Title : Matching and relocalization under lighting and scene variations

---

- **Location:** INRIA Nancy Grand Est research center

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

- **Project-team:** Magrit

- **Scientific Context:**

The basic concept of augmented reality (AR) is to place virtual objects registered with the environment into the user's/camera perception. One of the main challenges of AR is to compute the pose of the camera with a good accuracy so that virtual objects appear as fixed to the environment.

Most of the time, the pose is computed from 2D/3D correspondences between the current image and a 3D textured model of the scene. When large urban models are considered, there may be a large temporal difference between the moment the model was acquired and the current image. Geometric differences may happen : street furnitures, cars or even buildings may have appeared or disappeared since the model acquisition. In addition there may be no relationship between the intensities for some fraction of the pixels in the two images due to snow covering rooftops, leaves missing in winter... The goal of this postdoctoral position is to design matching methods between models and images which are robust against lighting and climatic variations.

- **Missions:**

There have been many attempts to make matching robust to lighting variations and scene variations, ranging from 2D filters to light reconstruction:

1. use of low level processing, as histogram equalization [1], to improve the similarities of the images. Recently, histogram normalization has been integrated into a global 2D/2D homography based registration process in an iterative procedure[2] .
2. use of more complex matching criterion that go beyond pixel similarity. Mutual information [3] is a good example of such a criterion that has proven to be efficient for multimodal matching and more recently in tracking [4].
3. Reconstruction or approximation of an illumination model or production of illumination invariant images [2,6].

However, many of these approaches are dedicated to particular assumption on the scene on or the lighting. Many works are especially designed under the assumption of a global homography within the images. Though the homography model is well suited to planar environments, the main problem with urban scenes is that we have to consider piece-wise homography models. The homography constraint is correct only on – possibly small - parts of the environments making many unknowns involved in the estimation of the illumination models with constraints on small areas, thus prone to convergence difficulties.

The goal of this postdoctoral position is to extend existing works on matching in challenging conditions to the case of true 3D scenes. Challenges are both in terms of identification of the different parts of the model in the image and in terms of robust estimation of multiple illumination models.

- **Bibliography**

[1] *I.J. Cox, Sébastien Roy and Sunita L. Hingorani.*
Dynamic Histogram Warping of Image Pairs for Constant Image Brightness
In International Conference on Image Processing 1995.
[2] *Yu Y ; Hunag K ; Chen W and Tan T.* A Novel Algorithm for View and Illumination Invariant Image Matching. *In* IEEE Transactions on Image Processing, 21 (1) , *2012.*
[3] *F. Maes, A. Collignon, D. Vandemeulen, G. Marchal and P. Suetens.* Multimodality image registration by maximization of mutual information. In IEEE TMI, 16(2),1997.
[4] A. Dame and E. Marchand. Optimal Detection and Tracking of Feature Points using Mutual Information. In IEEE Int. Conf. on Image Processing, ICIP'09,2009.
[5] *Y. Weiss.* Deriving intrinsic images from image sequences. in International Conference on Computer Vision, 2001.
[6] *P.Y. Laffont, A. Bousseau, G. Drettakis.* Rich Intrinsic Image Decomposition of Outdoor Scenes from Multiple Views. IEEE Transactions on Visualization and Computer Graphics, in press, 2013.

Post-doctorants INRIA 2013

- **Skills and profile**

Required qualification: PhD in *computer science or applied mathematics.*

- **Additional information:**

Supervision and contact : Marie-Odile Berger (marie-odile.berger@loria.fr) and Gilles Simon (gilles.simon@loria.fr)

Additional links : *see the magrit website http://magrit.loria.fr for papers and demos about the activities of the team.*

Duration : 1 year (possibly extendable)
Starting date : between Sept. 1st 2013 and Jan. 1st 2014
Salary: 2.620 euros gross monthly (about 2.135 euros net)

The required documents for an INRIA postdoc application are the following:
- CV, including a description of your research activities (2 pages max) and a short description of what you consider to be your best contributions and why (1 page max and 3 contributions max); the contributions could be theoretical, implementation, or industry transfer. Include also a brief description of your scientific and carreer projects.
- The report(s) from your PhD external reviewer(s), if applicable.
- If you haven't defended yet, the list of expected members of your PhD committee (if known) and the expected date of defense (the defense, not the manuscript submission).
- Your best publications, up to 3.
- At least one recommendation letter from your PhD advisor, and possibly up to two other letters. The recommendation letter(s) should be sent directly by their author to the prospective postdoc advisor (with cc to Sylvain.Lazard@inria.fr).

All these documents should be sent in two pdf files **before June 11th**; one file should contain the publications, the other should contain all the other documents. These two files should be sent files to your prospective postdoc advisor (in addition to the application on the web).