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PRINCIPLES OF IMAGE PROCESSING **Course Code : 316319**

Programme Name/s : **Artificial Intelligence/ Artificial Intelligence and Machine Learning**
Programme Code : **AI/ AN**
Semester : **Sixth**
Course Title : **PRINCIPLES OF IMAGE PROCESSING**
Course Code : **316319**

I. RATIONALE

Digital Image processing allows computers to extract meaningful information from images or various day-to-day applications, which also enhance visual quality and enable automated analysis of image data. Image processing is important for applications where immediate responses are needed. This course provides the skills to manipulate and analyze digital images, including techniques to enhance image quality, extract features, segment objects and perform analysis on visual data.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to attain following Industry Identified Competency through various Teaching Learning Experiences:
Use image processing techniques to retrieve useful information from the image.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Explain concepts of digital image processing.
- CO2 - Elaborate image processing techniques to enhance image quality.
- CO3 - Identify image compression and segmentation techniques.
- CO4 - Use image restoration techniques.
- CO5 - Identify image processing techniques for feature detection.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316319	PRINCIPLES OF IMAGE PROCESSING	PIP	DSC	3	-	-	1	4	2	3	30	70	100	40	-	-	-	-	25	10	125

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Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Explain types of image processing techniques. TLO 1.2 Differentiate Megapixels and Image Quality. TLO 1.3 Explain steps involved in digital image processing with diagram. TLO 1.4 Explain components of an Image Processing System. TLO 1.5 Compare different image file formats. TLO 1.6 State different operation on images. TLO 1.7 Describe applications of Digital Image Processing.	**Unit - I Introduction to Image Processing** 1.1 Image : Pixel, Distance measures, Color fundamentals & models – RGB , HIS, YIQ, Types of an image : Vector and Raster , Types of image processing, Formation of digital image , resolution(Spatial and gray level), Megapixels and Image Quality. Image Acquisition: Cameras and sensors 1.2 Block Diagram: Fundamental Steps in Digital Image Processing, Advantages and disadvantages 1.3 Components of an Image Processing System, Difference between Image Sampling & quantization 1.4 Image file formats : JPEG , PNG, GIF, TIFF, BMP , Image Histogram 1.5 Operations on images : image addition, subtraction, logical operations, scaling, translation, rotation. Applications of Digital Image Processing	Presentations Video Demonstrations Lecture Using Chalk-Board
2	TLO 2.1 Explain Gray Level Transformations. TLO 2.2 Describe techniques of Spatial domain enhancement. TLO 2.3 Describe techniques of Frequency domain enhancement. TLO 2.4 Explain Homomorphic filtering.	**Unit - II Image Enhancement in Spatial Domain and Frequency Domain** 2.1 Basic Gray Level Transformations (Linear ,Logarithmic, Power – law) , Histogram Processing , Enhancement Using Arithmetic/Logic Operation 2.2 Spatial domain enhancement : Point operations- Log transformation, Power-law transformation, Piecewise linear transformations, Histogram equalization. Filtering operations- Image smoothing, Image sharpening 2.3 Frequency domain enhancement: 2-D Discrete Fourier Transform (DFT) ,Smoothing and Sharpening in frequency domain. Homomorphic filtering	Presentations Video Demonstrations Lecture Using Chalk-Board

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Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Explain types of redundancy. TLO 3.2 Describe Image and Video Compression Standards. TLO 3.3 Describe various coding compression techniques. TLO 3.4 Use Huffman coding to compress the text data in a string.. TLO 3.5 Use DCT to analyze the performance of image compression. TLO 3.6 Compare Point Detections, Line Detection and Edge Detection. TLO 3.7 Explain Laplacian of Gaussian (LoG), Difference of Gaussian (DoG).	**Unit - III Image Compression and Image Segmentation** 3.1 Types of redundancy: Spatial Redundancy, Spectral Redundancy, Temporal Redundancy 3.2 Fidelity criteria : Objectives, Importance. Image and Video Compression Standards – JPEG, MPEG-1,MPEG-3 3.3 Lossless compression: Run length coding, Huffman coding 3.4 Lossy compression techniques – Discrete Cosine Transform (DCT) based compression 3.5 Image Segmentation: Comparison of Point Detections, Line detection and Edge Detection, First order derivative - Prewitt and Sobel. Second order derivative – Laplacian of Gaussian (LoG), Difference of Gaussian (DoG)	Presentations Hands-on Lecture Using Chalk-Board Video Demonstrations
4	TLO 4.1 Compare constraint, unconstraint, and interactive restoration. TLO 4.2 Explain Image Degradation Model. TLO 4.3 Describe various noise models. TLO 4.4 Identify image processing techniques to reduce the noise and restore the image to its original quality. TLO 4.5 Compare Harmonic Mean Filter and Arithmetic Mean Filter. TLO 4.6 Compare Inverse Filtering and Wiener filtering. TLO 4.7 Write the applications of Image restoration.	**Unit - IV Image Restoration** 4.1 Image restoration: Definition, Concepts of restoration: constraint and unconstraint restoration, interactive restoration, Image Degradation/ Restoration Model, Difference between restoration and enhancement 4.2 Noise models: Gaussian Noise, Exponential Noise, Uniform Noise 4.3 Mean Filters : Overview of Arithmetic Mean Filter, Geometric Mean Filter, Harmonic Mean Filter, Band reject Filters, Band pass Filters 4.4 Overview of Inverse Filtering and Wiener filtering, applications of Image restoration	Presentations Lecture Using Chalk-Board Demonstration

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Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Explain importance of Texture Analysis. TLO 5.2 Explain Types of Shapes. TLO 5.3 Identify the method to enhance the contrast of a blurry image taken in low light to make it clear. TLO 5.4 Describe Color Feature Extraction. TLO 5.5 Draw components of an object recognition system. TLO 5.6 Identify object detection technique to detect and count the vehicles from a traffic surveillance camera. TLO 5.7 Elaborate feature extraction methods to recognize specific patterns to detect defects in a manufactured product.	**Unit - V Image Analysis** 5.1 Feature Extraction: Texture analysis: Definition, Importance of Texture Analysis, overview of Texture Analysis Methods Shape analysis: Definition, Types of Shapes, concept of Shape Representation Color analysis: Definition, Color Spaces, Color Feature Extraction : Color Histogram , Color Moments , Color Coherence Vector (CCV) , Color Correlogram , Color Transfer 5.2 Object Recognition : components of an object recognition system (Model database , Feature detector , Hypothesizer, Hypothesis verifier) , Complexity of Object Recognition : Two-dimensional, Three-dimensional. Overview of Methods for Object Recognition : Feature-Based Recognition, Template Matching, Deep Learning (CNNs), Point Cloud Matching (3D Recognition), Object Detection Algorithms (YOLO, SSD) 5.3 Feature Detection : Global Features, Local Features, Relational Features 5.4 Overview of Advanced Image Processing concepts: Deep Learning and Convolutional Neural Networks (CNNs), 3D Image Processing and Computer Vision, Computer-Aided Diagnosis (CAD) in Medical system	Presentations Lecture Using Chalk-Board Demonstration

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES : NOT APPLICABLE.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

- Use Fourier Transform to analyze the frequency domain of an image.
- Use image compression algorithms like JPEG or PNG and compare the quality of the compressed and original image.
- Perform basic operations like resizing, rotating, and cropping images.
- Differentiate between 3-D and 2-D image processing.
- Explain how applying filters affects the fidelity of an image.

Micro project

- Make a collage by arranging multiple images into a single image.
- Rotate an image by a specific angle.
- Convert an image from RGB to grayscale.
- Display the color histogram of an image.
- Resize an image to user-defined dimensions (height and width).

Other

- Complete course of Digital Image Processing on NPTEL.
- Complete course of Fundamentals of Digital Image and Video Processing on Coursera.

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Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Not Applicable	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Introduction to Image Processing	CO1	5	4	6	2	12
2	II	Image Enhancement in Spatial Domain and Frequency Domain	CO2	8	4	4	6	14
3	III	Image Compression and Image Segmentation	CO3	10	4	6	4	14
4	IV	Image Restoration	CO4	10	2	8	4	14
5	V	Image Analysis	CO5	12	4	8	4	16
Grand Total				**45**	**18**	**32**	**20**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two unit tests of 30 marks will be conducted and average of two unit tests will be considered.
- Formative assessment of self learning of 25 marks should be assessed based on self learning activity such as Infosys Springboard Certification/Microprojects/Assignment(60% weightage to process and 40% to product)

Summative Assessment (Assessment of Learning)

- End Semester Exam

XI. SUGGESTED COS - POS MATRIX FORM

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Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	-	-	-	-	-	-			
CO2	2	2	1	-	-	-	-			
CO3	2	2	2	2	1	-	1			
CO4	2	2	2	2	1	1	1			
CO5	2	2	3	3	2	1	1			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	S. Annadurai	Fundamentals of Digital Image Processing	Pearson Education India, ISBN: 9788177584790, 9788177584790
2	Rafael C. Gonzalez, Richard E. Woods	Digital Image Processing Fourth edition (30 July 2018)	Pearson Education; ISBN-13 978-9353062989
3	Alasdair McAndrew	A Computational Introduction to Digital Image Processing, 2nd Edition	Chapman and Hall/CRC, ISBN-13 ? : ? 978-0367783334
4	William K. Pratt	Digital Image Processing: PIKS Scientific Inside	Wiley India Private Limited; Fourth edition ,ISBN-13 ? : ? 978-8126526840
5	Kenneth R. Castleman	Digital Image Processing	Pearson Education India, ISBN-13 978-8131712863

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.geeksforgeeks.org/digital-image-processing-basics/	Digital Image Processing Basics
2	https://www.tutorialspoint.com/dip/index.htm	Image Processing for Beginners
3	https://www.tpointtech.com/digital-image-processing-tutorial	Digital Image Processing Tutorial
4	https://onlinecourses.nptel.ac.in/noc22_ee116/preview	Image processing techniques, algorithms and their applications
5	https://www.coursera.org/learn/digital	Fundamentals of Digital Image and Video Processing
6	https://www.coursera.org/learn/introduction-image-processing	Introduction to Image Processing

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students