PROPOSITION DE STAGE EN COURS D'ETUDES

Référence : **DTIS-2025-08** *(à rappeler dans toute correspondance)*	Lieu : Toulouse
Département/Dir./Serv. : DTIS/IDCO	Tél. : +33 05 62 25 27 37
Responsable(s) du stage : Sofiane Kraïem, Mathieu Rognant	Email. : sofiane.kraiem@onera.fr mathieu.rognant@onera.fr

DESCRIPTION DU STAGE

Thématique(s) :   Robotique, identification et commande des systèmes

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

Intitulé : Implementation of a vision based control strategy for the On-Orbit Capture of target with a Space Manipulator System

Context :

The orbit removal and servicing topics are expected to play a key part in future space missions, and the studied concepts often include robotic manipulators to carry out these missions. Robotic manipulators in space are already in use but are teleoperated given the complexity to steer them on a free-floating platform. The goal of the study is to perform a rendezvous with a cooperative or noncooperative object, using an automatic manipulator arm to grasp the object.

Research Objectives :

In a capture context, the use of visual sensors could increase the autonomy capabilities of an SMS operating in a complex and dynamic environment [1]. Vision-based control strategies enable approach, capture and object manipulation phases to be carried out by controlling the relative movements between the robot and its target based on visual observations. Several challenges must then be overcome to reliably perform on-orbit service tasks, including robust target identification, precise planning and control of target approach, and mitigation of contact effects [2, 3, 4].

Thanks to the outcomes of recent research activities, the research group has developed a simulation platform for the synthesis, validation and comparison of control laws [5, 6]. On these bases, the objectives of this research internship are as follows:

- Make use of the platform and the simulation tools to allow the integration of additional features and validate control strategies

- Implement a state of the art vision-based strategy to estimate the relative pose of a target

- Design an adaptive control law to proceed to the capture and detumbling of a target

Project Description :

To achieve the proposed objectives, the study will be carried out as follows:

- Literature review on computer vision strategies for On-Orbit Operations with an SMS [1]

- Implement a ROS package to track a target and estimate its properties

- Design and test adaptive control laws to perform the capture of a target

References :

[1] L. M. Amaya-Mejıa, M. Ghita, J. Dentler, M. Olivares-Mendez Miguel et Carol, Visual Servoing for Robotic On-Orbit Servicing : A Survey, International Conference on Space Robotics (iSpaRo) (2024).

[2] Y. Shi, B. Liang, X. Wang, W. Xu et H. Liu, Modeling and simulation of space robot visual servoing for autonomous target capturing, in 2012 IEEE International Conference on Mechatronics and Automation, pp. 2275–2280. IEEE (2012).

[3] . P. Alepuz, M. R. Emami et J. Pomares, Direct image-based visual servoing of free-floating space manipulators, Aerospace Science and Technology, 55, pp. 1–9 (2016).

[4] . Zhao, M. R. Emami et S. Zhang, Image-based control for rendezvous and synchronization with a tumbling space debris, Acta Astronautica, 179, pp. 56–68 (2021).

[5] S. Kraïem, Development of steering law for On Orbit Servicing operation, Thèse de doctorat, Institut Supérieur de l'Aéronautique et de l'Espace (ISAE) (2022)

[6] S. Kraïem, M. Rognant, S. Waitman, Simulation platform to design and validate control laws for a space manipulator system performing on-orbit servicing, International Conference on Space Robotics (iSpaRo) (2024).

Est-il possible d'envisager un travail en binôme ?   No

Méthodes à mettre en oeuvre :

☐ Recherche théorique   ☑ Travail de synthèse

☑ Recherche appliquée   ☑ Travail de documentation

☐ Recherche expérimentale   ☑ Participation à une réalisation

Possibilité de prolongation en thèse : Yes

Durée du stage :   Minimum : 5   Maximum : 6

Période souhaitée : February-October

PROFIL DU STAGIAIRE

Connaissances et niveau requis : Matlab/Simulink, ROS-ROS2	Ecoles ou établissements souhaités :