Optimization in Computer Vision School – References

April 27, 2008

Note: Section numbers in this outline correspond to the session numbers in the school program.

1 Intro to the Course (Aanaes)

No references

2 Convex Optimization (Vanderberghe)

The main reference is the book "Convex Optimization" by Boyd and Vanderberghe. [1]

3 Introduction to Quasi-Newton Methods (Hartley)

This lecture will summarize some common methods used in Computer Vision for continuous nonlinear optimization problems.

The commonly used bundle-adjustment method is described in [2]

Further information can be found in the textbook [3]

4 Quasi-Convex Optimization in Computer Vision (Hartley)

The paper [4] gives an overview of many of the subjects discussed in this course, and includes an extensive list of references.

In this lecture, the basic theory and rationale behind L_∞ optimization will be given. This is described in [5, 6]

Further applications of this basic method are discussed in [7, 8, 9]

5 Branch and Bound for Vision Applications (Kahl)

The branch-and-bound technique was described in [10]

Applications of branch-and-bound are discussed in the later papers [11, 12, 13]

The technique of Linear Matrix Inequalities (otherwise known as Semi-definite programming) [14] will also be described in this lecture.

6 Exercises I

7 Pseudo-Boolean Optimization I (Hartley)

I will describe some of the background to Pseudo-boolean optimization, and its connection with graph-cut algorithms. A very useful reference is the survey paper [15].

The question of what functions can be solved using graph cuts [16] will also be discussed.

8 Poster Session

9 Graph Cuts and Markov Random Fields (Torr)

Phil Torr will discuss recent work in Graph Cuts and MRFs. Primary references are [17, 18].

10 Pseudo-Boolean Optimization II (Hartley)

In this continuation of description of Pseudo-boolean optimization, I will continue study of the Boros-Hammer paper [15], including discussion of Roof-dual methods, and the elimination algorithm (called the "Basic Algorithm") in [15].

11 Intro to Robust Statistics (Aaneas)

References to be supplied.

12 Exercises II

13 Quasi-Convexity and Global Optimization on $SO(3)$ (Hartley)

Recent papers have combined the study of L_∞ methods with branch-and-bound. This topic will be discussed, with particular reference to search over rotation

space.

The most useful reference for this technique is [19].

Applications of this method to other problems are discussed in the papers [20, 21, 8].

14 Quasi-Convexity: Fast Algorithms and Outliers (Kahl)

Recent work on quasi-convexity has focussed on obtaining fast algorithms that overcome the disadvantage of straight SOCP implemention. Relevant references include [22, 23].

The detection of outliers is an important topic in L_∞ optimization. The following papers that address this issue are [24, 25, 26, 27].

References

[1] Boyd, S., Vanderberghe, L.: Convex Optimization. Cambridge University Press (2004)

[2] Triggs, W., McLauchlan, P.F., Hartley, R.I., Fitzgibbon, A.: Bundle adjustment for structure from motion. In: Vision Algorithms: Theory and Practice. Springer-Verlag (2000) 298–372

[3] Hartley, R.I., Zisserman, A.: Multiple View Geometry in Computer Vision – 2nd Edition. Cambridge University Press (2004)

[4] Hartley, R., Kahl, F.: Optimal algorithms in multiview geometry. In: Proc. Asian Conference on Computer Vision. Volume 1. (2007) 13 – 34

[5] Hartley, R., Schaffalitzky, F.: L_∞ minimization in geometric reconstruction problems. In: Proc. IEEE Conference on Computer Vision and Pattern Recognition, Washington DC. (2004) I–504–509

[6] Kahl, F., Hartley, R.: Multiple view geometry under the L_∞-norm. IEEE Transactions on Pattern Analysis and Machine Intelligence (2007)

[7] Sim, K., Hartley, R.: Recovering camera motion using L_∞ minimization. In: Proc. IEEE Conference on Computer Vision and Pattern Recognition, New York City. (2006) 1230 – 1237

[8] Kim, J.H., Hartley, R., Frahm, J.M., Pollefeys, M.: Visual odometry for non-overlapping views using second-order cone programming. In: Proc. Asian Conference on Computer Vision. Volume 2. (2007) 353 – 362

[9] Salzman, M., Hartley, R., Fua, P.: Convex optimization for deformable surface 3D tracking. In: Proc. International Conference on Computer Vision. (2007)

[10] Agarwal, S., Chandraker, M.K., Kahl, F., Kriegman, D.J., Belongie, S.: Practical global optimization for multiview geometry. In: Proc. European Conference on Computer Vision, Graz, Austria (2006) 592–605

[11] Chandraker, M.K., Agarwal, S., Kriegman, D.J., Belongie, S.: Globally convergent algorithms for affine and metric upgrades in stratified autocalibration. In: Proc. International Conference on Computer Vision, Rio de Janeiro, Brazil (2007)

[12] Olsson, C., Kahl, F., Oskarsson, M.: Optimal estimation of perspective camera pose. In: Proc. International Conference on Pattern Recognition. Volume II., Hong Kong, China (2006) 5–8

[13] Lu, F., Hartley, R.: A fast optimal algorithm for L_2 triangulation. In: Proc. Asian Conference on Computer Vision. Volume 2. (2007) 279–288

[14] Kahl, F., Henrion, D.: Globally optimal estimates for geometric reconstruction problems. International Journal of Computer Vision **74** (2007) 3–15

[15] Boros, E., Hammer, P.L.: Pseudo-boolean optimization. Discrete Appl. Math. **123** (2002) 155 – 225

[16] Kolmogorov, V., Zabih, R.: What energy functions can be minimized via graph cuts? IEEE Transactions on Pattern Analysis and Machine Intelligence **26** (2004) 147–159

[17] Kohli, P.: Minimizing Dynamic and Higher Order Energy Functions using Graph Cuts. PhD thesis, Department of Computing, Oxford Brookes University (2007)

[18] Mudigonda, P.K.: Combinatorial and Convex Optimization for Probabilistic Models in Computer Vision. PhD thesis, Department of Computing, Oxford Brookes University (2008)

[19] Hartley, R., Kahl, F.: Global optimization through rotation space search. submitted (2008)

[20] Åström, K., Enqvist, O., Olsson, C., Kahl, F., Hartley, R.: An L_∞ approach to structure and motion problems in 1D-vision. In: Proc. International Conference on Computer Vision. (2007)

[21] Li, H., Hartley, R.: The 3D – 3D registration problem revisited. In: Proc. International Conference on Computer Vision. (2007)

[22] Olsson, C., Eriksson, A., Kahl, F.: Efficient optimization of L_∞-problems using pseudoconvexity. In: Proc. International Conference on Computer Vision, Rio de Janeiro, Brazil (2007)

[23] Seo, Y., Hartley, R.: A fast method to minimize L_∞ error norm for geometric vision problems. In: Proc. International Conference on Computer Vision. (2007)

[24] Sim, K., Hartley, R.: Removing outliers using the L_∞ norm. In: Proc. IEEE Conference on Computer Vision and Pattern Recognition, New York City. (2006) 485 – 494

[25] Ke, Q., Kanade, T.: Quasiconvex optimization for robust geometric reconstruction. IEEE Transactions on Pattern Analysis and Machine Intelligence **29** (2007) 1834–1847

[26] Li, H.: A practical algorithm for L-infinity triangulation with outliers. In: CVPR. Volume 1. (2007) 1–8

[27] Olsson, C., Enqvist, O., Kahl, F.: A polynomial-time bound for matching and registration with outliers. In: Proc. IEEE Conference on Computer Vision and Pattern Recognition. (2008)