EBME 461 - Biomedical Image Processing and Analysis

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Principles of image processing and analysis with applications to biomedical images from the nano-scale to 3D whole organ imaging. Topics include image filtering, enhancement, restoration, registration, morphological processing, segmentation, and visualization. Prerequisite: ESCI 313, EBME 409, or equivalent. In addition to lectures, there are many class demonstrations of image processing algorithms. Homework computer projects are done in Matlab or IDL.

List of Lectures

Organizational meeting; Matlab demo

Overview of image processing and image fundamentals (types of processing, why process, image representation,
video signals, camera modes, imperfections and corrections in camera imaging)

DIP Station demo and lab (rendering, LUT's, file formats, ROI's, histograming, thresholding, binary images)

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

Geometric transforms - zoom, rotation, warp

Image transforms from linear systems
- 2D Fourier transforms
- 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.)

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

3D visualization
- fundamentals
- applications

3D registration of PET and MRI images

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

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

Grades: homework and Matlab labs (35%), midterm (30%), final (35%)

Office hours: after class, phone: (368-4099 or 368-8812), e-mail: dlw@pw.cwru.edu

Teaching Assistant: Ravindra Manjeswhar, ravi@morph.ebme.cwru.edu, responsible for Matlab and homework projects, etc.

Recommended text: Digital Image Processing. Gonzalez and Woods.

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 Woods.
The Image Processing Handbook. CRC Press. John C. Russ.
Digital Image Processing. Prentice Hall. Kenneth R. Castleman.