PROPOSITION DE STAGE EN COURS D'ETUDES

Référence : DTIS-2025-67 *(à rappeler dans toute correspondance)*	Lieu : Toulouse
Département/Dir./Serv. : DTIS/COVNI ENAC/OPTIM/SYSDYN	Tél. : 05 62 25 29 22/ 05 62 25 96 16
Responsable(s) du stage : Fabrice Demourant Gautier Hattenberger	Email. : fabrice.demourant@onera.fr gautier.hattenberger@enac.fr

DESCRIPTION DU STAGE

Thématique(s) :   Identification et Commande des Systèmes

Type de stage :   ☒ Fin d'études bac+5   ☒ Master 2   ☐ Bac+2 à bac+4   ☐ Autres

Intitulé : Modeling and integration of command laws on a convertible micro-drone

The general architecture of the Heewing T1 Ranger is a small foam plane with two motors that can tilt from horizontal to vertical position and a third-placed on the tail boom. They ensure lift and controllability when the forward speed is insufficient and for vertical takeoff and landing.

HEEWING T1 RANGER in VTOL configuration

In previous works [1][2][3], the ONERA and ENAC research teams have investigated several types of control laws for the stabilization and guidance of such hybrid platforms. In particular, the Incremental Nonlinear Dynamic Inversion (INDI) is a promising solution to have a unified control scheme [4]. This architecture can be combined with a robust linear controller to meet some specifications, if necessary. This controller is already implemented

in the Paparazzi UAV System[1], as an open-source software and hardware platform designed for research on mini-UAV.

The objectives of this internship are to:
- To analyze the literature on the control of hybrid UAVs;
- To model this aircraft and identify the different parameters from flight test analyses;
- To adapt the INDI controller to fulfill the stabilization and guidance objectives;
- To implement the solution within the Paparazzi UAV System;
- To perform flight tests to evaluate the performances of the control;

This 6-month Master 2 internship is in cooperation between ONERA and ENAC, both based in Toulouse, France. It will benefit from the Indoor Flight Arena located on ENAC campus for preliminary tests and the outdoor flight tests area of ENAC or ONERA.

[1] Florian Sansou, Gautier Hattenberger, Luca Zaccarian, Fabrice Demourant, Thomas Loquen. Modelling and Hovering Stabilisation of a Free-Rotating Wing UAV. *2024 International Conference on Unmanned Aircraft Systems (ICUAS)*, Jun 2024, La Canée (Crete), Greece. pp.779-785, ⟨10.1109/ICUAS60882.2024.10556832⟩

[2] Armand-Ioan Curpanaru, Fabrice Demourant, Florian Sansou. Control of the DarkO Tail-Sitter Drone through an LMI-Based Static Output Feedback Design. *IMAV 2024*, Sep 2024, Bristol, United Kingdom. ⟨hal-04726253⟩

[3] Florian Sansou, Fabrice Demourant, Gautier Hattenberger, Thomas Loquen, Luca Zaccarian. Open wind tunnel experiments of the DarkO tail-sitter longitudinal stabilization with constant wind. *Automatic control in aerospace*, Nov 2022, Mumbai, India. pp.1-6, ⟨10.1016/j.ifacol.2023.03.001⟩

[4] E. J. J. Smeur, Murat Bronz, G. C. H. E. de Croon. Incremental control and guidance of hybrid aircraft applied to the Cyclone tailsitter UAV. *Journal of Guidance, Control, and Dynamics*, 2019, ⟨10.2514/1.G004520⟩

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1 https://paparazziuav.org

☐ Recherche théorique	☐ Travail de synthèse
☒ Recherche appliquée	☐ Travail de documentation
☐ Recherche expérimentale	☐ Participation à une réalisation

Possibilité de prolongation en thèse : Non

Durée du stage :   Minimum : 5 mois   Maximum : 6 mois

Période souhaitée : Début Mars-Avril 2025

PROFIL DU STAGIAIRE

Connaissances et niveau requis :	Ecoles ou établissements souhaités : Grandes Ecoles/Universités.
- Connaissances robotique ou drones - Connaissances en automatique - Connaissances en systèmes embarqués temps-réel - Bonne maîtrise du C et de Python et/ou Matlab.	