Rensselaer Polytechnic Institute

ECSE 35-6640 Digital Picture Processing - Spring 2008

92697 ECSE-6640-01 DIGITAL PICTURE PROC LEC 3 M R 2:00 3:20PM Nagy JONSSN 4104

Monday-Thursday 2:00 – 13:50 JEC 4104

Instructor: Professor George Nagy (nagy@ecse.rpi.edu)

Office hours: Mon. 12-1, Thur. 4-5, or by appointment, JEC 6020, 276-6078

Prerequisites: modest programming skills; linear systems and data structures

Grading:

Assignments`	70 %
Term paper	10%
Software trial by fire	20%

Text: Only handouts and urls. cf: http://irisKeith Price Bibliography Image Processing Books.usc.edu/Vision-Notes/bibliography/book29.html

Topics:

Digital picture processing in context
Image acquisition and display, optical density, halftones
Spatial sampling and quantization: test charts and calibration
Common image formats, representation, and compression methods
Image and text compression methods and software
Elementary picture-processing operations; morphology
Geometric and intensity quantization and normalization
Picture segmentation and connected component labeling (CC)
Image registration (2-D and 3-D)
Vectorization and tracing as an alternative to thinning and skeletonization
Color models, formats, and transformations
Selected applications: e.g. **ballots,** forms, micrographs, biometrics, remote sensing, image databases, digital libraries, line art, documents,

Assignments (~10): mostly using RPI or Open Source software (e.g. Photoshop, Matlab, Excel, JBIG, ZIP), and a term paper. Students may work alone or in *ad hoc* teams of two. Some of the procedures mastered in the course will be repeated in a (solo) take-home Trial-by-Fire. The class will be small enough to accommodate individual preferences in some assignments.

Course objective: All of the assignments will be based on optically scanned or photographed documents, which we will use to demonstrate various picture processing concepts and algorithms. On completion of the course, students should be sufficiently familiar with the (meager) theoretical foundation, notation and vocabulary of digital picture processing to pursue matters of interest in the current technical literature. They will understand some of the engineering aspects of a prototypical application of digital picture processing.

All Rensselaer academic honesty rules apply.

DPP 08 Schedule

1-14 Scope and Context; Quantitative Picture Processing: Tools
1-17 Photometry and Geometry of Imaging Devices, Calibration and Characterization

1-21 Martin Luther King Day
1-24 Grayscale/B&W: halftone screens and dithers; aliasing artifacts, Moire effects

1-28 Binarization: histogram, global, local
1-31 Prof. J. Kanai: Image file types: *pixel/vector*: GIF, BMP, :PNG, PEG, TIF, PBM, PGM, PPM, PS, EPS; PSD, Latex, SGML, HTML, XML, PDF, ODA

2-4 Compression: lossy/lossless, grayscale/B&W, Huffman: LZ77, LZ78, LZW
2-7 CCIT G3/4, Arithmetic Coding, JBIG, Symbol-based: JBIG-2, DjVu

2-19 (Tuesday) Image registration (intensity and feature-based), ICP, rectification
2-21 Connected Components

2-25 Mathematical morphology (bilevel only)
2-28 Elementary point, alg, geom. operations, edge detection, Laplacian of a Gaussian, Camy

3-3 Prof. Steve Rice FindSounds (Comparisonics)
3-6 Thinning, medial axis, chamfer distance

3-10 Spring Break

3-17 Hough transform and intro to Radon transform
3-20 (2x) Prof. Elisa Barney-Smith, Radon Transform, 3-D biomedical pictures, ?

3-24 No lecture
3-27 Dirk Padfield, Image segmentation

3-31 Random Phase Noise
4-3 Line drawings – vectorization and symbol extraction

4-7 Document segmentation and logical content labeling
4-10 The eye, color

4-14 The many shades of white
4-17 Interactive recognition - CAVIAR
4-21 Student presentations
4-24 Student presentations

4-28 Review
5-1 Reading Day

5-5 5pm to 5-6 5pm 24-HOUR STRESS TEST

Term Paper - Due Thursday March 20, 2008

The objectives of this assignment are to familiarize you with image processing periodicals; to expose you to a topic possibly not covered in class; to give you practice in preparing a paper according to standards expected in submission for publication.

Find three articles, by separate authors, on a **single topic** in picture processing (but *not* document image processing) from one of the broad journals below or from a more discipline-specific journal (e.g., *IEEE Transactions on Medical Imaging* or *Journal of Flow Visualization and Image Processing*)

IEEE Transactions on Pattern Analysis and Machine Intelligence
IEEE Transactions on Image Processing
ICGST International Journal on Graphics, Vision and Image Processing (GVIP)
Computer Vision and Image Understanding,
Image and Vision Computing
Machine Vision and Applications
The Journal of Electronic Imaging.

Graphical Models and Image Processing
Image Understanding
Machine Vision and Applications (Springer)
Journal of Mathematical Imaging and Vision (Kluwer)
Image and Vision Computing (Butterworth)
Int'l. J. of PR and AI (World Scientific)
Advanced Imaging (PTN Publishing Company)
You may also use any completed PhD dissertation.

Prepare a 4-6 page (double-spaced) critique of the subject that you have chosen. Integrate the findings of the three papers and comment on how they support or negate each other's observations. Evaluate whether their main conclusions are credible.

In addition to your choice of articles and the perceptiveness and incisiveness of your observations, your paper will be graded on style, including organization, syntax, and professional presentation. Write concisely and precisely. Be sure to provide the *complete* bibliographic citations of the papers you review (use the same format for citations as one of the journals from which you take your material), and please append copies of the papers (they will be returned).

The best papers will be circulated to the class. You are urged to ask others, including classmates, to read your drafts and make suggestions. Your message should be understandable without reference to the original articles. I shall also ask some of you to present your findings in class.

If you wish to use material from other sources, please check with me by March 3. Avoid conference proceedings, which often contain hastily assembled and incomplete reports. I shall also be glad to comment on a draft if you get it to me at least two weeks before the due date, but this is optional.

Start now.

Have Professor Nagy sign your bibliography on or before Monday March 3.

DPP08 Term Papers
April 2008

Jonathon Wu

Genetic Algorithms for Fractal Image Compression

(1) M. F. Barnsley, Fractals Everywhere. New York: Academic, 1988.
(2) A. E. Jacquin, ^ÓFractal Image Coding: A review,^Ô Proc. IEEE, vol. 81
(3) S. K. Mitra, C. A. Murphy, M. K. Kundu, ^ÓTechnique for Fractal Image Compression Using Genetic Algorithm,^Ô IEEE Transactions on Image Processing, vol. 7
(4) M. S. Wu, J. H. Jeng, J. G. Hsieh, ^ÓSchema genetic algorithm for fractal image compression,^Ô Engineering Applications of Artificial Intelligence, vol. 20
(5) Y. Zheng, G. Liu, X. Niu, ^ÓAn Improved Fractal Image Compression Approach by Using Iterated Function System and Genetic Algorithm,^Ô Computers and Mathematics with Applications, vol. 51
(6) Y. Fisher, E. W. Jacobs, and R. D. Boss, ^ÓFractal image compression using iterated transforms,^Ô in Image and Text Compression, J. A. Storer, Ed. Boston, MA: Kluwer, 1992, pp. 36-61.

Isaac Abbott

A review of Data Extraction Techniques for Form Documents

[1] F. Cesarini, M. Gori, S. Marinai, and G. Soda, "INFORMys: A Flexible Invoice-Like Form-Reader System", IEEE Trans. Pattern Analysis & Machine Intelligence, vol. 20, no. 7, pp. 730-745, July 1998.

[2] S. H. Kim, J. Kim, S. Lee and J.I. Doh, "A Form Processing System with Korean and Alphanumeric Character Recognition," Proc. French-Korean Workshop Man-Machine Handwritten Communication, pp. 151-163, Paris, France, May 1996.

[3] Lin Yu Tseng and Rung Ching Chen, "Recognition and Data extraction of Form Documents Based on Three Types of Line Segments", Pattern Recognition, vol. 31, no. 10, pg 1525-1540, 1998.

[4] J. Mao, R. Lorie, and K. Mohiuddin, "A system for automatically reading IATA flight coupons", Proc. 4th Int^Òl Conf. Document Analysis and Recognition, vol. 1, pp.153 ^Ö 157, 1997.

[5] J. Mao, M. Abayan, and K. Mohiuddin, "A Model-Based Form Processing Sub-System", Proc. 13th Int^Òl Conf. Pattern Recognition, vol. 3, pp. 691-695, 1996.

Lu Zhou

Study on Image Mosaicing

1. H. S. Sawhney and R. Kumar, “True multi-image alignment and its application to mosaicing and lens distortion correction,” IEEE Trans. Pattern Anal. Mach. Intell. 21(3), 235-243 (1999).

2. H. Nicolas, “New methods for dynamic mosaicking,” IEEE Trans. Image Process. 10(8), 1239-1251(2001).

3. D. Kim and K. Hong, “Real-time mosaic using sequential graph” Journal of Electronic Imaging. 15(2), 023005 (2006).

Piyushee Jha

Segmentation Techniques for Iris Recognition

References

[1] J. Daugman, ^ÓHigh confidence visual recognition of persons by a test of statistical independence,^Ô IEEE Trans. Pattern Anal. Mach. Intell., Vol. 15, No. 11, pp 1148 ^Ö 1161, 1993.

[2] R. Wildes, ^ÓIris Recognition: An emerging biometric technology,^Ô Proceedings of the IEEE, Vol. 85, No. 9, pp 1348 ^Ö 1363, Sept. 1997.

[3] H. Proenca and L.A. Alexandre, ^ÓIris Segmentation methodology for non-cooperative recognition,^Ô IEE Proc.-Vis. Image Signal Process., Vol. 153, No. 2, pp 199 - 205, April 2006.
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[4] K.W. Bowyer, K.Hollingsworth, and P.J. Flynn, ^ÓImage understanding for iris biometrics: A survey,^Ô Computer Vision and Image Understanding, 2007.

Ryan Desmond

Corner Detection

H. Wang and M. Brady, "Real-time corner detection algorithm for motion estimation," Image and Vision Computing, vol. 13, no. 9, pp. 695-703, Nov 1995

M. Trajkovic and M. Hedley, "Fast corner detection," Image and Vision Computing, vol 16, no. 2, pp. 75-87, Feb 1998

F. Mokhtarian and R. Suomela, "Robust Image Corner Detection Through Curvature Scale Space," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 20, no. 12, pp. 1376-1381, Dec 1998

Joshua Fialkoff

A Survey of Methods for Background Separation

[1] Michael Harville, Gaile Gordon, and John Woodfill. Foreground segmentation using adaptive mixture models in color and depth. IEEE Workshop on Detection and Recognition of Events in Video (Event '01), 00:3, 2001.

[2] Liyuan Li, Weimin Huang, Irene Yu-Hua Gu, and Qi Tian. Statistical modeling of complex background for foreground object detection. IEEE Transactions on Image Processing, 13(11):1459{1472, November 2004.

[3] Kentaro Toyama, John Krumm, Barry Brumitt, and Brian Meyers. Wallfower: Principles and practice of background maintenance. Computer Vision, 1:255{261, 1999.

Raghav Padmanabhan

Image Processing Techniques Applied to Digitized Mammograms

[1] E. Gascaa, J.S. Sánchezb, R. Alonso, Detection of Microcalcifications Using Higher Order Statistics, IEEE Signal Processing Letters, Vol. 4, No. 8, August 1997

[2] Joachim Dengler, Sabine Behrens, johann Friedrich Desaga, Segmentation of Microcalcifications in Mammograms, IEEE Transactions on Medical Imaging, Vol. 12,
No.4, December 1993.

[3] Nenad Vujovic, Dragana Brzakovic, Establishing the Correspondence Between Control Points in Pairs of Mammographic images, IEEE transactions on Image Processing, vol. 6 , No 10, October 1997

Anne Miller

Some Applications of Digital Image Processing to Archeological Research

Clogg, Phile: Margarita Diaz-Andreu, Brian Larkman,
^ÓDigital Image Processing and the Recording of Rock Art.^
Ô Journal of Archaeological Science. 837-843. 2000, vol. 27.

Kitadai, Akihito; Kei Saito, Daisuke Hachiya, Masaki Nakagawa, Hajime Baba, and Akihiro Watanabe, ^ÓDesign and Prototype of a Support System for Archeologists to Decode
Scripts on Mokkan.^Ô Proc. 13th Conference of the International Graphonomics Society (IGS), Salerno, Italy, 2005. 54-58.

Wenger, Emanuel; Victor M. Karnaukhov, Alois Haidinger and Maria Stieglecker. ^ÓA Digital Image Processing and Database System for Watermarks in Medieval Manuscripts.^Ô
International Cultural Heritage Informatics Meeting: Cultural Heritage: Technologies in the Third Millennium, 2001, Vol. 2. 259-264.