Nano-space drone for ISS indoor servicing: development and real-time validation.

ISAE-SUPAERO

NICOLAS BAUDIN
INTERNSHIPS IN FRANCE INITIATIVE

Name of the hosting institution in France	ISAE-SUPAERO
Name of the host laboratory / research team	DCAS Design and Control of Aeropsace System department
Address	10, Avenue Edouard Belin
Website	https://www.isae-supaero.fr/en/
Name of the supervisor	Daniel Alazard
Function	Full Professor
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Internship offer

Topic of the internship (title)	Nano-space_drone for ISS indoor servicing: development and real-time validation			
Proposed dates of the internship	**Start:**	2019-09-02	**End**	2020-01-31

Scientific and academic objectives of the internship (detailed description of the internship content, work expected from the intern and expected outcomes):

ISAE-SUPAERO in cooperation with CNES and ONERA develops a cluster of 6 nano CMGs (Control Moment Gyros). A first prototype was already developed and tested during a 0-g flight campaign. A steering law of the cluster with singularity avoidance capabilities in case of the nominal configuration or degraded configurations (1 or 2 CMG failure) was designed and implemented on the on-board computer based on ROS (Robot Operating System). The objectives of this internship are to develop and to implement a system to control the 3 translation degrees of freedom (d.o.f.) using propellers as actuators and vision-based navigation in order to propose a 6 dof space drone able to fly inside the ISS (Internal Space Station, with a pressurized environment). More particularly:
* sizing and realization of the translation control system with energy, budget,
* coordinated control of translation and rotation,
* vison-based navigation, and to perform real-time validation on the prototype.

See annex for more details

Does the project involve a French industrial partner?	No
Targeted Australian university	Any

Expected profile of applicant

Level of study	End of Bachelor or Master thesis
Discipline	Aerospace engineering
Required qualities, knowledge and skills	* ROS (Robot Operating System) * Control design and signal/image processing * General background in Aerospace engineering

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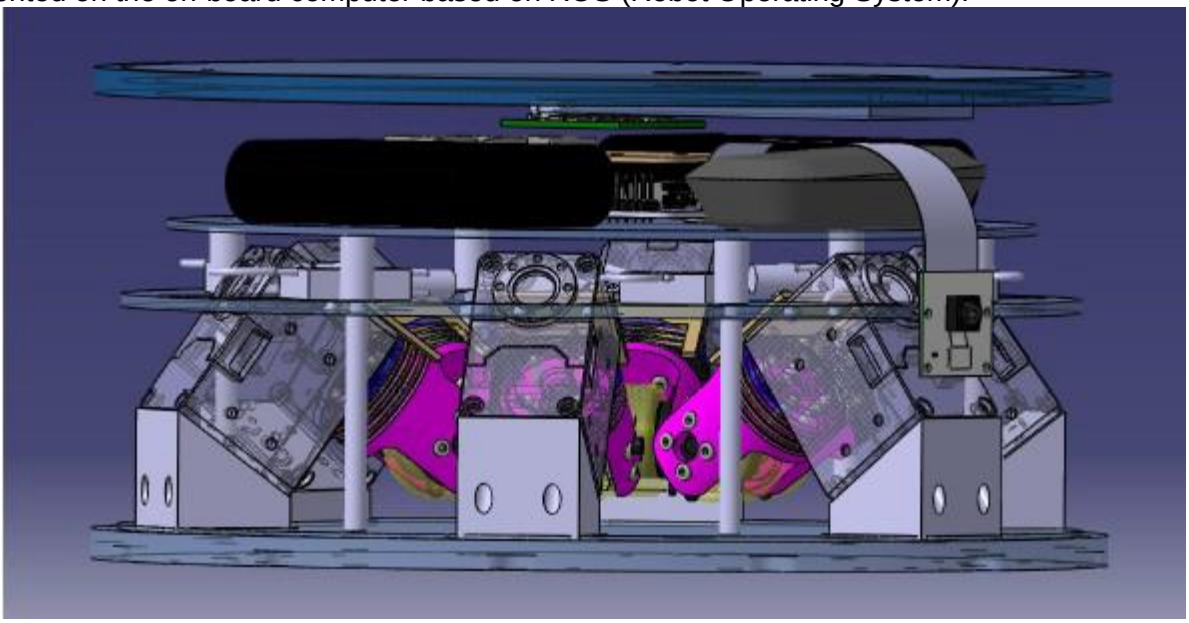
Nano-space-drone for ISS indoor servicing: development and real-time validation.

Context:
ISAE-SUPAERO in cooperation with Cnes and ONERA develops a cluster of 6 nano CMGs (Control Moment Gyros). A first prototype was already developed (see Figure below) and tested during a 0-g flight campaign. A steering law of the cluster with singularity avoidance capabilities in case of the nominal configuration or degraded configurations (1 or 2 CMG failure) was designed ([1]) and implemented on the on-board computer based on ROS (Robot Operating System).



The cluster of 6 nano-CMGs.

Objectives
The objectives of this internship are to develop and to implement a system to control the 3 translation degrees of freedom (d.o.f.) using propelers as actuators and vision-based navigation in order to propose a 6 dof space drone able to fly inside the ISS (Internal Space Station, with a pressurized environment). More particularly:

- sizing and realization of the translation control system with energy budget,
- coordinated control of translation and rotation,
- vison-based navigation,

and to perform real-time validation on the prototype.
This subject is a multi-disciplinary subject. A background in control design, aerospace engineering, signal/image processing **and ROS** will be particularly appreciated.

Supervisor
Daniel ALAZARD, ISAE-SUPAERO/DCAS

Referrences:
[1] H. Evain, M. Rognant, D. Alazard et J. Mignot, Nonlinear Dynamic Inversion for Redundant Systems Using the EKF Formalism, Proceedings of the 2016 American Control Conference, pp. 348–353 (2016).
[2] H. Evain, M. Rognant, D. Alazard & J. Mignot. Design of a new real-time steering law for control moment gyro clusters. 10th International ESA Conference on Guidance, Navigation and Control Systems, Salzbourg, 2017.
[3] H. Evain, T. Solatges, A. Brunet, A. Dias Ribeiro, L. Sipile, M. Rognant, D. Alazard & J. Mignot. Design and Control of a Nano- Control Moment Gyro Cluster for Experiments in a Parabolic Flight Campaign. IFAC World Congress session GDR MACS, 2017.