M2 Internship
"Detection and Correction of Sunglint in Coastal Aerial Imaging"

Context and Challenges

Coastal areas, essential to society but highly vulnerable to climate change, require accurate and up-to-date information on benthic habitats. Remote sensing has become a key tool, and very high-resolution (VHR) imagery from UAVs or aerial surveys offers significant potential. However, its exploitation remains limited by a major scientific challenge: the presence of sunglint, which is particularly problematic in VHR imagery.

Classical approaches based on the Cox-Munk statistical model are widely used to correct sunglint in low and medium resolution satellite images, but they are not directly applicable to VHR imagery, where individual waves are visible. Recent deep learning based approaches [1], [2] have shown notable improvement in sunglint detection in UAV imagery, but the restoration phase still relies on spatial or temporal interpolations or transfers, without explicitly integrating physical constraints (Fresnel reflection, water column attenuation). Similarly, methods based on linear regression between spectral bands depend on the assumption of zero reflectance in the near-infrared. This assumption limits their applicability in shallow coastal areas, where benthic reflectance is not negligible [3].

Missions

The objective of this internship is to explore and implement sunglint detection and correction approaches adapted to VHR coastal aerial imaging, by combining deep learning detection methods and physical model-based correction methods. This work will constitute a first step towards a more robust and physically interpretable approach, aiming to improve the use of such imagery for applications such as bathymetry estimation or benthic mapping.

The internship will utilize aerial data from the BD ORTHO database (IGN), which has already been cross-calibrated with Sentinel-2 to minimize the effects related to solar geometry and atmospheric conditions [4], [5]. The idea is to test deep learning-based detection methods (e.g. U-Net [1], [2]) and to explore correction methods that combine empirical models (inter-band regressions [6]) and physical constraints (Fresnel reflection) [7].

The missions will include:
- Literature review on sunglint correction methods in coastal imaging.
- Familiarization with coastal aerial imagery data.
- Analyzing sunglint issues in VHR images.
- Detecting sunglint using classical methods (e.g., thresholding, spectral indices) and building an initial annotated dataset (semi-automatic labeling with manual refinement).
- Implementing a supervised detection method (e.g., U-Net) on this dataset.
- Exploring and prototyping a correction approach that combines deep learning with physical constraints.

Expected deliverables

- An internship report.
- An annotated database of sunglint areas in coastal aerial imagery.
- A prototype of a sunglint correction method.
- A first version of a tool (open-source scripts or code) for sunglint detection and correction.

Organisation

Duration: 5-6 months, starting in February/March 2026
Location: The LASTIG laboratory, located in the Île-de-France region in Champs-sur-Marne, École nationale des sciences géographiques (Géodata Paris), near the RER A train station (Noisy Champ).
Salary: Internship gratification under French law.

The **National Institute of Geographic and Forest Information (IGN)** is a public administrative institution under the supervision of the French ministries in charge of ecology and forestry. Its mission is to produce and distribute reference data (open data) and representations (online and printed maps, geovisualizations) related to the knowledge of the national territory and French forests, as well as their evolution over time.

LASTIG lab (LAboratoire en Sciences et Technologies de l'Information Géographique pour la ville intelligente et les territoires durables) conducts application-oriented research in geographic information science and technology. The unit's research covers the entire lifecycle of geographic or spatial data, from acquisition to visualization, including modeling, integration, and analysis.

Candidate profile

Level: Master's student (M2) or engineering student in the last year of studies.
Background: Remote sensing, image processing, geomatics, applied physics, or artificial intelligence applied to imagery.

Skills
- Strong background in image processing and deep learning (segmentation, convolutional neural networks such as U-Net).
- Strong skills in Python and its scientific libraries (NumPy, SciPy, scikit-image, TensorFlow or PyTorch)
- Interest in physical modeling (Fresnel reflection, light–water interactions) and applications in coastal imagery.
- Prior experience in optical remote sensing or analysis of aerial/satellite imagery is a plus.
- Analytical thinking, scientific rigor, and interest in numerical experimentation.

This internship is intended to lead to a PhD, as part of a collaboration between the LASTIG laboratory (IGN) and the LIS laboratory (UTLN).

Contact

Please send a CV and a cover letter, with transcripts from the last two years of study (M1 and M2, or Bac+4 and Bac+5).

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Bibliography

[1] J. Qin, M. Li, J. Zhao, D. Li, H. Zhang, and J. Zhong, "Advancing sun glint correction in high-resolution marine UAV RGB imagery for coral reef monitoring," *ISPRS J. Photogramm. Remote Sens.*, vol. 207, pp. 298–311, Jan. 2024, doi: 10.1016/j.isprsjprs.2023.12.007.

[2] J. Chen *et al.*, "Detecting sun glint in UAV RGB images at different times using a deep learning algorithm," *Ecol. Inform.*, vol. 81, p. 102660, Jul. 2024, doi: 10.1016/j.ecoinf.2024.102660.

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[5] A. Nghien, M. Lei, M. Brédif, and O. Hagolle, "Radiometric Cross-Calibration of an Aerial Sensor with Satellite Top-of-Atmosphere Reflectance," in *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, Prague, Czech Republic, May 2025, pp. 49–55. doi: 10.5194/isprs-archives-XLVIII-M-7-2025-49-2025.

[6] J. Martin, F. Eugenio, J. Marcello, and A. Medina, "Automatic Sun Glint Removal of Multispectral High-Resolution Worldview-2 Imagery for Retrieving Coastal Shallow Water Parameters," *Remote Sens.*, vol. 8, no. 1, p. 37, Jan. 2016, doi: 10.3390/rs8010037.

[7] T. Harmel, M. Chami, T. Tormos, N. Reynaud, and P.-A. Danis, "Sunglint correction of the Multi-Spectral Instrument (MSI)-SENTINEL-2 imagery over inland and sea waters from SWIR bands," *Remote Sens. Environ.*, vol. 204, pp. 308–321, Jan. 2018, doi: 10.1016/j.rse.2017.10.022.