

# GUJARAT TECHNOLOGICAL UNIVERSITY

## ELECTRONICS AND COMMUNICATION ENGINEERING

### FUNDAMENTALS OF IMAGE PROCESSING

SUBJECT CODE: 2181102

B.E. 8<sup>th</sup> SEMESTER

**Type of course:** Department Elective-III

**Prerequisite:** Knowledge of Fourier Transform and Digital Signal Processing

**Rationale:** This is fundamental course of computer vision. This course will strengthen fundamental knowledge about digital image processing techniques. Digital image processing is used in almost all engineering fields and wide range of applications in industrial automation, medical, agriculture, security, entertainment, education and many more.

**Teaching and Examination Scheme:**

Teaching Scheme			Credits C	Examination Marks						Total Marks
L	T	P		Theory Marks			Practical Marks			
			ESE (E)	PA (M)		ESE (V)		PA (I)		
				PA	ALA	ESE	OEP			
4	0	2	6	70	20	10	20	10	20	150

**Content:**

Sr. No.	Course content	No. of Hours	% Weightage
1	<b>Digital Image Fundamentals</b> Light, brightness adaption and discrimination, Human visual system, Image as a 2D data, Image representation Gray scale and Colour images, Image sampling and quantization	4	6
2	<b>Image enhancement and filtering in spatial domain:</b> Intensity transformation functions: Contrast stretching, Thresholding, Image negative, Log transformation, Power-law transformation, Intensity level slicing and Bit-plane slicing. Image histogram, Histogram equalisation process. Fundamentals of spatial filtering, Correlation and convolution, Spatial filtering mask for low pass filtering (smoothing) and high pass filtering (sharpening).	8	16
3	<b>Image filtering in the frequency domain:</b> Preliminary Concepts, Extension to functions of two variables, Image Smoothing, Image Sharpening, Homomorphic filtering, 2D- DFT, 2D-FFT, 2D- DCT, Fundamentals of 2D-wavelet transform, Image pyramids, sub-band coding.	8	14
4	<b>Image restoration:</b> Reasons for image degradation, Model of image degradation/restoration process, Noise probability density functions, Image restoration using spatial filtering (Mean filters, Order statistic filters and adaptive filters), Inverse Filtering, MMSE (Wiener) Filtering	8	14

<b>5</b>	<b>Colour Image Processing:</b> Colour Fundamentals, Colour Models, Pseudo-colour image processing.	<b>4</b>	<b>6</b>
<b>6</b>	<b>Image Compression:</b> Fundamentals of redundancies, Basic Compression Methods: Huffman coding, Arithmetic coding, LZW coding, JPEG Compression standard, Wavelet based image compression	<b>8</b>	<b>14</b>
<b>7</b>	<b>Image Segmentation:</b> Edge based segmentation, Region based segmentation, Region split and merge techniques, Region growing by pixel aggregation, optimal thresholding.	<b>8</b>	<b>14</b>
<b>8</b>	<b>Morphological Image Processing:</b> Basic morphological operations, Erosion, dilation, opening, closing, Structuring elements, Hit-or-Miss transform, Basic Morphological Algorithms: hole filling, connected components, thinning, skeletons, Reconstruction by erosion and dilation	<b>8</b>	<b>16</b>

<b>Distribution of Theory Marks</b>					
R Level	U Level	A Level	N Level	E Level	C Level
<b>15</b>	<b>20</b>	<b>30</b>	<b>20</b>	<b>10</b>	<b>5</b>

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)**

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

#### **Reference Books:**

1. Digital Image Processing, Rafael C. Gonzalez and Richard E. Woods, Third Edition, Pearson Education
2. Digital Image Processing, S Jayaraman, S Esakkirajan, T Veerakumar, Tata McGraw Hill Publication
3. Digital Image Processing, S Sridhar, Oxford University Press.

#### **Course Outcomes:**

After learning the course the students should be able to..

- [1] Understand image representation
- [2] Enhance image quality using image enhancement techniques
- [3] Filter given image using frequency domain filtering technique
- [4] Select the right image restoration technique to remove degradation from given image
- [5] Represent image using minimum number of bits using image compression
- [6] Understand image segmentation technique
- [7] Do morphological operations on given image

#### **List of Experiments:**

- [1] Write program to read and display digital image using SCILAB
  - Become familiar with SCILAB Basic commands

- Read and display image in SCILAB
  - Resize given image
  - Convert given color image into gray-scale image
  - Convert given color/gray-scale image into black & white image
  - Draw image profile
  - Separate color image in three R G & B planes
  - Create color image using R, G and B three separate planes
  - Flow control and LOOP in SCILAB
  - Write given 2-D data in image file
- [2] To write and execute image processing programs using point processing method
- Obtain Negative image
  - Obtain Flip image
  - Thresholding
  - Contrast stretching
- [3] To write and execute programs for image arithmetic operations
- Addition of two images
  - Subtract one image from other image
  - Calculate mean value of image
  - Different Brightness by changing mean value
- [4] To write and execute programs for image logical operations
- AND operation between two images
  - OR operation between two images
  - Calculate intersection of two images
  - Water Marking using EX-OR operation
  - NOT operation (Negative image)
- [5] To write a program for histogram calculation and equalization
- [6] To write and execute program for geometric transformation of image
- Translation
  - Scaling
  - Rotation
  - Shrinking
  - Zooming
- [7] To understand various image noise models and to write programs for image restoration
- Remove Salt and Pepper Noise
  - Minimize Gaussian noise
  - Median filter and Weiner filter
- [8] Write and execute programs to remove noise using spatial filters
- Understand 1-D and 2-D convolution process
  - Use 3x3 Mask for low pass filter and high pass filter
- [9] Write and execute programs for image frequency domain filtering
- Apply FFT on given image
  - Perform low pass and high pass filtering in frequency domain
  - Apply IFFT to reconstruct image
- [10] Write a program in SCILAB for edge detection using different edge detection mask
- [11] Write and execute program for image morphological operations erosion and dilation.

[12] To write and execute program for wavelet transform on given image and perform inverse wavelet transform to reconstruct image.

**Design based Problems (DP)/Open Ended Problem:**

- Remove noise from given image (Faculty should give different images with different types of degradations and noise and students should be asked to minimize noise and degradation)
- Analyze given image and find out objects of given properties (Faculties will give image which is having mixture of different objects, students will be asked to find out objects of given properties)
- Design automated inspection system

**Major Equipment:**

- DSP TMS630C6748 Kit for hardware implementation (Optional)

**List of Open Source Software/learning website:**

- SCILAB
- Open CV
- Python

**Website:**

- <http://fossee.in/>
- [www.scilab.in](http://www.scilab.in)
- <http://opencv.org/>

**ACTIVE LEARNING ASSIGNMENTS:** Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.