

## ECE 595 Topics: Introduction to 2D & 3D Digital Image Processing

**Catalog Data:** ECE595 Introduction to 2D and 3D Digital Image Processing (3 cr.) Class 3. An introduction to 2D and 3D image processing. Lecture and projects covering a wide range of topics including 2D and 3D image analysis, image segmentation; color image processing, image sharpening, linear and filtering, image restoration, and image registration.

**Prerequisites:** ECE301 or Graduate Standing

**Prerequisites by topic:** Discrete Time Fourier Transform, Discrete Fourier Transform.

**Textbook:** **Richard E. Woods, *Multidimensional Signal, Image and Video Processing and Coding*, 1<sup>st</sup> Edition, Academic Press, 2006.**

**References:** Kenneth R. Castleman, *Digital Image Processing*, Prentice Hall, 1996.

**Coordinators:** Paul Salama, Associate Professor of Electrical and Computer Engineering and Lauren Christopher Assistant Professor of Electrical and Computer Engineering

**Goals:** To introduce to undergraduate students and beginning graduate students to image processing techniques used in 2D and 3D imaging. Students will learn the topics through a set of projects commonly used image processing techniques.

**Outcomes:** Upon completion of the course, students should be able to

1. Determine the frequency content of discrete time and discrete space signals [a, b1, b2]
2. Apply different image enhancement methods to enhance blurred images. [a,b1,b2,c,e]
3. Apply different image filtering schemes to enhance noisy images. [a,b1,b2,c,e]
4. Apply different schemes to segment images [a, c, e]
5. Obtain the optimal transformation for image registration [a, c, e]
6. Extract depth information from image sequences [a, c, e]

**Topics Covered:**

1. Mathematical Foundation for Digital Image Processing:
  - a. 1D Discrete Space Fourier Transform (1D-DSFT)
  - b. 1D Discrete Fourier Transform 1D-(DFT)
  - c. 2D Discrete Space Fourier Transform (2D-DSFT)
  - d. 2D Discrete Fourier Transform (2D-DFT)
  
2. Image Enhancement, Restoration, and Filtering:
  - a. Histograms and Point-wise Operations
  - b. Spatial Filtering - 2-D Finite Impulse Response Filters (FIR) and Infinite Impulse Response (IIR)
  - c. Sharpening Filters – Unsharp Mask
  - d. Frequency Domain Filtering
  - e. Contrast and Color Enhancement
  - f. Red-eye Detection (Flash Effect on Cornea)
  
3. Image Registration: Multi-Image Registration Using Rigid Body Transformations
  
4. Image Segmentation:
  - a. Edge Detection – Laplacian of Gaussian (LoG), Canny, 1<sup>st</sup> Order Operators
  - b. Thresholding – Local, Global
  - c. Morphological Operations – Binary
  - d. Hough Transform
  
5. 3D Image Processing:
  - a. 3D DSFT and 3D Filtering
  - b. 3D Volume Rendering and Visualization - Medical Images
  - c. 3D depth information from defocus
  - d. 3D display technologies
  - e. 4D Extensions (3D plus time)

**Computer usage:** Required

**Projects:** The projects will center on the topics covered and are aimed to enhance student learning.

**ABET category:** Engineering science 3 credits or 100 %

**Prepared by:** Paul Salama, Lauren Christopher Date: September 18, 2008.  
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