

## Master's internship M2, 2021

Univ. Gustave Eiffel - IGN/ENSG, LaSTIG lab.

### **Interface and evaluate SOTA image matching algorithms in MicMac** Interfaçage et l'évaluation des corrélateurs récents de la littérature dans MicMac

#### Keywords

Computer vision, photogrammetry, dense marching, artificial intelligence, epipolar geometry

#### Context

The proposed internship is part of a French research project [AI4GEO](#) that brings together several research laboratories, including IGN (LaSTIG), CNES, ONERA, Airbus, BpiFrance. The goal of the project is to develop technological modules that enable large-scale production of 3D maps and other related products, for instance, semantic layers. This internship is proposed within the development module that aims at high fidelity surface reconstruction from very high resolution (VHS) satellite imagery, such as Pléiades or Worldview.

In the 5 years we have seen an explosion of various image matching algorithms based on artificial intelligence (AI) [Laga et al., 2020; Michel et al., 2020]. Their performance exceeds that of the classical, hand-crafted dense image matching techniques [Pierrot Deseilligny & Paparoditis, 2006; Hirschmuller, 2007], especially when re-trained on sensor-specific datasets. Most importantly, the algorithms are open-source and freely available from public repositories. Within this context, the internship will deal with evaluation and integrating of selected *state-of-the-art* image matching algorithms within the free open-source software for photogrammetry – [MicMac](#).

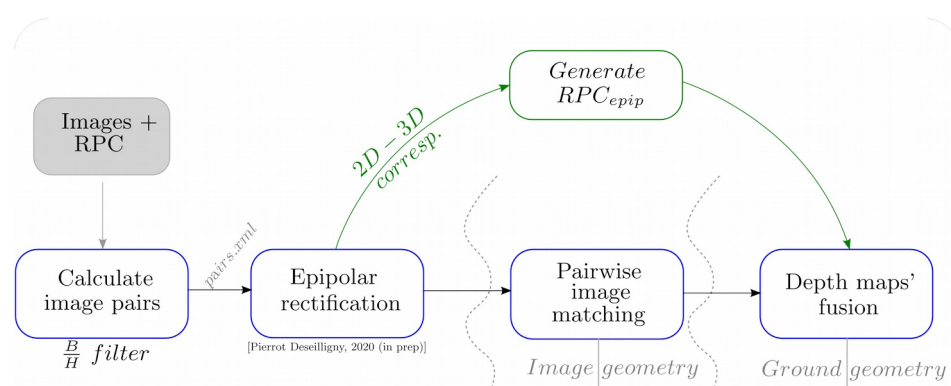


Figure 1. 3D reconstruction pipeline adapted to satellite images.

## Subject

The current 3D surface reconstruction satellite pipeline in MicMac consists of the following steps (see Fig.1):

- Extraction of features & refinement of geolocalisation with bundle adjustment
- Selection of image pairs
- Epipolar rectification
- Pairwise image matching
- Re-generation of RPC geolocations corresponding to images in epipolar geometry
- Fusion of per-pair reconstructions

The main task of the internship is to work on the *Pairwise image matching* module. In the 1<sup>st</sup> month, the student will familiarize himself/herself with the architecture of the MicMac's pipeline, and carry out a literature review. The months 2-4 will be devoted to: (1) the conceptualization of the format in which MicMac will interface with the number of selected AI image matchers; and (2) the implementation. Finally, during months 5-6, using several benchmark datasets, an extensive assessment of the performance of the available algorithms will be conducted.

**Skills acquired throughout the internship:** By the end of the internship the student will acquire an in-depth expertise in satellite image processing for 3D reconstruction, both from the user and development point of view. The student will learn how to evaluate the quality of a DSM, and how to compare two DSMs obtained with different techniques. Last but not least, the student will have a thorough understanding of the image matchers based on deep learning methods, and the satisfaction to have contributed to an open-source project.

## Organization

**Duration:** 6 months

**Workplace:** IGN (French Mapping Agency), LaSTIG lab, Paris area, Saint-Mandé (73 avenue de Paris, metro Saint-Mandé Line 1), France. The LaSTIG research laboratory, and hosts over forty researchers working in the field of photogrammetry, computer vision, pattern recognition and remote sensing.

**Salary :** ~1500EUR brut (SMIC)

## Candidate's profile

Bac+5 in computer science, applied math or geomatics; good knowledge in photogrammetry/computer vision, as well as good skills in C/C++ or Python.

## Submitting your candidature

Send an e-mail to Ewelina and Marc, in a single PDF file:

- o CV & motivation letter
- o Transcript of grades from the last two years of study
- o Two references (name, phone number and email address)

## Contact

- Ewelina Rupnik, researcher UGE/IGN/LaSTIG – [ewelina.rupnik@ign.fr](mailto:ewelina.rupnik@ign.fr)
- Marc Pierrot Deseilligny, researcher UGE/IGN/LaSTIG – [marc.pierrot-deseilligny@ensg.eu](mailto:marc.pierrot-deseilligny@ensg.eu)

## Bibliography

Hamid Laga, Laurent Valentin Jospin, Farid Boussaid, and Mohammed Bennamoun. A survey on deep learning techniques for stereo-based depth estimation. arXiv preprint arXiv:2006.02535, 2020.

Hirschmuller, H., 2007. Stereo processing by semiglobal matching and mutual information. *IEEE Transactions on pattern analysis and machine intelligence*, 30(2), pp.328-341.

Hirschmuller, H., & Scharstein, D. (2008). Evaluation of stereo matching costs on images with radiometric differences. *IEEE transactions on pattern analysis and machine intelligence*, 31(9), 1582-1599.

Michel, J., Sarrazin, E., Youssefi, D., Cournet, M., Buffe, F., Delvit, J., Emilien, A., Bosman, J., Melet, O., L'Helguen, C., 2020. A new satellite imagery stereo pipeline designed for scalability, robustness and performance. *Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences*, 2, 171-178

Pierrot Deseilligny, M. & Paproditis, N. (2006). Multiresolution and optimization-based image matching approach : an application to surface reconstruction from SPOT6-HRS stereo imagery. *Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences*, 36 (1/W41), 1-5.

Rupnik, E., Pierrot-Deseilligny, M. and Delorme, A., 2018. 3D reconstruction from multi-view VHR-satellite images in MicMac. *ISPRS Journal of Photogrammetry and Remote Sensing*, 139, pp.201-211.

Rupnik, E., Deseilligny, M.P., Delorme, A. and Klinger, Y., 2016. Refined satellite image orientation in the free open-source photogrammetric tools Apero/Micmac. *ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, 3, p.83.

Shivam Duggal, Shenlong Wang, Wei-Chu Ma, Rui Hu, and Raquel Urtasun. Deepprunner: Learning efficient stereo matching via differentiable patchmatch. In Proceedings of the IEEE International Conference on Computer Vision, pages 4384–4393, 2019