IMAGE PROCESSING

1.Thông tin về học phần (General Information)

Tên học phần (Course name): Image Processing

Mã học phần (Course code): INT_E14123

Số tín chỉ (Number of credits): 3

Loại học phần (Course type): Elective

Học phần tiên quyết (Prerequisites):

Học phần trước (Previous courses):

Học phần song hành (Parallel courses):

Các yêu cầu đối với học phần (Course requirements):

- Lecture room: Projector, microphone and speaker, Chalkboard or Whiteboard.
- Laboratory: Computer with Internet connection, Projector, microphone and speaker, Chalkboard or Whiteboard.

Giờ tín chỉ đối với các hoạt động (Teaching and Learning hours):

- Lý thuyết (Lectures): 32h
- Bài tập (Exercises): 0h
- Bài tập lớn (Projects): 8h
- Thực hành (Labs): 4h
- Tự học (Individual reading): 1h

Địa chỉ Khoa/Bộ môn phụ trách học phần (Address of the Faculty/Department in charge of the course):

- Address: Faculty of Information Technology 1 - Posts and Telecommunications Institute of Technology, Km10, Nguyen Trai Street, Ha Dong District, Hanoi.
- Phone number: (024) 33510432

2. Mục tiêu học phần (Objectives)

Về kiến thức (Knowledge):

The main aim of this course is to provide learners with an introduction to basic concepts, methodologies applicable to digital image processing, and a foundation that can be used as the basis for further study and research in this field. Students will gain understanding of:

- Components of an image processing system and its applications, image fundamentals;
- Methods of image filtering and enhancement;
- Color image processing;
- Morphological operators;
- Algorithms of image segmentation;
- Feature extraction and image pattern classification.

Kỹ năng (Skills):

This course aims to equip learners with skills in:

- Discussions in the working group using concepts and methodologies applicable to digital image processing;

- Using a popular library for image processing/computer vision and using a popular machine learning framework;

- Designing, implementing, and evaluating solutions for digital image processing problems.

Thái độ, Chuyên cần (Attitude):

Students are required to attend the classes and complete exercises and assignments.

3. Tóm tắt nội dung học phần (Description)

In this course, mainstream areas of image processing are covered, including image fundamentals, image filtering and enhancement (intensity transformations and spatial filtering), color image processing, morphology (operations that process images based on shapes such as erosion, dilation, opening, closing), segmentation, image feature extraction, and image pattern classification. Also, computer laboratory exercises are designed to introduce methods of real-world image data manipulation.

4. Nội dung chi tiết học phần (Outlines)

Chapter 1. Introduction
1.1. Digital image processing
1.2. The origins of digital image processing
1.3. Examples of fields that use digital image processing
1.4. Fundamental steps in digital image processing
1.5. Components of an image processing system
1.6. Digital image fundamentals

Chapter 2. Intensity transformations and spatial filtering
2.1. Background
2.2. Some basic intensity transformation functions
    2.2.1. Image negatives
    2.2.2. Log transformations
    2.2.3. Power-Law (Gamma) transformations
    2.2.4. Histogram processing
2.3. Fundamentals of spatial filtering
2.4. Smoothing (Lowpass) spatial filters
    2.4.1. Box filter kernels
    2.4.2. Lowpass Gaussian filter kernels
    2.4.3. Order-statistic (nonlinear) filters
    2.5. Sharpening (highpass) spatial filters
    2.5.1. Foundation
    2.5.2. Using the second derivative for image sharpening - the Laplacian
    2.5.3. Unsharp masking and highboost filtering
    2.5.4. Using first-order derivatives for image sharpening - the gradient
2.6. Combining spatial enhancement methods

Chapter 3. Color image processing
3.1. Color fundamentals
3.2. Color models
    3.2.1. The RGB color model
    3.2.2. The CMY and CMYK color models
    3.2.3. The HSI color model
    3.2.4. A device independent color model
3.3. Pseudocolor image processing
3.4. Basics of full-color image processing

3.5. Color transformations
    3.5.1. Formulation
    3.5.2. Color complements
    3.5.3. Color slicing
    3.5.4. Tone and color corrections
    3.5.5. Histogram processing of color images
3.6. Color image smoothing and sharpening
    3.6.1. Color image smoothing
    3.6.2. Color image sharpening
3.7. Using color in image segmentation
    3.7.1. Segmentation in HSI color space
    3.7.2. Segmentation in RGB space
    3.7.3. Color edge detection
3.8. Noise in color images
3.9. Color image compression

Chapter 4. Morphological image processing
4.1. Preliminaries
4.2. Erosion and dilation
4.3. Opening and closing
4.4. The hit-or-miss transform
4.5. Some basic morphological algorithms
    4.5.1. Boundary extraction
    4.5.2. Hole filling
    4.5.3. Extraction of connected components
    4.5.4. Convex hull
    4.5.5. Thinning
    4.5.6. Thickening
    4.5.7. Skeletons
    4.5.8. Pruning

Chapter 5. Image Segmentation
5.1. Fundamentals
5.2. Point, line, and edge detection
    5.2.1. Background
    5.2.2. Detection of isolated points
    5.2.3. Line detection
    5.2.4. Edge models
    5.2.5. Basic edge detection
    5.2.6. More advanced techniques for edge detection
    5.2.7. Linking edge points
5.3. Thresholding
    5.3.1. Foundation
    5.3.2. Basic global thresholding
    5.3.3. Optimum global thresholding using Otsu’s method
    5.3.4. Using image smoothing to improve global thresholding
    5.3.5. Using edges to improve global thresholding
    5.3.6. Multiple thresholds
    5.3.7. Variable thresholding
5.4. Segmentation by region growing and by region splitting and merging
    5.4.1. Region growing
    5.4.2. Region splitting and merging
    5.5. Region segmentation using clustering and superpixels
    5.5.1. Region segmentation using K-Means clustering

5.5.2. Region segmentation using superpixels
5.6. Region segmentation using graph cuts
5.7. Segmentation using morphological watersheds
5.8. The use of motion in segmentation

Chapter 6. Feature extraction
6.1. Background
6.2. Boundary preprocessing
6.2.1. Boundary following (tracing)
6.2.2. Chain codes
6.2.3. Boundary approximations using minimum-perimeter polygons
6.3. Boundary feature descriptors
6.4. Region feature descriptors
6.5. Principal components as feature descriptors
6.6. Histogram of oriented gradients (HOG)
6.7. Local binary patterns (LBP)
6.8. Scale-invariant feature transform (SIFT)
6.9. Haar-like feature
6.10. Kernel descriptor

Chapter 7. Image pattern classification
7.1. Background
7.2. Patterns and pattern classes
7.2.1. Pattern vectors
7.2.2. Structural patterns
7.3. Pattern classification by prototype matching
7.4. Support-vector machine (SVM)
7.5. AdaBoost
7.6. Optimum (Bayes) statistical classifiers
7.7. Neural networks and deep learning
7.8. Deep convolutional neural networks

5. Học liệu (Textbooks)

5.1. Học liệu bắt buộc (Required Textbooks)

[1]. Gonzalez, R. C. and Woods, R. E. Digital Image Processing, 4th ed., Pearson/Prentice Hall, NY, 2018.

5.2. Học liệu tham khảo (Optional Textbooks)

[2]. Richard Szeliski. Computer Vision: Algorithms and Applications (Texts in Computer Science), Springer, 2011.

[3]. Goodfellow, I., Bengio, Y. and Courville, A. Deep learning. MIT press, 2016.

[4]. Jan Solem. Programming Computer Vision with Python, O'Reilly Media, 2012.

6. Phương pháp, hình thức kiểm tra – đánh giá kết quả học tập học phần (Grading Policy)

Grading method	Percentage	Group/Individual
- Attendance	10%	Individual
- Exercises	10%	Individual
- Mid-term projects/exam	30%	Group or individual
- Final examination	50%	Individual

Trưởng Bộ môn **(Head of Department)**	**Giảng viên biên soạn** **(Lecturer)**
Ngô Xuân Bách	**Nguyễn Văn Tới**