Enhancing dense matching with Deep Learning

Post doc

Key Words : Dense Matching, Correlation, Convolutional neural networks, Deep Learning, Forestry, Image, Lidar

FIGURE 1 – Vertical images of an urban area (left) and a forest (right).

1 Context : the ai4geo project

The market of earth observation data has a rapid growth around 15% per year. Production of precise geospatial data is a major stake for many applications. Acquiring high resolution data over large areas can be complex and costly. Once acquired, the data needs to be processed to create the scene geometry (through a Digital Surface model or a surface mesh for instance) and its semantics, which still requires a lot of manual editing making the process long and costly. Moreover the quantity of data keeps increasing with the avalanche of HD satellite, aerial, drone and mobile mapping imagery.

The ambition of the AI4GEO project is to develop in 4 years the main blocks of a completely automatized processing pipeline for 2D and 3D geospatial data at the scale of the planet based on satellite imagery that is both global and increasingly accurate. The satellite data will be hybridated with exogen data to increase its value, qualification level and to answer specific use cases. These processing blocks will rely on Articial Intelligence methods and Cloud technologies allowing for global scale processing.

The main objectives of the ai4geo project will be to model the whole earth (Earth Digital Twin) consisting of 2D and 3D cartographic data with costs divided by 10 and processing speed increased by 10 in order to favor the emergence of new geoservices

2 Post-doc objectives

This post-doc is integrated in the ai4geo project 3D pipeline that aims at reconstructing the 3D earth geometry by dense matching. If this technique is well developped now [1-3], it still fails to produce a good quality reconstruction on certain difficult cases such as strongly repetitive textures,

textureless areas, specular surfaces and on strong depth discontinuities which are often encountered in urban areas and on the forest canopy (cf Figure 1). Recent works have demonstrated that the use of Deep Learning and in particular Convolutional Neural Networks (CNNs) techniques allow for a significant improvement of dense matching in such difficult cases [4-9]. Thus the aim of this post-doc is to leverage on such techniques in order to increase the quality of the reconstruction and to handle these issues better.

The input data for the post doc will consist of oriented aerial or satellite images over urban and forested areas as well as LiDAR scans of the same areas to serve as ground truth and learning data. The main objective is to exploit this learning data in order to develop a dense matching method specifically adapted to handling vertical images of forest.

The work will use the free open source chaine MicMac as photogrammetric infrastructure and the devlopment realized will be integrated to MicMac

3 Profile

— PhD in Computer Vision, image processing, machine learning or optimization.
— Good skills in C++
— Autonomy, rigor, pragmatism
— Strong taste for scientific research

4 Environment

The contacts and coadvisers for this post-doc are :

	Marc PIERROT DESEILLIGNY	Bruno VALLET
Phone :	+33 1 43 98 61 48	+33 1 43 98 80 81
email :	marc.pierrot-deseilligny@ign.fr	bruno.vallet@ign.fr

The post-doc will last 24 months starting october to december 2019 and will take place in the ACTE Team [1] located at the main IGN center at Saint-Mandé (close to Paris, metro line 1, Saint-Mandé station). The ACTE team is a part of the Lastig lab [2] which is a mixed research unit specialized on Geo-Information Science strongly connected to IGN (Institut National de l'Information Géographique et Forestière) which is the french National Mapping Agency. The ACTE team leads research activities in the field of computer science applied to photogrammetry, image processing, computer vision and remote sensing dedicated to ground-based, aerial and satellite multi-sensor imagery (optical, LiDAR, radar, etc.)

Marc Pierrot Deseilligny [3] is the head of the LaSTIG lab and coordinator for IGN of the ai4geo project and a member of the ACTE research team.

Bruno Vallet [4] is full time researcher at IGN in the LaSTIG lab, coordinator of the ACTE research team and coordinator of the work package of the ai4geo project on 3D.

5 Application

Interested candidates must send to the contacts mentionned above, **in a single pdf before the end of september 2019** :

— a detailed résumé,
— a motivation letter explaining the interest in the topic and suggesting ideas for solutions,
— the names and contacts of at least two references.

1. http ://recherche.ign.fr/acte.php
2. http ://recherche.ign.fr/lastig.php
3. https ://micmac.ensg.eu/index.php/Marc_Pierrot-Deseilligny
4. http ://recherche.ign.fr/labos/matis/cv.php ?nom=Vallet

6 Bibliography

[1] Bleyer, M., Rhemann, C. and Rother, C., 2011, August. PatchMatch Stereo-Stereo Matching with Slanted Support Windows. In Bmvc (Vol. 11, pp. 1-11).

[2] Furukawa, Y. and Hernández, C., 2015. Multi-view stereo : A tutorial. Foundations and Trendső in Computer Graphics and Vision, 9(1-2), pp.1-148.

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

[4] Liang, Z., Feng, Y., Guo, Y., Liu, H., Chen, W., Qiao, L., Zhou, L. and Zhang, J., 2018. Learning for disparity estimation through feature constancy. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (pp. 2811-2820).

[5] Luo, W., Schwing, A.G. and Urtasun, R., 2016. Efficient deep learning for stereo matching. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (pp. 5695-5703).

[6] Savinov, N., Hane, C., Ladicky, L. and Pollefeys, M., 2016. Semantic 3d reconstruction with continuous regularization and ray potentials using a visibility consistency constraint. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (pp. 5460-5469).

[7] Yao, Y., Luo, Z., Li, S., Shen, T., Fang, T. and Quan, L., 2019. Recurrent mvsnet for high-resolution multi-view stereo depth inference. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (pp. 5525-5534).

[8] Zbontar, J. and LeCun, Y., 2015. Computing the stereo matching cost with a convolutional neural network. In Proceedings of the IEEE conference on computer vision and pattern recognition (pp. 1592-1599).

[9] Zbontar, J. and LeCun, Y., 2016. Stereo Matching by Training a Convolutional Neural Network to Compare Image Patches. Journal of Machine Learning Research, 17(1-32), p.2.