Medical Image Processing for Interventional Applications

Feature Matching

Online Course – Unit 13

Andreas Maier, Sebastian Bauer, Frank Schebesch
Pattern Recognition Lab (CS 5)

virtuelle hochschule bayern

FRIEDRICH-ALEXANDER UNIVERSITÄT ERLANGEN-NÜRNBERG
TECHNISCHE FAKULTÄT

Topics

Feature Matching

- Correspondence search
- Acceleration

Summary

- Take Home Messages
- Further Readings

Feature Matching

- We know how to detect points.
- We know how to compute feature descriptors.

→ **How to match them?**

Correspondence Search

- Nearest neighbor matching of feature vectors:

→ Distance metrics: L_1-Norm, Euclidean, KL divergence

Correspondence Search

- Nearest neighbor matching of feature vectors:

→ Distance metrics: L_1-Norm, Euclidean, KL divergence

- Removal of outliers (erroneous correspondences):
  - filter the set of correct matches from the full set
  - compare distance of nearest neighbor to second nearest neighbor
  - clustering strategies
  - …

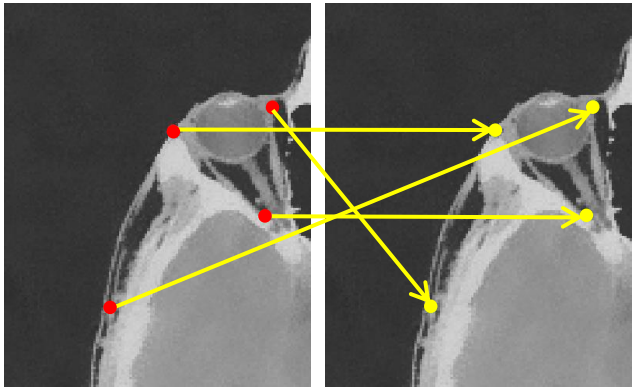

Figure 1: Unfiltered set of correspondences

Correspondence Search

- Nearest neighbor matching of feature vectors:

→ Distance metrics: L_1-Norm, Euclidean, KL divergence

- Removal of outliers (erroneous correspondences):
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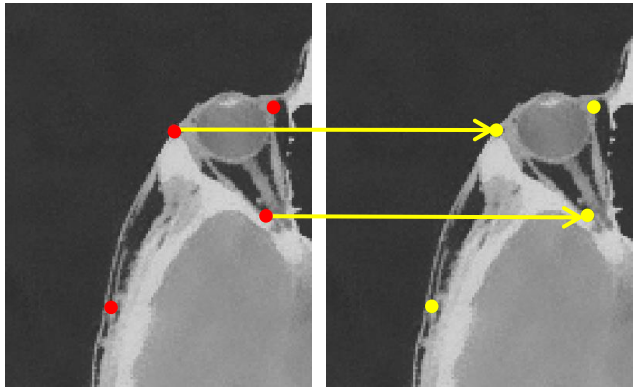

Figure 2: Outliers are removed

Implementation

- Naive approach:
  - Exhaustive brute force search
  - Curse of dimensionality

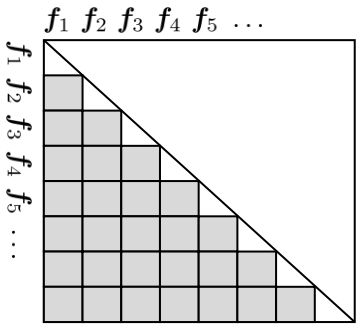

Figure 3: Checking all possible correspondences is usually not reasonable.

Implementation

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  - Exhaustive brute force search
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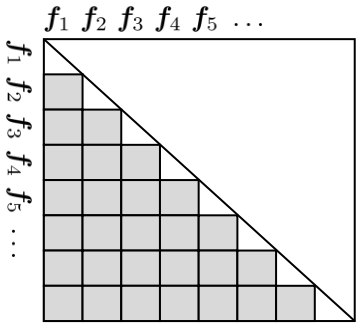

Figure 3: Checking all possible correspondences is usually not reasonable.

- Acceleration structures
  - Nearest neighbor techniques (kd-tree, …)
  - Hashing
  - …

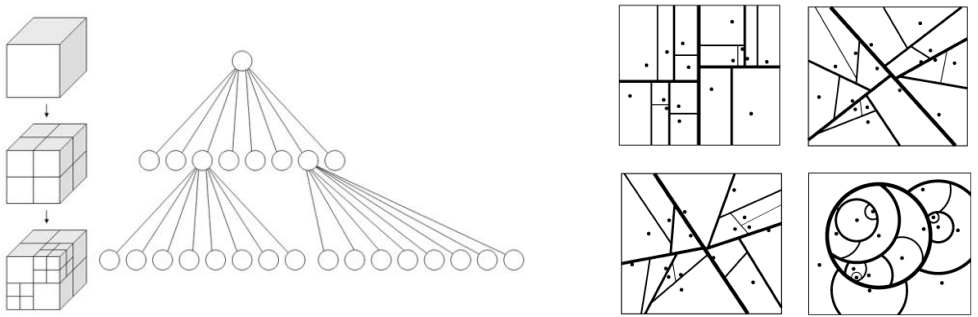

Figure 4: Schemes for faster matching strategies based on tree structures

Hardware Acceleration Techniques

Random **b**all **c**over (RBC, Cayton, 2011):

- Acceleration structure for efficient NN search
- Exploits parallel architecture of modern GPUs
- Both construction of data structure and queries based on brute force primitive

Hardware Acceleration Techniques

Random **b**all **c**over (RBC, Cayton, 2011):

- Data Point
- Representative
- Nearest Representative
- NN List

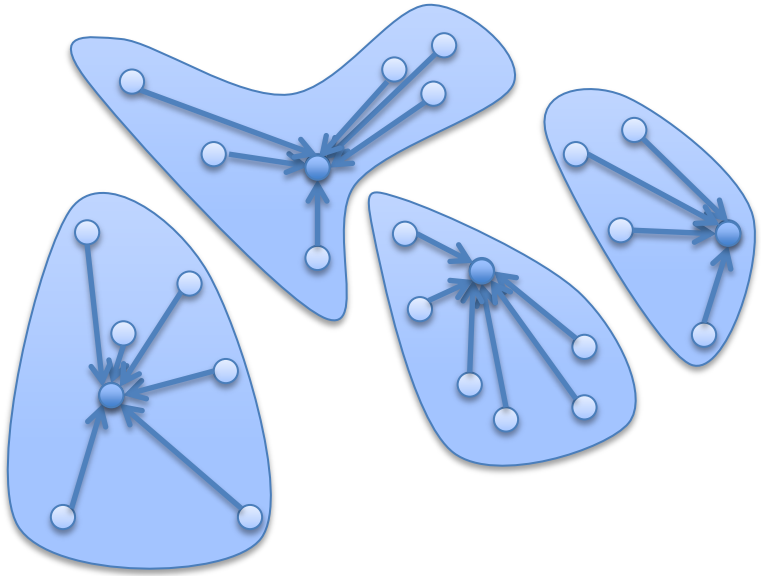

Figure 4: Construction

Hardware Acceleration Techniques

Random **b**all **c**over (RBC, Cayton, 2011):

- Data Point
- Representative
- Nearest Representative
- NN List
- Query Point

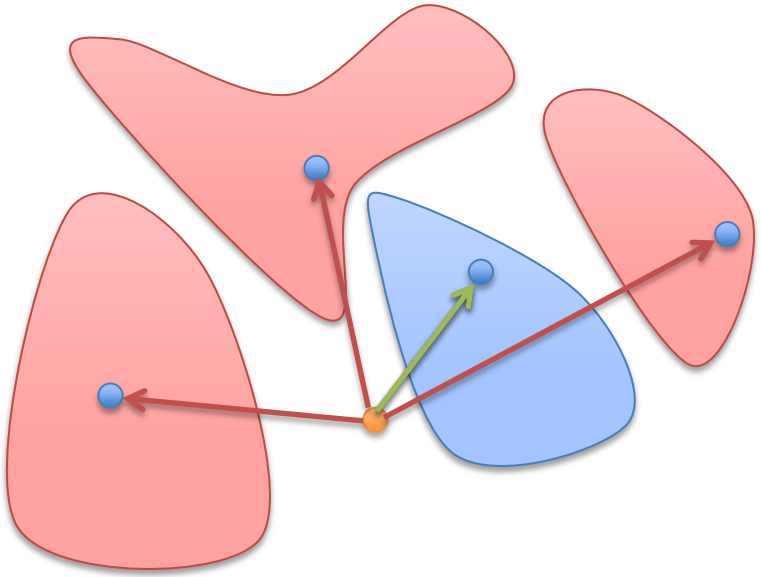

Figure 5: Query

Hardware Acceleration Techniques

Random **b**all **c**over (RBC, Cayton, 2011):

- Data Point
- Representative
- Nearest Representative
- NN List
- Query Point
- Nearest Neighbor (approximative)

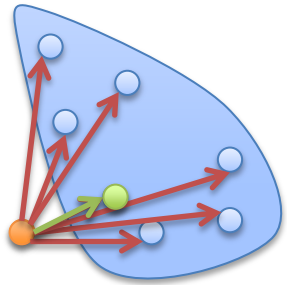

Figure 6: Possible query result

Topics

Feature Matching

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Take Home Messages

- Feature matching is the process of finding valid correspondences of feature vectors between images.
- Brute force search might work with a small set of key points, but is naturally not recommended.
- Several acceleration techniques exist of which we have introduced Cayton's RBC approach.

Credits:
We acknowledge the contributions of F.F. Li, E. Angelopoulou, D. Lowe, and A. Berg for their material in units 9-14 (on feature detectors/descriptors).

Further Readings

- David G. Lowe. “Distinctive Image Features from Scale-Invariant Keypoints”. In: *International Journal of Computer Vision* 60.2 (Nov. 2004), pp. 91–110. DOI: 10.1023/B:VISI.0000029664.99615.94
- L. Cayton. “Accelerating Nearest Neighbor Search on Manycore Systems”. In: *2012 IEEE 26th International Parallel and Distributed Processing Symposium*. IEEE, May 2012, pp. 402–413. DOI: 10.1109/IPDPS.2012.45
- A. E. Johnson and M. Hebert. “Using Spin Images for Efficient Object Recognition in Cluttered 3D Scenes”. In: *IEEE Transactions on Pattern Analysis and Machine Intelligence* 21.5 (May 1999), pp. 433–449. DOI: 10.1109/34.765655