

## **Assignment 2: Face Biometrics**

Submit your slides before the midnight of Sept. 19th.

Select one paper on face recognition and present it on Sept. 19th. We have five groups in total and each group will have 15 minutes. Please email me your group member names as well as title of the paper. To avoid conflict of selection, I will post your selection as soon as I get an email from your group.

### **General Papers**

Here are some excellent papers that every researcher in this area should read. They present a logical introductory material into the field and describe latest achievements as well as currently unsolved issues of face recognition.

W. Zhao, R. Chellappa, A. Rosenfeld, P.J. Phillips, Face Recognition: A Literature Survey, ACM Computing Surveys, 2003, pp. 399-458

R. Brunelli, T. Poggio, Face Recognition: Features versus Templates, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 15, No. 10, October 1993, pp. 1042-1052

M. Kirby, L. Sirovich, Application of the Karhunen-Loeve Procedure for the Characterization of Human Faces, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 12, No. 1, January 1990, pp. 103-108

L. Sirovich, M. Kirby, Low-dimensional Procedure for the Characterization of Human Faces, Journal of the Optical Society of America A - Optics, Image Science and Vision, Vol. 4, No. 3, March 1987, pp. 519-524

L. Sirovich, M. Meytlis, Symmetry, Probability, and Recognition in Face Space, PNAS - Proceedings of the National Academy of Sciences, Vol. 106, No. 17, 28 April 2009, pp. 6895-6899

P. Sinha, B. Balas, Y. Ostrovsky, R. Russell, Face Recognition by Humans: 19 Results All Computer Vision Researchers Should Know About, Proceedings of the IEEE, Vol. 94, No. 11, November 2006, pp. 1948-1962

R. Gross, S. Baker, I. Matthews, T. Kanade, Face Recognition Across Pose and Illumination, Handbook of Face Recognition, Stan Z. Li and Anil K. Jain, ed., Springer-Verlag, June, 2004, 27 pages

G. Shakhnarovich, B. Moghaddam, Face Recognition in Subspaces, Handbook of Face Recognition, Eds. Stan Z. Li and Anil K. Jain, Springer-Verlag, December 2004, 35 pages

T. De Bie, N. Cristianini, R. Rosipal, Eigenproblems in Pattern Recognition, Handbook of Computational Geometry for Pattern Recognition, Computer Vision, Neurocomputing and Robotics, E. Bayro-Corrochano (editor), Springer-Verlag, Heidelberg, April 2004

R. Gross, J. Shi, J. Cohn, Quo vadis Face Recognition? - The current state of the art in Face Recognition, Technical Report, Robotics Institute, Carnegie Mellon University, Pittsburgh, PA, USA, 25 pages

L. Torres, Is there any hope for face recognition?, Proc. of the 5th International Workshop on Image Analysis for Multimedia Interactive Services, WIAMIS 2004, 21-23 April 2004, Lisboa, Portugal

L.-F. Chen, H.-Y.M. Liao, J.-C. Lin, C.-C. Han, Why Recognition in a Statistics-based Face Recognition System Should be based on the Pure Face Portion: a Probabilistic Decision-based Proof, Pattern Recognition, Vol.34, No.5, 2001, pp. 1393-1403

X. Lu, Image Analysis for Face Recognition, personal notes, May 2003, 36 pages

B. Moghaddam, Principal Manifolds and Probabilistic Subspaces for Visual Recognition, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 24, Issue 6, June 2002, pp. 780-788

B. Moghaddam, A. Pentland, Probabilistic Visual Learning for Object Representation, IEEE Trans. on Pattern Analysis and Machine Intelligence, Vol. 19, No. 7, July 1997,

pp. 696-710

M. Turk, A Random Walk through Eigenspace, IEICE Transactions on Information and Systems, Vol. E84-D, No. 12, December 2001, pp. 1586-1595

W.Y. Zhao, R. Chellappa, Image-based Face Recognition: Issues and Methods, Image Recognition and Classification , Ed. B. Javidi, M. Dekker, 2002, pp. 375-402

W.S. Yambor, Analysis of PCA-based and Fisher Discriminant-Based Image Recognition Algorithms, M.S. Thesis, Technical Report CS-00-103, Computer Science Department, Colorado State University, July 2000

M. Nixon, Eye Spacing Measurement for Facial Recognition, Proceedings of the Society of Photo-Optical Instrument Engineers, SPIE, Vol. 575, No. 37, August 1985, pp. 279-285

J. Ruiz-del-Solar, P. Navarrete, Eigenspace-based face recognition: a comparative study of different approaches, IEEE Transactions on Systems, Man and Cybernetics, Part C, Vol. 35, Issue 3, August 2005, pp. 315-325

B. Moghaddam, Principal Manifolds and Probabilistic Subspaces for Visual Recognition, IEEE Trans. on Pattern Analysis and Machine Intelligence, Vol. 24, No. 6, June 2002, pp. 780-788

## **Standards**

### [Face Recognition Format for Data Interchange](#)

This standard specifies definitions of photographic (environment, subject pose, focus, etc.) properties, digital image attributes and a face interchange format for relevant applications, including human examination and computer automated face recognition.

### [Biometric data interchange formats - Part 5: Face image data](#)

ISO/IEC 19794-5:2005 specifies scene, photographic, digitization and format requirements for images of faces to be used in the context of both human verification and computer automated recognition. The approach to specifying scene and photographic requirements in this format is to carefully describe constraints on how a photograph should appear rather than to dictate how the photograph should be taken. The format is designed to allow for the specification of visible information discernable by an observer pertaining to the face, such as gender, pose and eye colour. The digital image format can be either ISO standard JPEG or JPEG2000. Finally, the 'best practice' appendices provide guidance on photo capture for travel documents and face recognition performance versus digital compression.

Oriana Yuridia Gonzalez Castillo, Report: Survey About Facial Image Quality, Fraunhofer Institute for Computer Graphics Research, Darmstadt, Germany, December 2006

### Cognitive Vision / Psychology / Neuroscience

It is the general opinion that advances in computer vision research will provide useful insights to neuroscientists and psychologists into how human brain works, and vice versa. Psychology and neuroscience issues potentially interesting to face recognition system designers (according to Zhao et al. Survey, 2003) are:

- is face recognition a dedicated process?
- is face perception the result of holistic or feature analysis?
- ranking of significance of facial features;
- caricatures;
- distinctiveness;
- the role of spatial frequency analysis;
- view-point invariant recognition?
- effect of lighting change;
- movement and face recognition;
- facial expression.

We would like to encourage this kind of interdisciplinary approach. Here are some recent papers linking two areas and some psychology- and neuroscience-based face recognition papers.

A.J. O'Toole, P.J. Phillips, F. Jiang, J. Ayyad, N. Penard, H. Abdi, Face Recognition Algorithms Surpass Humans Matching Faces over Changes in Illumination, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 29, No. 9, September

2007, pp. 1642-1646

A.M. Burton, V. Bruce, P.J.B. Hancock, From Pixels to People: A Model of Familiar Face Recognition, *Cognitive Science*, Vol. 23, No. 1, 1999, pp. 1-31

A.M. Burton, S. Wilson, M. Cowan, V. Bruce, Face recognition in poor-quality video: Evidence From Security Surveillance, *Psychological Science*, Vol. 10, No. 3, May 1999, pp. 243-248

H. Abdi, D. Valentin, B. Edelman, Eigenfeatures as intermediate level representations: the case for PCA models, *Brain and Behavioral Sciences*, Vol. 21, 1998, pp. 17-18

D. Valentin, H. Abdi, B. Edelman, What represents a face: A computational approach for the integration of physiological and psychological data. *Perception*, Vol. 26, 1997, pp. 1271-1288

D. Valentin, H. Abdi, B. Edelman, A.J. O'Toole, Principal Component and Neural Network Analyses of Face Images: What Can Be Generalized in Gender Classification? *Journal of Mathematical Psychology*, Vol. 41, 1997, pp. 398-412

G.W. Cottrell, What can computational models tell us about face processing?, Lecture, "Introduction to Cognitive Science" course, Cognitive Science Department, UC San Diego, USA

G. Lovell, Face Recognition, Tutorial Handouts, "Cognitive Psychology" Course, University of Stirling, UK

G. Schwarzer, D.W. Massaro, Modeling Face Identification Processing in Children and Adults, *Journal of Experimental Child Psychology*, Vol. 79, 2001, pp. 139-161

A. Schwaninger, C.-C. Carbon, H. Leder, Expert Face Processing: Specialization and Constraints, In G. Schwarzer & H. Leder, *Development of face processing*,

Goettingen: Hogrefe, pp. 81-97

A. Schwaninger, S. Ryf, F. Hofer, Configural information is processed differently in perception and recognition of faces, *Vision Research*, Vol. 43, 2003, pp. 1501-1505

Y. Yacoob, L. Davis, Smiling Faces are Better for Face Recognition, *Proceedings of the Fifth IEEE International Conference on Automatic Face and Gesture Recognition*, 20-21 May 2002, Washington D.C., USA, pp. 59-64

J. Schmidhuber, Facial Beauty and Fractal Geometry, Technical Report IDSIA-28-98, Machine Learning Institute, IDSIA, 1998, 7 pages

## Highly Cited Papers

Here you can find papers on face recognition that have more than 500 citations based on the SCOPUS or WoS databases. The below documents are sorted based on the number of citations according to SCOPUS database. Number of citations according to Google Scholar database are presented for completeness only. More information about the search conditions that were used to generate the results are presented below.

<b>HIGHLY CITED PAPERS</b>	<b>Cited By (SCOPUS)</b>	<b>Times Cited (WoS)</b>	<b>Cited By (Google Scholar)</b>
M. Turk, A. Pentland, Eigenfaces for Recognition, <i>Journal of Cognitive Neuroscience</i> , Vol. 3, No. 1, Win. 1991, pp. 71-86	<b>2977</b>	<b>2411</b>	5332
P.N. Belhumeur, J.P. Hespanha, D.J. Kriegman, Eigenfaces vs. Fisherfaces: Recognition Using Class Specific Linear Projection, <i>IEEE Transactions on Pattern Analysis and Machine Intelligence</i> , Vol. 19, No. 7, July 1997, pp. 711-720	<b>2031</b>	<b>1794</b>	3181
A.K. Jain, R.P.W. Duin, J. Mao, Statistical Pattern Recognition: A Review, <i>IEEE Transactions on Pattern Analysis and Machine Intelligence</i> , Vol. 22, No. 1, January 2000, pp. 4-37	<b>1169</b>	<b>968</b>	1849
M.-H. Yang, D.J. Kriegman, N. Ahuja, Detecting Faces in Images: A Survey, <i>IEEE Transactions on Pattern Analysis and Machine Intelligence</i> , Vol. 24, No. 1, January 2002, pp. 34-58	<b>906</b>	<b>745</b>	1474
R. Chellappa, C.L. Wilson, S. Sirohey, Human and Machine	<b>891</b>	<b>704</b>	1653

Recognition of Faces: A Survey, Proceedings of the IEEE, Vol. 83, Issue 5, May 1995, pp. 705-740			
P.J. Phillips, H. Moon, S.A. Rizvi, P.J. Rauss, The FERET Evaluation Methodology for Face-Recognition Algorithms, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 22, No. 10, October 2000, pp. 1090-1104	<b>852</b>	<b>753</b>	1373
W. Zhao, R. Chellappa, P.J. Phillips, A. Rosenfeld, Face Recognition: A Literature Survey, ACM Computing Surveys, Vol. 35, No. 4, 2003, pp. 399-458	<b>793</b>	<b>626</b>	1548
L. Wiskott, J.-M., Fellous, N. Kruger, C.D. Von Malsburg, Face Recognition by Elastic Bunch Graph Matching, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 19, No. 7, July 1997, pp. 775-779	<b>761</b>	<b>701</b>	1410
V. Bruce, A. Young, Understanding Face Recognition, The British Journal of Psychology, Vol. 77, No. 3, August 1986, pp. 305-327	<b>755</b>	---	1178
P. Viola, M.J. Jones, Robust Real-Time Face Detection, International Journal of Computer Vision, Vol. 57, No. 2, 2004, pp. 137-154	<b>664</b>	<b>528</b>	921
R. Brunelli, T. Poggio, Face Recognition: Features versus Templates, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 15, No. 10, October 1993, pp. 1042-1052	<b>640</b>	<b>684</b>	1459
M. Kirby, L. Sirovich, Application of the Karhunen-Loeve Procedure for the Characterization of Human Faces, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 12, No. 1, 1990, pp. 103-108	<b>602</b>	<b>626</b>	1193
J. Sergent, S. Ohta, B. MacDonald, Functional Neuroanatomy of Face and Object Processing, A Positron Emission Tomography Study, Brain, Vol. 115, No. 1, February 1992, pp. 15-36	<b>594</b>	<b>682</b>	689
S. Bentin, T. Allison, A. Puce, E. Perez, G. McCarthy, Electrophysiological Studies of Face Perception in Humans, Journal of Cognitive Neuroscience, Vol. 8, No. 6, 1996, pp. 551-565	<b>566</b>	<b>559</b>	635
B. Moghaddam, A. Pentland, Probabilistic Visual Learning for Object Representation, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 19, No. 7, July 1997, pp. 696-710	<b>582</b>	<b>595</b>	986
R. Diamond, S. Carey, Why Faces Are and Are Not Special. An Effect of Expertise, Journal of Experimental Psychology: General, Vol. 115, No. 2, 1986, pp. 107-117	<b>516</b>	---	674

J.W. Tanaka, M.J. Farah, Parts and Wholes in Face Recognition, Quarterly Journal of Experimental Psychology Section A: Human Experimental Psychology, Vol. 46, No. 2, 1993, pp. 225-245	<b>512</b>	---	604
D.L. Swets, J.J. Weng, Using Discriminant Eigenfeatures for Image Retrieval, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 18, No. 8, 1996, pp. 831-836	<b>509</b>	<b>460</b>	806