Writer Retrieval and its Application to Music Scores

Vincent Christlein March 08, 2016 Pattern Recognition Lab (CS 5)











Motivation





Benchmark Datasets

ICDAR13

- Training: 100, test-set: 250
- 4 forms (2 English / 2 Greek)

Other datasets

- CVL: 309 authors, 5 forms (1 German, 4 English)
- KHATT: 1000 authors, 4 forms (Arabic)
- IAM: 301 authors, 2 forms (English)

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Method Overview









Offline Writer Retrieval – Method Categories

Textural based

Use global statistics to describe handwriting.

Allographic based

Writer is described by the vocabulary of letter parts.





Examples for Textural based Methods



¹A.A. Brink et al. "Writer identification using directional ink-trace width measurements". In: *Pattern Recognition* 45.1 (Jan. 2012), pp. 162–171

²Marius Bulacu and Lambert Schomaker. "Text-independent writer identification and verification using textural and allographic features." In: *IEEE Transactions on Pattern Analysis and Machine Intelligence* 29.4 (Apr. 2007), pp. 701–17



Examples for Textural based Methods



Hinge Feature - Probability Density Functions³

³Marius Bulacu and Lambert Schomaker. "Text-independent writer identification and verification using textural and allographic features." In: IEEE Transactions on Pattern Analysis and Machine Intelligence 29.4 (Apr. 2007), pp. 701–17



Pipeline (Allograph-based Methods)



Encoding methods in computer vision (bag of visual words): Vector quantization, Fisher vectors, VLAD, ...



My Work













Results on ICDAR13

		TOP-1	TOP-2	TOP-3	mAP	
	CS ⁴	95.1	19.6	7.1	_	-
	Sparse-LBP ⁵	96.9	59.9	29.2	_	
	Proposed	99.4	81.0	61.8	88.0	
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⁴R. Jain and D. Doermann. "Writer Identification Using an Alphabet of Contour Gradient Descriptors". In: ICDAR. Washington DC, Aug. 2013, pp. 550-554.

⁵A. Nicolaou et al. "Sparsely Sampled Binary Patterns for Writer Identification". In: *ICDAR*. Nancy, France, 2015.



Writer Retrieval in Historical Data









Historical Dataset

Clusius Dataset⁶

- Carolus Clusius (1526–1609)
- 1600 letters, 330 authors
- \rightarrow Use Subset of 2032 images, written by 182 scribes

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[Letter from Johannes Brambach to Carolus Clusius 1586-08-21, img-id: 896664_CLUY073-001-b, Leiden University Library, VUL 101 accessed via Digital Special Collections]

⁶Huygens Institute for the History of the Netherlands (Royal Netherlands Academy of Arts and Sciences)



Writer Retrieval in Historical Data

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[Letter 12977 from Adolf Zauner to Hugo Schuchardt 1912-02-27, Universitätsbibliothek Graz, department for special collections, legacy of Hugo Schuchardt]

Need contours \rightarrow segmentation



Segmentation w. Bradley

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Text Detection





Contour Image

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Results⁷

Dataset	SOFT-1	SOFT-5	SOFT-10	mAP
Clusius	81.7	87.5	89.7	29.1
Clusius-4	57.3	69.5	74.0	37.6

⁷ V. Christlein et al. "Automatic Writer Identification In Historical Data: A Case Study". In: Zeitschrift für digitale Geisteswissenschaften (To appear)



Error Sources

• Bad segmentation / text detection





Error Sources

- Bad segmentation / text
 detection
- No handwriting (wrong side)





Error Sources

- Bad segmentation / text
 detection
- No handwriting (wrong side)
- Wrong writer?!













Bach Dataset

- 62 images
- 5 composers
 - 11 Anna Magdalena Bach
 - 9 Carl Philipp Emanuel Bach
 - 9 Christian Gottlob Meissner
 - 16 Johann Heinrich Bach
 - 17 Johann Sebastian Bach

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[A. M. Bach, ID: 078, page 002r, www.bach-digital.de]



Evaluation 1: Full dataset, clustering

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Evaluation 2

- Full dataset
- · Leave-one-image-out cross validation

Hard-1	Hard-2	Hard-3	Hard-4	mAP
100	90.3	80.6	66.1	70.3

However, typical one document contains similar "looking" images (same background artifacts, etc.)

 \rightarrow document-independent evaluation neccessary!



Evaluation 3

- Split dataset in document independent training (43 images) and testing sets (19 images)
- Linear SVM as classifier
- Result: 63% accuracy



Evaluation 3

- Split dataset in document independent training (43 images) and testing sets (19 images)
- Linear SVM as classifier
- Result: 63% accuracy

	A. M. B.	C. P. E. B.	C. G. M.	J. H. B.	J. S. B.
A. M. B.	3	0	0	0	1
C. E. B.	0	1	0	0	3
C. G. M.	0	3	2	0	0
J. H. B.	0	0	0	5	0
J. S. B.	0	0	0	0	1



CVC-MUSCIMA Dataset⁸

- 1000 music scores
- 50 musicians contributed 20 pages
- 500 training, 500 test

Recognition Result: 100%

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⁸Alicia Fornés et al. "CVC-MUSCIMA: a Ground Truth of Handwritten Music Score Images for Writer Identification and Staff Removal". In: International Journal on Document Analysis and Recognition (IJDAR) 15.3 (2011), pp. 243–251. ISSN: 1433-2825



Summary & Outlook

Summary

- Allograph- vs. textural-based methods
- Possible to analyze large datasets
- Works really good on clean documents

Future Work

- Train on larger data corpus
- Better preprocessing
- Segmentation / contour detection



[J.S.Bach, ID: 0415, p.003r, www.bach-digital.de]













Results on ICDAR13 – Intra Language

TOP-1	English	Greek
Comb. ⁹	0.974	0.992
Proposed + Wfull	0.986	1.0

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⁹Rajiv Jain and David Doermann. "Combining Local Features for Offline Writer Identification". In: Frontiers in Handwriting Recognition (ICFHR), 2014 14th International Conference on. Heraklion, Sept. 2014, pp. 583–588.