CS825 - Image Processing
2021 Spring/Summer
Course Outline

Part 1: Lectures

1. **Chapter 1: Introduction**
   - Image v.s. digital image
   - Image analysis v.s. computer graphics
   - Differences between image processing, pattern recognition, and computer vision
   - Sample applications
   - Image analysis systems
   - Popular image processing software systems
2. **Chapter 2: Digital Image Fundamentals**
   - Spatial sampling and image resolution
   - Intensity level quantization and perceived smoothness

- Color Fundamentals
- Basic representation of digital images (raw images)
- Popular encoded image formats

3. **Chapter 3: Image Enhancement**
    - Human vision structure
    - Characteristics of Human Vision System (HVS)
        - Primary colors
        - Brightness level adaptation
        - Webber ratios
    - Histograms
    - Image Intensity Mapping
    - Histogram Equalization
    - Histogram Specification
4. **Chapter 4: Image Analysis – Spatial Domain Techniques**
    - Mathematical fundamentals

    - Inner-products in vector space
    - Correlation
    - Convolution
    - Operators
- Sub-image template matching
- Linear smoothing filters
- 1st derivatives (Gradient) and edge detection
- 2nd derivatives (Zero-crossing) and edge detection
- Scale-space filtering
- Non-linear Filters

5. **Chapter 5: Image Analysis – Frequency Domain Techniques**
    - Mathematical Fundamentals
        - Inner-products in functional space
        - Base functions
        - Projection of signal onto base functions

- Fourier Transforms in 1D and 2D
- Properties of Fourier Transform
- Fast Fourier Transform (FFT)
- Low-pass and High-pass Filtering

6. **Chapter 6: Region Analysis**
   - Contour Tracing
   - Morphological Operations
   - Region Contour representations
   - Hough Transform and Line Detection
   - Image Segmentation
   - Region Representations and Properties
7. **Chapter 7: Face Detection and Recognition**
   - Fast face detection
   - Principal Component Analysis (PCA)
   - Eigen-Face

Part 2: Student Presentations

- Every student will give a presentation to the class approximately 30 minutes long followed by a 10 minutes question period.
- Each presentation should be based on primarily one research article.
- A list of classic research articles will be posted for your consideration.
- You can choose articles outside of the list with my approval.

Part 3: Term Projects

- Every student will do a term project individually.
- Sample projects will be posted for your reference in terms of scope, depth, and level of difficulty.
- You should write a proposal for your project by the end of June for my approval.
- The term project is due on August 15th, 2020.