PHD CANDIDATE RECRUITMENT (M/F)

PhD title :

Development of a Nonlinear Vibration Isolation Device for Payloads on Aerospace Platforms

Work place : Salon-de-Provence and Marseille - France

Keywords : Structural dynamics, Vibration control

Contract : short-term, fully-funded **Length :** 36 months, full-time

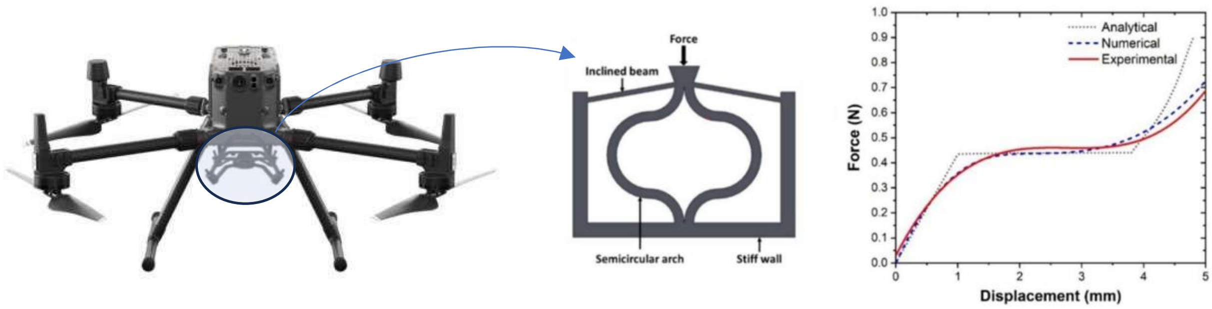
Starting date : between My and October 2026

JOB DESCRIPTION

Context and objectives of the project

With the rise of multicopter drones (see for instance the figure below) in civil and industrial applications—such as mapping, surveillance, delivery, or technical inspections—the stability and accuracy of onboard instruments have become major concerns. Vibrations generated by motors, propellers, or the dynamic motion of the drone directly affect the quality of measurements or captured images. These disturbances are particularly problematic in applications requiring high precision. A recurring technical challenge in designing such systems is **the transmission of vibrations** from the drone platform to its payload. In this context, the objective of this PhD project is to develop an original method for **controlling vibrations transmitted from a multicopter drone to its payload**.

A commonly used approach to limit transmitted vibrations is to use passive linear isolators. These are effective at attenuating vibrations whose frequencies exceed a few times the isolator's cutoff frequency. To ensure good vibration isolation, isolators must therefore be designed with low stiffness, which leads to significant static deflection under the payload weight. This can be problematic in applications requiring high stability.



The originality of this project lies in **exploiting nonlinear behaviors** to design an isolator with **both high static stiffness**—limiting deformation under load—and **low dynamic stiffness**—ensuring effective vibration isolation. This strategy makes it possible to reconcile mechanical robustness and dynamic performance, overcoming the limitations of classical linear solutions.

In practice, nonlinear isolators typically combine a linear stiffness with a softening nonlinear stiffness, which can be achieved using buckled beams as illustrated in the above figure. Although more effective than linear counterparts, the operating range of nonlinear isolators remains limited. One research direction in this project will be to **optimize the nonlinear coupling stiffness** to extend this range, especially during transient flight phases. Damping also plays a key role in the performance of these systems. A high quality factor ensures strong attenuation when the excitation frequency is well above the cutoff. However, for such high quality factors, resonance amplification can damage the payload during rotor spin-up. Considering nonlinear dissipation mechanisms is a promising direction to achieve high-frequency performance while limiting low-frequency vibratory amplitudes. Another research focus will be the practical implementation of non-standard nonlinear stiffness and damping. A promising path is the use of **architected materials**, combined with **topology optimization** techniques.

From a methodological perspective, a complementarity between theoretical developments and experimental studies is expected. This PhD project will therefore include developing an experimental **proof of concept** of the proposed isolator. The isolator will be **integrated on a drone** at the École de l'air et de l'espace and **tested under real-world conditions** at Air Base 701 in Salon-de-Provence. The PhD student will receive drone pilot training from the Drone Crew Training Center (CIFED) at the École de l'air et de l'espace to actively participate in flight tests.

References

Xu, Y., Dong, H. W., & Wang, Y. S. (2024). Topology optimization of programable quasi-zero-stiffness metastructures for low-frequency vibration isolation. International Journal of Mechanical Sciences, 280, 109557.

Dalela, S., Balaji, P. S., Leblouba, M., Trivedi, S., & Kalam, A. (2024). Nonlinear static and dynamic response of a metastructure exhibiting quasi-zero-stiffness characteristics for vibration control: an experimental validation. Scientific Reports, 14(1), 19195.

Han, H., Sorokin, V., Tang, L., & Cao, D. (2022). Lightweight origami isolators with deployable mechanism and quasi-zero-stiffness property. Aerospace Science and Technology, 121, 107319.

Dalela, S., Balaji, P. S., & Jena, D. P. (2022). A review on application of mechanical metamaterials for vibration control. Mechanics of advanced materials and structures, 29(22), 3237-3262.

Candidate profile

This PhD project, which combines modeling, numerical simulation, and experimental characterization of a vibration control device, is intended for candidates holding an engineering degree or a Master's degree in mechanics, aerospace, or a related field.

Skills — or at least a strong interest — in structural dynamics, control, numerical simulation, and experimental measurements are particularly sought after.

HOSTING INSTITUIONS

Centre de Recherche de l'École de l'air et de l'espace (CRÉA), Salon-de-Provence

CRÉA is the interdisciplinary research unit of the École de l'air et de l'espace, a prestigious French military academy, in Salon-de-Provence. Closely connected to Air Base 701, it benefits from rare access to aerospace resources such as aircraft and flight zones. The center includes around thirty teacher-researchers in engineering and social sciences. Their academic research shares a common goal: understanding the evolution of military use of aerospace systems.

Supervision at CRÉA: Benjamin Chouvion and Gaël Chevallier

Laboratoire de Mécanique et d'Acoustique (LMA), Marseille

LMA is a joint research unit (AMU–CNRS–Centrale Méditerranée, UMR 7031) specializing in solid mechanics (structures, materials, interfaces) and acoustics (wave propagation in complex media). It has internationally recognized expertise in nonlinear dynamic absorbers for acoustics and structural dynamics, along with extensive experimental facilities to support this project.

Supervision at LMA: Stéphane Bourgeois, Renaud Côte, and Etienne Gourc

CONTACTS

For any further information regarding the scientific program, please contact the following persons by email:

- EAE : Benjamin Chouvion : benjamin.chouvion@ecole-air.fr
- Centrale/LMA : Stéphane Bourgeois : stephane.bourgeois@centrale-marseille.fr

The following application files must be submitted:

- A CV
- A cover letter
- Your most recent academic transcript from your Master's program or engineering school