EE5806: TOPICS IN IMAGE PROCESSING

Effective Term
Semester B 2024/25

Part I Course Overview

Course Title
Topics in Image Processing

Subject Code
EE - Electrical Engineering
Course Number
5806

Academic Unit
Electrical Engineering (EE)

College/School
College of Engineering (EG)

Course Duration
One Semester

Credit Units
3

Level
P5, P6 - Postgraduate Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
[MA2149 Mathematical Analysis, or MA2170 Linear Algebra and Multi-variable Calculus]; and
[EE3210 Signals and Systems, or EE3118 Linear Systems and Signal Analysis] or EE5410 Digital Signal Processing

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

This course aims to provide students with an understanding of digital image processing techniques, including image reconstruction and restoration, pattern recognition and video analysis.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe Image transformations.		x	x	
2	Describe Image reconstruction and restoration.		x	x	
3	Describe Image segmentation and pattern recognition.		x	x	
4	Perform Video analysis.				x
5	Apply computer algorithms to practical problems.				x

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures	Key mathematical, algorithmic and system concepts are described and illustrated	1, 2, 3	2 hrs/wk
2	Tutorials	Key mathematical, algorithmic and system concepts are worked out based on examples and exercises	1, 2, 3	1 hr/wk
3	On-line learning	Key mathematical, algorithmic and system concepts concepts are demonstrated with web-based multimedia materials	1, 2, 3	
4	Computer projects, demo and presentation	Key concepts are applied to solve real-world image and video processing problems	4, 5	

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Tests (min.: 2)	1, 2, 3, 4, 5	30	
2	#Assignments (min.: 3)	1, 2, 3, 4, 5	20	

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

2

Additional Information for ATs

Remark: To pass the course, students are required to achieve at least 30% in course work and 30% in the examination.
may include homework, tutorial exercise, project/mini-project, presentation

Assessment Rubrics (AR)

Assessment Task

Examination (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Achievements in CILOs

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair

(C+, C, C-) Moderate

Marginal

(D) Basic

Failure

(F) Not even reaching marginal level

Assessment Task

Coursework (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Achievements in CILOs

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair

(C+, C, C-) Moderate

Marginal
(D) Basic

Failure
(F) Not even reaching marginal level

Assessment Task
Examination (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Achievements in CILOs

Excellent
(A+, A, A-) High

Good
(B+, B) Medium

Marginal
(B-, C+, C) Low

Failure
(F) Not even reaching marginal level

Assessment Task
Coursework (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Achievements in CILOs

Excellent
(A+, A, A-) High

Good
(B+, B) Medium

Marginal
(B-, C+, C) Low

Failure
(F) Not even reaching marginal level

Additional Information for AR

Constructive Alignment with Programme Outcomes

PILO 1, 2 - By taking this course, students will learn advanced digital image processing techniques, including various image transformations, image reconstruction from incomplete information, image segmentation and recognition and video sequence analysis.

PILO 3 - Students will be able to design and conduct digital imaging experiments and analyze and interpret image and video data, as evidenced from computer projects, demo and presentation. Examples include designing a system for image reconstruction from Fourier magnitude only or phase only data and detection of moving objects in video sequences. Students will be encouraged to engage in discovery and innovation related activities, such as studying the latest digital imaging technologies in computer and mobile applications.
PILO 4 - Students will be able to identify, formulate and solve engineering problems using digital imaging techniques. An example is how to remove the blurring in an image from a moving object. One has to understand how to model the motion, its effect on image formation and remove the motion artifacts under various real world constraints.
PILO 5 - Students will be able to develop new digital imaging technology and industrial products. For example, student can be asked to do a project on human face image identification on a mobile phone. This requires research and development of efficient hardware and software and the knowledge gained in this course can help student achieve the goals.

Part III Other Information

Keyword Syllabus

Basic Image Processing Methods
Image sampling and quantization; filtering in spatial and frequency domains; color imaging; contrast enhancement.

Image Transformations
The two-dimensional Fourier transform (2D DFT); principal component analysis; 2D autoregressive (AR) and moving average (MA) models; non-linear transforms.

Image Reconstruction and Restoration
Spatial and frequency domain representation of 2D signals; image reconstruction from projections, image reconstruction from Fourier magnitude information only or phase information only; medical imaging systems; projection onto convex sets for image reconstruction and restoration.

Image Segmentation and Pattern Recognition
Pattern recognition techniques; image segmentation; point detection, line detection, edge detection; thresholding, clustering, region growing methods; decision function; pattern classification by distance and maximum likelihood; training techniques; application of AI techniques.

Video Analysis
Kalman filtering, linear prediction, motion detection and estimation; point and line matching, object tracking; efficient computer algorithms.

Applications
Examples include artefact removal from highly compressed images, medical image reconstruction from incomplete information, object detection, tracking and recognition.

Reading List

Compulsory Readings

	Title
1	Gonzalez R. C. and Woods R.E.: Digital Image Processing, Third Edition (Prentice Hall, 2008).
2	Lecture notes on: http://www.eespeech.cityu.edu.hk/~ebook/ee5806/

Additional Readings

	Title
1	Szeliski R.: Computer Vision, Algorithms and Applications, Springer-Verlag, 2011.
2	Animation movies on: http://www.eespeech.cityu.edu.hk/~ebook/ee5806/