COURSE DESCRIPTION FORM: CS-4055: Digital Image Processing

INSTITUTION FAST School of Computing, National University of Computer and Emerging Sciences, Islamabad

PROGRAM(S) TO BE EVALUATED BS-CS: **Fall 2021**

Course Description

Course Code	CS-4055
Course Title	Digital Image Processing
Credit Hours	3
Grading Policy	Absolute grading
Policy about missed assessment items in the course	Retake of missed assessment items (other than sessional/ final exam) will not be held. Student who misses an assessment item (other than sessional / final exam) is awarded zero marks in that assessment item i.e. late submission will not be accepted. For missed sessional/ final exam, exam retake/ pretake application along with necessary evidence are required to be submitted to the department secretary. The examination assessment and retake committee decides the
Course Plagiarism Policy	Plagiarism in any kind of assessment including project or sessional/ final exam, assignments quizzes, will result in F grade in the course.
Prerequisites by Course(s) and Topics	None
Assessment Instruments with Weights (homework, quizzes, midterms, final, programming assignments, lab work, etc.)	Assessment items and their weights

Assessment Item	Number	Weight (%)
Assignments	4	15
Quizzes	4	10
Project	1	15
Midterm	1	20
Final Exam	1	40

Course Instructors	Dr. Akhtar Jamil
Course Coordinator	Dr. Akhtar Jamil
URL (if any)	
Current Catalog Description	Introduction to Image Processing, Image formation, edges and shapes, shape description and analysis, Compression, Spatial filtering, Image enhancement, image segmentation, feature extraction, object detection and tracking
Textbook (or **Laboratory Manual**	Digital Image Processing, Rafael C. Gonzalez.

for Laboratory Courses)	
Reference Material	1. Computer Vision: Algorithms and Applications by Richard Szeliski 2. Computer Vision: A Modern Approach, David A. Forsyth and Jean Ponce 3. Additional material will be provided by the instructor (if required)
Course Learning Outcomes	

A. Course Learning Outcomes (CLOs)

After completion of the course, the students shall be able to:

1. Understand the basic theoretical foundation of fundamentals of Digital Image Processing concepts.
2. Concepts of digital image acquisition; image manipulation; preprocessing; segmentation;
3. Understand the various algorithms involved in image analysis.
4. Given a real work problem, be able to analyze the problem and design an image analysis pipeline to address the problem.
5. Be able to implement the algorithms in MATLAB / OpenCV or any programming language.
6. Do research and solve a real-problem in the form of a project

B. Program Learning Outcomes (PLOs)

PLO 1	Computing Knowledge	Apply knowledge of mathematics, natural sciences, computing fundamentals, and a computing specialization to the solution of complex computing problems.
PLO 2	Problem Analysis	Identify, formulate, research literature, and analyze complex computing problems, reaching substantiated conclusions using first principles of mathematics, natural sciences, and computing sciences.
PLO 3	Design/ Develop Solutions	Design solutions for complex computing problems and design systems, components, and processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
PLO 4	Investigation & Experimentation	Conduct investigation of complex computing problems using research based knowledge and research based methods
PLO 5	Modern Tool Usage	Create, select, and apply appropriate techniques, resources and modern computing tools, including prediction and modelling for complex computing problems.
PLO 6	Society Responsibility	Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal, and cultural issues relevant to context of complex computing problems.

PLO 7	Environment and Sustainability	Understand and evaluate sustainability and impact of professional computing work in the solution of complex computing problems
PLO 8	Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of computing practice.
PLO 9	Individual and Team Work	Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
PLO 10	Communication	Communicate effectively on complex computing activities with the computing community and with society at large.
PLO 11	Project Management and Finance	Demonstrate knowledge and understanding of management principles and economic decision making and apply these to one's own work as a member or a team.
PLO 12	Life Long Learning	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological changes.

C. Mapping of CLOs on PLOs

LO: Course Learning Outcome, PLOs: Program Learning Outcomes)

		PLOs											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CLOs	1	✓											
	2	✓	✓	✓	✓								
	3			✓		✓							
	4	✓	✓	✓	✓	✓							
	5						✓			✓	✓		

Topics Covered in the Course, with Number of Lectures on Each Topic (assume 15-week instruction and one-hour lectures)

Week	List of Topics	Contact Hours	CLO(s)
1.	**Introduction to course and Image Processing** • Introduction to Course • Image Processing fundamentals, • DIP Applications, • Image Acquisition and Steps in Image Processing • Elements of Digital Image Processing Systems • Working with images in Matlab/OpenCV	**3**	**1**
2.	**Image Processing Fundamentals (continue)** • Sampling and quantization, • Logarithmic Transform	**3**	**1,2**

		• Translation, Scaling, Rotation and Perspective Projection of image • Image processing with OpenCV		
	3.	**Intensity Transformation** • Fundamentals of Intensity transformation, • Pixel and its relationships like Neighbours and Connectivity • Contrast Stretching Transform • Color Images and color conversions • Color Filtering • Image Smoothing and Contrast • Spatial Filtering • Segmentation of color objects using RGB and HSV based filtering	**3**	**1,2,3**
	4.	**Spatial Filtering** • Histogram processing • Histogram Equalization • Histogram Matching • Adaptive Histogram Equalization • Linear vs Non-linear spatial filtering	**3**	**1,2,3**
	5.	**Image SEGMENTATION** • Edge Detection • Edge based method	**3**	**1,2,3,4**
	6.	**Image SEGMENTATION** • Point Line and Edge detection • vertical and horizontal Sobel filters, canny edge detection • Introduction to Thresholding, Adaptive thresholding, and multi-level thresholding • Introduction to Hough transformation • Connected Component and Contour Analysis	**3**	**1,2,3**
	7.	**Image SEGMENTATION** • Advanced Techniques for segmentation • MeanShift segmentation and Camshift Segmentation • Distance Transform and watershed segmentation	**3**	**1,2,3**
	8.	**Image Compression** • Fundamentals of image compression • Information Redundancy • Huffman Coding for image compression	**3**	**1,2,4,5**
	9.	**Mid term**	**3**	
	10.	**Morphological Processing** • Erosion and Dilation • Opening and Closing • Hit or Miss Transformation	**3**	**1-5**
	11.	**Morphological Processing** • Opening by reconstruction • Advane Morphological Operations	**3**	**1-5**

		Case Study: Horizontally aligned Text from Videos		
	12.	**Feature Extraction and Representation** • Chain Codes • Polygon Approximations • Boundary Descriptors	**3**	**1-5**
	13.	**Feature Extraction and Representation (Cont.)** • HoG descriptors • SIFT Features • ORB Features • Case Study	**3**	**1-5**
	14.	**Image classification** • Neural networks for image classification • SVM for image classification • Case Study: COVID-19 classification from x-Ray images	**3**	**1-5**
	15.	**Presentations and Discussions**	**3**	**1-6**
		Total	**45**	

Programming Assignments Done in the Course	Students have to implement and use different algorithms discussed in class. Students will also be required to do one project in which an algorithm will be implemented.			
Class Time Spent (in percentage)	**Theory**	**Problem Analysis**	**Solution Design**	**Social and Ethical Issues**
	45	35	18	2
Oral and Written Communications	Every student is required to submit at least __1___ written reports of typically _5____ pages and to make __1___ oral/pre-recorded presentation of typically ____10 - 15 ___ minutes' duration explain all concepts that have been implemented as part of the project.			

Practical/ Programming Work/ Tools: Matlab, OpenCV