RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

ONERA
THE FRENCH AEROSPACE LAB

www.onera.fr

# PROPOSITION DE SUJET DE THESE

**Intitulé : Satellite attitude estimation from resolved ground-based images with bayesian filtering**

Référence : **TIS-DTIS-2026-16**
*(à rappeler dans toute correspondance)*

| **Début de la thèse : Octobre 2026** | **Date limite de candidature : Mai 2026** |
|---|---|

**Mots clés**

Attitude estimation. Bayesian filtering. Computer vision. Space domain awareness.

**Profil et compétences recherchées**

Skills in Bayesian estimation (e.g. Kalman filtering), Computer vision and programming (Python). Strong interest in research.

**Présentation du projet doctoral, contexte et objectif**

Development of human activities in the space domain has significantly evolved over the past decade, with a growing number of emerging space-faring nations and commercial actors gaining access to the operational environment. The multiplication and diversification of space activities has brought about a stronger need for assessment of space domain awareness (SDA).

Most of SDA is presently performed through radar detection and tracking or, in the optical domain, by light-curves analysis or laser ranging. These various approaches provide limited information on the resident space objects (RSO) characteristics. In particular, it is difficult or impossible to retrieve the satellite attitude, shape and other relevant information to assess the nature and situation of RSOs. Ground based high resolution imaging systems based on large telescopes and adaptive optics can represent a game changer, by providing high resolution image sequences of resident space objects. These image sequences open the door to new strategies for image processing and estimation of characteristics of RSOs.

ONERA has been working on these approaches for several years and has committed to the development of the largest European ground-based telescope (2.5 m) dedicated to satellite observation, the PROVIDENCE project (optics research platform, vector of innovation for defense on the control and understanding of the environment and characterization of objects in space). First light is foreseen end 2028. This PhD is proposed within this framework and aims at developing image processing strategies to estimate RSOs' attitude, and if possible RSO's 3D shape, based on high spatial resolution image sequences similar to what the Providence system shall provide.

The objective is to investigate and combine multiple information extraction methods—such as light curve analysis, silhouette detection, and geometric feature identification—in order to densely capture key image information and mitigate ambiguities. The fusion of these complementary approaches is expected to enhance robustness and reliability. The extracted states will then be used as inputs to Bayesian filters capable of handling a wide range of possible solutions while incorporating prior knowledge about the scene (for instance, through particle filtering).

The developed solutions will be tested and evaluated using SIRIUS, an ONERA rendering engine that can simulate in details the hyperspectral images at high spatial and spectral resolution of an RSO, based on its 3D models and surface materials, including the process of image formation with adaptive optics correction. Validation on real images will also be considered, either on a smaller telescope or with PROVIDENCE's first images by the end of the thesis.

**Collaborations envisagées**

Collaboration with the SIRIUS ONERA team for the exploitation of hyperspectral information, and possibly with the ONERA electromagnetic and radar department for joint optical and ISAR observation.


| **Laboratoire d'accueil à l'ONERA** | **Directeur de thèse** |
|---|---|
| Département : Traitement de l'information et Systèmes | Nom : Cyril Petit |
| Lieu (centre ONERA) : Palaiseau | Laboratoire : ONERA/DOTA |
| **Contact** : Nicolas Merlinge et Hanae Labriji | Tél. : +33 1 46 73 47 54 |
| Email : nicolas.merlinge@onera.fr , hanae.labriji@onera.fr | Email : cyril.petit@onera.fr |


Pour plus d'informations : https://www.onera.fr/rejoindre-onera/la-formation-par-la-recherche