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.


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 \([a, b_1, b_2]\)
2. Apply different image enhancement methods to enhance blurred images \([a,b_1,b_2,c,e]\)
3. Apply different image filtering schemes to enhance noisy images \([a,b_1,b_2,c,e]\)
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, 1st 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%

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