Open internship positions in the IMAGINE Group (spring-summer 2015)

The IMAGINE Group

The IMAGINE Group is a joint research project of the École des Ponts ParisTech (ENPC) and the French Scientific and Technical Centre for Building (CSTB), part the Gaspard-Monge Computer Science lab (LIGM) of University Paris Est (UPE).

The research domains of IMAGINE are **computer vision, machine learning, optimization** and **constraint programming**. In particular, IMAGINE has been working for many years on dense multi-view stereovision for 3D reconstruction, targeting high-precision and robustness. This expertise has been transferred in 2011 to the startup company Acute3D, created by members of the group. Acute3D's technology currently powers Autodesk's 123D Catch, a web service that builds 3D models from photographs. However, the domains of interest of IMAGINE are not restricted to 3D reconstruction, as can be seen by the following list of internships.

Open internship positions (spring-summer 2015)

Below is a list of internships open in the IMAGINE Group in spring-summer 2015. Note that only a subset of these positions will be filled, depending on the profile of applicants.

No. INT15-01: [MSc 2] Urban scene understanding via graphical models and discrete optimization

No. INT15-02: [MSc 2] Semantic and volumic 3D reconstruction of indoor scenes from range data

No. INT15-03: [MSc 2] Plane detection with a complete parameter estimation method using Q-intersection

No. INT15-04: [MSc 2] Node selection in a Branch and Bound algorithm for constrained global optimization

No. INT15-05: [MSc 2] Elimination of erroneous image matching in multi-view stereovision

No. INT15-06: [MSc 2] Wide baseline photogrammetric reconstruction of indoor scenes

To apply to one of these internships, please send an email to the contact people mentioned in the internship description, with:

- the number(s) and title(s) of the internship(s) you are interested in,
- your CV,
- a transcript of your grades/marks for last year and this year (even if incomplete),
- a short statement of your interest & competence with respect to the proposed subject(s).

Incomplete applications will not be considered.

We also have a number of **PhD positions** to be filled in 2015, some of which are related to these internships. Making a good internship in the group offers very good chances to obtain a PhD fellowship afterwards.

No. INT15-01

Type of Internship
Research (Master 2nd year)

Title

Urban scene understanding via graphical models and discrete optimization

Context

Urban scene understanding is not only a challenging computer vision problem, but also an important preliminary task for various applications such as location recognition, autonomous driving and robot navigation. We are therefore interested in developing a system for carrying out efficient and robust urban scene understanding from both static and from movable platforms.

Objectives

This internship aims to accomplish a part of such a system. More specifically, in this project, we will first test those state-of-the-art methods (e.g., [1,2,3]) and then aim to improve them by better exploring graphical models so as to fuse richer statistical priors and/or geometric constraints, as well as to improve the efficiency of their inference.

Profile

C++ and Matlab programming experience, basic knowledge of computer vision and machine learning.

References

[1] H. Isack, Y. Boykov. Energy-based Geometric Multi-Model Fitting. IJCV, 2012.

[2] E. Tretiak, O. Barinova, P. Kohli, V. Lempitsky. Geometric image parsing in man-made environments. IJCV, 2011.

[3] A. Geiger, M. Lauer, C. Wojek, C. Stiller, R. Urtasun. 3D Traffic Scene Understanding from Movable Platforms. PAMI, 2014.

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No. INT15-02

Type of Internship

Research (Master 2nd year)

Title

Semantic and volumic 3D reconstruction of indoor scenes from range data

Context

Due to technology leaps and cost reduction, capturing 3D range data (e.g., using laser scans, photogrammetry or the Kinect sensor) has become available to a wide class of users, with numerous applications. One of our goals is to develop a method to reconstruct a geometric and semantic representation of scenes acquired with such range sensors, in particular indoor scenes.

Objectives

The project is very ambitious and we thus propose a number of subtasks to work on, possibly leading to several internships:

- adapting [1] from laser scans to Kinect and/or photogrammetric data, which are more noisy, have a different geometry and possibly require the registration/fusion of several acquisitions,

- extending [1] to work on large scenes, using strategies to limit surface extension hypotheses so that reconstruction can be performed on smaller fractions of the data and later merged.

- decomposing the reconstructed volume into a small number of non-intersecting cuboids corresponding for instance to wall portions (extending 2D results such as [5] to 3D), possibly with holes (for door and window openings) and using gravity constraints as well as visual cues,

- inferring semantic label for these cuboids using domain-specific knowledge, possibly learning priors such as adjacency and size constraints from datasets of semantized 3D building models.

Profile

C++ proficiency, basic computational geometry skills, computer vision basics. Python is a plus.

References

[1] Alexandre Boul'ch, Martin de La Gorce, Renaud Marlet. Piecewise-planar 3D reconstruction with edge and corner regularization. Symposium on Geometry Processing, 2014.

[2] Y. M. Kim, N. J. Mitra, D. Yan, L. Guibas. Acquiring 3D indoor environments with variability and repetition. SIGGRAPH Asia, 2012.

[3] H. S. Koppula, A. Anand, T. Joachims, A. Saxena. Semantic labeling of 3D point clouds for indoor scenes. NIPS 2011.

[4] T. van Lankveld, M. J. van Kreveld, R. C. Veltkamp. Identifying rectangles in laser range data forurban scene reconstruction. Computers & Graphics, vol 35, 2011.

[5] C. Nogueira de Meneses, C. Carvalho de Souza. Exact solutions of rectangular partitions via integer programming. Int. J. Comput. Geom. Appl., 2000.

[6] T. Shao, A. Monszpart, Y. Zheng, B. Koo, W. Xu, K. Zhou, N. J. Mitra. Imagining the unseen: stability-based cuboid arrangements for scene understanding. SIGRAPH Asia, 2014.

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No. INT15-03

Type of Internship
Research (Master 2^{nd} year)

Title

Plane detection with a complete parameter estimation method using Q-intersection

Context

Shape detection is a basic task in image processing and there exist randomized algorithms like RANSAC that are able to find, in a 3D point cloud, a plane (or another shape as a sphere or a cylinder) maximizing the number of points (inliers) being at a given distance of it. Some extensions of RANSAC have been built to find several shapes in a greedy manner. We propose to study an alternative innovative technique, based on a complete tree search in the parameter space, to find all the planes having as support a given number of points. Some preliminary results have been obtained on artificial point clouds, but a validation and generalization of the method on real scenes is still to be done.

Objectives

A plane is described by a set of parameters. The complete search builds a search tree in the parameter space, and uses the Q-intersection contractor that contracts a current box in the search tree into a box compatible with at least Q points of the cloud, i.e., these Q points fit the thick equation of a plane with an interval for each parameter.

The first part of the internship will consist of the study of the existing Q-intersection algorithms, the existing parameterizations and a selection of some of them. The main part of the internship will consist in adapting the method to real scenes, determining the limits of the approach (in percentage of inliers), studying the sensitivity to noise in the image, and precision issues: how to stop the splitting in order not to obtain too many small boxes representing near solutions, and how to regroup solutions containing the same inliers. Implementation will be done in C++, using the Ibex interval solver library.

Profile

Knowledge on algorithms, C++ programming, and combinatorial optimization is required. Some knowledge on image and 3D processing is desirable but not mandatory.

References

[1] G. Trombettoni, I. Araya, B. Neveu, G. Chabert. Inner Regions and Interval Linearizations for Global Optimization. Proc. of AAAI 2011, pages 99-104, San Francisco, CA, USA.

[2] C. Carbonnel, G. Trombettoni, P. Vismara, and G. Chabert. Q-intersection algorithms for constrained-based robust parameter estimation. Proc. of AAAI 2014.

[3] A. Bethencourt and L. Jaulin. 3D Reconstruction Using Interval Methods on the Kinect Device Coupled with an IMU. Int. Journal of Advanced Robotic Systems, 10,2013.

[4] L. Jaulin and S. Bazeille. Image Shape Extraction using Interval Methods. Proc.of the 16th IFAC Symposium on System, pages 378–383, 2009.

[5] R. Schnabel, R. Wahl, and R. Klein. Efficient RANSAC for point-cloud shape detection. Computer Graphics Forum, 26(2) :214–226, 2007.

[6] G. Chabert, L. Jaulin. Contractor Programming. Artificial Intelligence,173:1079–1100, 2009.

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Internship in the IMAGINE Group — spring-summer 2015 – http://imagine.enpc.fr/

No. INT15-04

Type of Internship

Research (Master 2nd year)

Title

Node selection in a Branch and Bound algorithm for constrained global optimization

Context

Global optimization of a non linear function from a bounded box of R^n to R under non linear constraints, i.e., finding the global minimum of this function that satisfies the constraints, is in general an NP hard problem and there exists no polynomial algorithm for solving it. The most common complete algorithm is the "Branch and Bound" algorithm, that builds a search tree, bisecting the domains of the variables. The main researches in this area were made on linearization and constraint propagation techniques, but the performance is often very sensitive to the bisections and to the selection of the node to handle. The Best First strategy is often used, but it does not guide the search towards a feasible point. Finding quickly good feasible points can indeed speed up the search. It also useful for an anytime version of the algorithm.

Objectives

The main objective of the internship is a study how to take into account the constraints in a node selection strategy in a Branch and Bound algorithm in global (non convex) optimization in order to find feasible points.

In a first part, a bibliographic study on the different existing node selection strategies will be made, in particular for constrained optimization problems over continuous variables. Then, new strategies will be defined for selecting the current node for finding new better feasible points.

These strategies will be implemented in Ibex, an interval library developed by several research teams in France. They will be also tested on a benchmark of optimization instances.

Profile

Knowledge on algorithms, C++ programming, and combinatorial optimization is required.

References

[1] G. Trombettoni, I. Araya, B. Neveu, G. Chabert. Inner Regions and Interval Linearizations for Global Optimization. Proc. of AAAI 2011, pages 99-104, San Francisco, CA, USA.

[2] M.Cs. Markot, J. Fernandez, L.G. Casado, T. Csendes. New interval methods for constrained global optimization. Math. Program., Ser. A 106, 287–318 (2006).

[3] P Belotti, J. Lee, L. Liberti, F. Margot, and A. Wächter. Branching and bounds tightening techniques for non-convex MINLP. Optimization Methods and Software,24(4-5):597–634, 2009.

[4] B. Neveu, G. Trombettoni, and I. Araya. Node Selection Heuristics Using the Upper Bound in Interval Branch and Bound. MAGO'14, XII Global Optimization Workshop, Malaga, Spain, sept 2014.

[5] M. Tawarmalani, N. V. Sahinidis. Global optimization of mixed-integer nonlinear programs: A theoretical and computational study. Mathematical Programming, April 2004, Volume 99, Issue 3, pp 563-591.

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No. INT15-05

Type of Internship
Research (Master 2nd year)

Title

Elimination of erroneous image matching in multi-view stereovision

Context

In artificial environments, such as urban street level imagery for example, it is not unusual to be able to match pairs of images via the epipolar constraint, even though they represent different parts of the scene. For example, it may be that the left facade of a building matches with the right facade, due to architectural consistency. Such erroneous matching can lead to disastrous 3D reconstruction if not eliminated.

Objectives

The goal is to detect the erroneous image matching pairs. The input can be modeled as a visibility graph, with vertices being images and edges the matching pairs. To each edge is associated a rotation-translation, deduced from a computed essential matrix, which encodes the epipolar constraint. The basic idea is that composing the Euclidean transforms in a loop of the graph should result in the identity tranform, or just close to it due to noise [1]. Any significant deviation of this identity may be a hint of one outlying edge in the loop, without identifying precisely the culprit [2]. However, we can initiate the procedure with random trees in the graph. Assuming the edges of the trees contain no outliers, we can look at all edges of the graph that close a loop in the such a tree. If it results in an erroneous loop, the added edge should be discarded. On the contrary, if several created loops result in coherent loops, this is a hint that the tree, or a subtree, is correct. This can be checked using the *a contrario* framework [3]. Growing from reliable trees may make the algorithm fast and efficient.

Profile

C++ proficiency, computer vision basics.

References

[1] O. Enqvist, F. Kahl, and C. Olsson. Non-sequential structure from motion. ICCV Workshops, pages 264-271, 2011.

[2] C. Zach, M. Klopschitz, and M. Pollefeys. Disambiguating visual relations using loop contraints. CVPR, 2010.

[3] P. Moulon, P. Monasse, and R. Marlet. Global fusion of relative motions for robust, accurate and scalable structure from motion. ICCV, 2013.

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No. INT15-06

Type of Internship
Research (Master 2nd year)

Title

Wide baseline photogrammetric reconstruction of indoor scenes

Context

Multi-view stereovision techniques are now able to reconstruct 3D scenes from images, in general with a fair accuracy and robustness. However, most existing method are challenged in the context of scenes containing buildings and man-made objects. These scenes often present large uniform regions, such as white walls, that make pixel matching across images difficult and that leave large holes in the reconstructed scene. To obtain a plausible reconstruction in these uniform areas, methods in the literature [1-5] assume that the scene is mostly piecewise planar, with planes that are often vertical and horizontal. While they provide good reconstruction in regions that are observable in several images, a strong limitation of these method is that they do not provide any reconstruction in hidden regions or region visible in a single image, which often constitute a large part of the scene in scenarios where we have only few images taken from very different viewpoints, to reduce acquisition costs.

Objectives

The goal of this challenging internship is to develop a method to reconstruct a watertight piecewise-planar model of indoor scenes from a small set of images taken from very different viewpoints. Using strong scene priors as well as visual consistency information, it will be possible to extend in a plausible manner the reconstructed surface obtained with the state-of-the-art methods [1-5] in regions that are hidden or visible from a single image only. Similarly to [6], this method will be based on the partitioning of the space into convex cells using a plane arrangement. Contributions will be made in the definition of the surface prior and well as in the data consistency term, in particular using the visual information in region visible from a single image to decide how far planar regions need to be prolongated in these regions.

Profile

C++ and Matlab or Python programming experience. Basic knowledge in computer vision, machine learning and convex optimization.

References

[1] Y. Furukawa, B. Curless, S.M. Seitz, and R. Szeliski. Manhattan-World Stereo. CVPR 2009.

[2] S.N. Sinha, D. Steedly, R. Szeliski. Piecewise planar stereo for image-based rendering. ICCV 2009.

[3] K. Hyojin., X. Hong X., M. Nelson. Piecewise planar scene reconstruction and optimization for multi-view stereo. ACCV 2012.

[4] B. Mičušík, B., J. Košecká. Multi-view superpixel stereo in urban environments. IJCV 2010.

[5] D. Gallup, J. Frahm, M. Pollefeys. Piecewise planar and non-planar stereo for urban scene reconstruction. CVPR 2010.

[6] A. Boulch, M. de La Gorce, R. Marlet. Piecewise-Planar 3D Reconstruction with Edge and Corner Regularization. SGP 2014.

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