and sideslip (both free-stream and propwash-induced!). Nevertheless, even if mathematically elegant, a mathematical model has practical use only if consistent with reality. This thesis shows this is the case by means of wind tunnel data and flight experiments. I strongly believe phi-theory provides a fitting balance between model complexity and controller design simplicity. I prove this point by tuning MAVion's controller in simulation and test-flying it in reality – with a novel aided inertial navigation technique – without resorting to further exhausting experimental tuning campaigns.