**PhD Inria 2020**

**Title: Robust visual localization using high level features**

**Location:** The student will be based in the INRIA Nancy research center – France and will be a member of the MAGRIT group http://magrit.loria.fr

**Research theme:** Perception, Cognition, Interaction

**Project-team:** MAGRIT

**Key-words:** visual localization, machine learning, slam, augmented reality

**Context**

Applications are invited for a fully-funded PhD Studentship starting in October 2020 to undertake research in the area of Computer Vision and Machine Learning. The teams's main research focus on visual positioning and registration with applications to Augmented Reality.

This PhD thesis will address the problem of visual positioning with the aim of going beyond classical localization and mapping, which focuses currently only on point cloud representations. In contrast, our aim is to allow for 6DoF positioning and global scene understanding in wild and dynamic environments (e.g. crowded streets). We are interested in methods that scale up nicely with the size of the environment, and that can be used persistently over time by reusing consistent maps. Targeted applications are about augmented reality, especially in urban or industrial context.

Point-based positioning techniques are prone to error in scenes with repeated patterns and does not scale well [1]. Reasoning with objects takes advantage of a robust but approximated detection of features through the use of convolutional neural networks (CNN). However, computing the pose without prior from correspondences between detected objects and 3D models require particular 3d shape models. Both box [2] and ellipsoid models [3] have been considered in the past. We chose the latter representation and proved that it makes it possible to compute the pose in closed form (which is fast) based on very few objects (one if the camera orientation is known, two otherwise) [4,5].

**Subject**

The goal of this PhD is to push forward the state of the art in visual and spatio-temporal positioning in complex environments by merging novel machine-learning approaches with geometrical reasoning. In the continuity of our recent works on the joint use of geometric cues, especially vanishing points [6], and semantic cues/objects [4,5], our aim is to generate new high level features suitable for localization as well as means to match them, to define their uncertainty and to integrate them into localization procedures for improved robustness.

The PhD student will be tasked with:

- detecting vanishing points in complex (i.e. non-Manhattan) environments based on high-level (object) detections,
- estimating the uncertainty associated to low and high level features contributing to pose and SLAM and integrating them into the localization process
- developing new data association methods suited to objects and based on geometry, appearance and semantic criteria,
- defining improved approximations of 3d objects that can give rise to direct pose computation

This thesis is part of an international project with the German Research Center for Artificial Intelligence (DFKI, Kaiserslautern).

**Bibliography**


[1] *Torsten Sattler, Will Maddern, Carl Toft, Akihiko Torii, Lars Hammarstrand, et al.. Benchmarking 6DOF Outdoor Visual Localization in Changing Conditions. CVPR 2018.*

[2] *CubeSLAM: Monocular 3D Object SLAM. S. Yang and S. Scherer. IEEE Transactions on Robotics,35(4), 2019.*

[3] *M. Crocco, C. Rubino, and A. Del Bue. "Structure from Motion with Objects." CVPR 2016.*

[4] *V. Gaudillière, G. Simon, M.-O. Berger. "Camera Pose Estimation with Semantic 3D Model." IROS 2019.*

[5] *V. Gaudillière, G. Simon, and M.-O. Berger. "Camera Relocalization with Ellipsoidal Abstraction of Objects." ISMAR 2019.*

[6] *G. Simon, A. Fond, M.-O. Berger. "A-Contrario Horizon-First Vanishing Point Detection Using Second-Order Grouping Laws". ECCV 2018*


**Skills and profile**

Applicants must hold an MSc degree in computer science or electrical engineering with prior experience in computer vision and/or machine learning.

**How to apply**

Interested candidates should express their interest by sending the following documents as soon as possible to marie-odile.berger@inria.fr and gilles.simon@loria.fr : Brief statement of interest (max 1 page), CV, Certificate of academic degree with grades, A short (max one page) description of your Master thesis (or equivalent) or of the work in progress if not yet completed. Name and contact of two referees.

**Additional information:** See http://magrit.loria.fr for additional information on the activities of the team.

**Supervision and contact:** *marie-odile.berger@inria.fr*, *gilles.simon@loria.fr*

**Salary:** 1 958 euros gross monthly (about 1 580 euros net) during the first and the second years. 2 059 euros the last year (about 1 661 euros net). Medical insurance is included.

Application deadline : as soon as possible