Ecole Doctorale STIC

Sciences & Technologies de l'Information et de la Communication

ED STIC - Proposition de Sujets de Thèse

pour la campagne d'Allocation de thèses 2011

Titre du sujet :	Non-convex energy minimization by local decomposition
Mention de thèse :	Informatique
HDR Directeur de thèse inscrit à l'ED STIC :	Zerubia Josiane

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Description du sujet :

Context:

A large amount of computer vision and image processing problems is addressed by formulating an energy which measures the quality of a potential solution. One tries to minimize this energy, i.e. to find the configuration which corresponds to the lowest value of the energy. Several types of methods can be used to reach the optimal solution of a non-convex energy. Probabilistic algorithms [3,5,7] usually based on Monte Carlo sampling are well adapted for the complex configuration spaces (discrete and/or continuous). Some combinatorial methods [1,4,6] based on Graph-Cuts constitute efficient tools for relatively simple energies defined in discrete configuration spaces.

Many works have been proposed to improve these optimization algorithms. Most of them try to speed up the convergence by inserting some prior knowledge in the optimization procedures, e.g. [2,4], or by using data-driven concepts, e.g. [7]. However, few of them exploit the Markovian property of their energy, and try to decompose the general energy minimization problem in

independent sub-problems while minimizing the eventual approximation errors.

Goals of the PhD:
The aims of the PhD are to propose and develop efficient mathematical models for decomposing a global energy minimization problem into a set of independent local sub-problems. In particular, three major issues will have to be solved. First, some stability attributes will have to be found in order to efficiently partition the global problem, i.e. find partitions whose mutual interactions are as low as possible. It has to be general enough to be applied on various types of problems from image segmentation to extraction of a unknown number of objects. Then the candidate will propose different optimization methods to solve each local sub-problem. In particular, these methods will have to be programmed in parallel, e.g. using GPU, in order to speed up the global energy minimization and gain in terms of computation times compared to standard methods. The candidate will also propose an efficient forward-backward scheme for minimizing the eventual approximation errors.

Keywords:
computer vision, image processing, optimization, Monte Carlo sampling, graph-cuts, GPU.

Profile:
The ideal candidate should have good knowledge in image processing and applied mathematics, be able to program in C/C++, and be fluent either in French or in English.

References
[1] P. Kohli, and P.H.S. Torr. “Measuring Uncertainty in Graph Cut Solutions”. Computer Vision and Image Understanding, Vol. 112(1), 2008.
[2] N. Komodakis, N. Paragios and G. Tziritas. “MRF Energy Minimization and Beyond via Dual Decomposition”. IEEE Trans. On Pattern Analysis and Machine Intelligence, Vol. 33(3), 2011.
[3] F. Lafarge, G. Gimel’farb and X. Descombes. « Geometric Feature Extraction by a Multi-Marked Point Process”. IEEE Trans. On Pattern Analysis and Machine Intelligence, Vol. 32(9), 2010.
[4] V. Lempitsky, C. Rother and A. Blake. “LogCut - Efficient Graph Cut Optimization for Markov Random Fields”. IEEE International Conference on Computer Vision, Rio de Janeiro, Brazil, 2007.
[5] S. Li. Markov Random Field Modeling in Image Analysis. Springer Eds, 2001.
[6] R. Szeliski, R. Zabih, D. Scharstein, O. Veksler, V. Kolmogorov, A. Agarwala, M. Tappen and C. Rother. “A Comparative Study of Energy Minimization Methods for Markov Random Fields with Smoothness-Based Priors”. IEEE Trans. On Pattern Analysis and Machine Intelligence, Vol. 30(6), 2008.
[7] Z.W. Tu and S.C. Zhu. “Image Segmentation by Data-Driven Markov Chain Monte Carlo”
IEEE Trans. on Pattern Analysis and Machine Intelligence, vol.24, no.5, 2002.

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