

## PROPOSITION DE STAGE EN COURS D'ETUDES

Référence : **DTIS -2019-65**  
(à rappeler dans toute correspondance)

Lieu : Palaiseau

Département/Dir./Serv. : DTIS/IVA

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Responsable(s) du stage : Bertrand Le Saux, Marcela Carvalho, Pauline Trouvé-Peloux

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### DESCRIPTION DU STAGE

Thématique(s) : Intelligence artificielle et décision, Perception et traitement de l'information

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

#### **Intitulé : Deep neural networks for 3D point cloud prediction from a single image**

Sujet : 3D estimation is crucial for scene understanding (autonomous driving...) and accurate 3D reconstruction (3D mapping, robotics...). 3D from a single image has recently reached great performances thanks to deep neural networks. This might be a data acquisition paradigm shift, away from stereo vision and active laser scanners. We at ONERA/DTIS developed D3-Net [Carvalho et al., 2018a-b], one of the top state-of-the-art approaches to depth estimation by deep learning, awarded by a Best Paper Award at RFIAP2018, the French machine learning conference.

The objective of the internship is to push further this research work developing convolutional neural networks (CNNs) for directly estimating 3D point clouds, instead of depth rasters. Indeed, 3D point clouds are the standard in 3D data acquisition with laser and photogrammetry, and hence in 3D perception.

Especially, the intern will tackle two problems:

- Build convolutional network models for prediction of 3D real points. A particular care will be given to the design of the loss function, as the same geometry may admit different point cloud representations. Solutions based on Optimal Transport will be investigated [Fan et al., 2017];
- Predict only accurate points to avoid further errors in reconstruction algorithms. Various approaches will be compared, including simultaneous uncertainty prediction as in [Carvalho et al., 2018a], [Kendall & Gal, 2017], understanding of image hints which allow to estimate 3D: defocus, edges, scene statistics.

Work planning will consists in: design and development of CNNs of 3D point cloud prediction from a single image; coding (python) and experiments with CNNs using open libraries such as Pytorch or Tensorflow; application to robotics and computer graphics benchmarks and datasets such as ShapeNet, Stanford 2D-3D-S, or Semantic3D.

#### References:

[Carvalho et al., 2018b] On Regression Losses for Deep Depth Estimation M. Pinheiro de Carvalho, B. Le Saux, P. Trouvé-Peloux, F. Champagnat, A. Almansa IEEE Int. Conf. on Image Processing (ICIP'2018) Athens, Greece, October 2018.

[Carvalho et al., 2018a] Deep Depth from Defocus: how can defocus blur improve 3D estimation using dense neural networks? M. Pinheiro de Carvalho, B. Le Saux, P. Trouvé-Peloux, F. Champagnat, A. Almansa ECCV / Workshop on 3D Reconstruction in the Wild, Munich, Germany, September 2018.

[Fan et al., 2017] A Point Set Generation Network for 3D Object Reconstruction from a Single Image. Haoqiang Fan, Hao Su, Leonidas J. Guibas CVPR 2017, Hawaii, USA, July 2017.

[Kendall & Gal, 2017] What uncertainties do we need in Bayesian deep learning for computer vision ?

NIPS 2017, Long Beach, Cal., USA, December 2017.

Est-il possible d'envisager un travail en binôme ? **Non**

**Méthodes à mettre en oeuvre :**

- |   |  |
|---|--|
| <input checked="" type="checkbox"/> Recherche théorique | <input type="checkbox"/> Travail de synthèse             |
| <input checked="" type="checkbox"/> Recherche appliquée | <input type="checkbox"/> Travail de documentation        |
| <input type="checkbox"/> Recherche expérimentale        | <input type="checkbox"/> Participation à une réalisation |

Possibilité de prolongation en thèse : **Oui**

**Durée du stage :** Minimum : 4 months Maximum : 6 months

Période souhaitée : January – September 2019

**PROFIL DU STAGIAIRE**

Connaissances et niveau requis :

Machine Learning, Deep Learning, Image Processing and Algorithmic Geometry.

Programming experience (python, etc.)

Ecoles ou établissements souhaités :

Grandes Écoles, Master 2 recherche learning / computer vision

Ms. Eng. (CS, EE, ...), M.Sc.