EBME 512 - Biomedical Image Processing
David Wilson, Ph.D., Department of Biomedical Engineering
EEAP 431 - Digital Image Processing
Frank Merat, Electrical Engineering

Image processing with applictions is covered in this 3 hour course. This course covers the fundamentals of 2-dimensional image processing. Topics include image filtering, coding, enhancement, and segmentation. Advanced topics include camera calibration, industrial inspection, morphological processing and 3D processing and display. There will be classroom demonstrations, class homework, and a project using MATLAB and the MATLAB Image Processing Toolbox.

Textbook:

Digital Image Processing
Kenneth R. Castleman
Prentice-Hall
ISBN: 0-13-211467-4
Published: 08/21/95

Assignment:

Tentative List of Lectures (1 lecture)
Organizational meeting

Overview (2 lectures) Chapters 1-4.
Image processing and image fundamentals (types of processing, why process images, image representation, video signals, image processing equipment)
Image Processing Demos: image formats and types, ROI's, histogramming, and filtering

Image Representation and Transformation: (4 lectures) Chapter 8.
Geometric transforms - zoom, rotation, warp, atlas warping not in book.
15.1, 15.2
Geometric models for optical imaging: camera optics, homogeneous coordinates, coordinate transformations, camera distortion, lighting

Binary image processing (2 lectures) 19.2, 19.3 17.1
18.3
Thresholding, moments, run length encoding
Image connectivity, spatial tesselation, parallel limitations } Chapter 5
18.2

Spatial filtering (10 lectures)
general principles and implementation issues] Chapter 12.
spatial sampling?
feature extraction, edge detection
matched filtering and template matching] 18.5
Laplacian, LOG 18.4
image enhancement and noise reduction

Image transforms from linear systems (2 lectures) ~~Chapter 13~~
2D Fourier transforms Chapter 10
2D Fourier filtering
Other transforms: Walsh, Hadamard, etc. Chapter 13

Biomedical applications (2 lectures)
MRI reconstruction processing, other applications, demo
Digital subtraction angiography and image registration

Image coding and compression (2 lectures) } Chapter 17
JPEG, MPEG

Morphological processing (5 lectures) } 13.7
erosion, dilation, opening & closing
reconstructions using geometric dilation
skeletons, distance functions, granularity
segmentation techniques (watershed, inc)

Image segmentation (10 lectures) } chapter 18
measurement space segmentation (MRI T1 and T2 segmentation algorithm)
region growing schemes
edge linking and Hough transform
dynamic programming
deformable models
texture

Motion (2 lectures)
image motion, motion detection, moving edge detection, optical flow

Image Analysis (2 lectures)
Sequential search and matching, quad trees, pyramids .
20.1 – 20.3. Chap. 14.

Total: 44 lectures (we only have 30 lectures)

Suggestions:

Organization (1 lecture)	<--(-1) combine with overview
Overview (2 lectures)	
Image Representation and Transformation: (4 lectures)	<--(-1)
Binary image processing (2 lectures)	<--(-1)
Spatial filtering (10 lectures)	<--(-3)
Image transforms from linear systems (2 lectures)	
Biomedical applications (2 lectures)	
Image coding and compression (2 lectures)	<--(-1)
Morphological processing (5 lectures)	
Image segmentation (10 lectures)	<-- (-3)
Motion (2 lectures)	<-- (-1)
Image Analysis (2 lectures)	<-- (-2)

This cuts it to 31 lectures. One to go

Class Times: Tuesday and Thursday 2:45-4:00

Grades: homework and DipStation labs (25%), project and paper review (35%), final (40%)

Class project: Students will be must pick an algorithm published in a suitable journal and **implement** at least a portion of the algorithm. Students may work in teams of 2-3. Some suitable journals are: PAMI, CVGIP, IEEE Trans. Medical Imaging, IEEE Trans. Image Processing.

Office hours: after class. You can also reach me by phone (368-4099 or 368-8812), or e-mail at dwilson@morph.ebme.cwru.edu

Teaching Assistant: Ken Kump, kump@morph.ebme.cwru.edu, responsible for DIP station, etc.

Recommended text: Digital Image Processing. Prentice Hall. Kenneth R. Castleman.

Other references:
Computer and Robot Vision, Volume II. Haralick and Shapiro
Computer and Robot Vision, Volume I. Haralick and Shapiro
Digital Picture Processing. Vol. I and II. Rosenfeld and Kak.
Computer Vision. Ballard and Brown.
Digital Image Processing. Pratt
Digital Image Processing. Gonzalez and Wintz
The Image Processing Handbook. CRC Press. John C. Russ.
Digital Image Processing. Prentice Hall. Kenneth R. Castleman.
warping book
notes and papers

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Image processing with **biomedical imaging applications** is covered in this 3 hour course. Topics include filtering for image enhancement, image segmentation, morphological processing, and 3D processing and display. In addition to lectures, there are **class demonstrations** using DIP Station, an image processing program running on the MacIntosh computer. **MacIntosh computers** with Alice and DIPStation software are available for homework.

Tentative List of Lectures

Organizational meeting

Overview of image processing and image fundamentals (types of processing, why process, image representation, video signals, image processing equipment)

DIP Station demo and lab (rendering, file formats, ROI's, histograming, and prototype program)

Geometric transforms - zoom, rotation, warp

Spatial filtering - general principles & implementation issues
- feature extraction, edge detection
- matched filtering & template matching
- image enhancement & noise reduction

Image transforms from linear systems - 2D Fourier transforms (Dr. Duerk)
- 2D Fourier filtering
- MRI reconstruction processing, other applications, demos

Digital subtraction angiography and image registration

~~Motion estimation in image sequences~~

Morphological processing - erosion, dilation, opening, & closing - properties & application I
- erosion, dilation, opening, & closing - properties & application II
- erosion, dilation, opening, & closing - properties & application III
- reconstructions using geodesic dilation
- skeletons, distance functions, granularity, etc
- segmentation techniques (watershed, etc.) I
- segmentation techniques (watershed, etc.) II

Image segmentation - measurement space segmentation (MRI T1 & T2 segmentation algorithm)
- region growing schemes
- edge linking & Hough transform
- dynamic programming
- deformable models

Motion estimation - Horn and Shunck

3D image display - fundamentals
- applications

3D registration of PET and MRI images

Examples of medical image analysis algorithms (vessel tracking, volume analysis)

Project presentation