

GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRONICS & COMMUNICATION (SIGNAL PROCESSING & COMMUNICATION) (41)

DIGITAL IMAGE PROCESSING

SUBJECT CODE: 2714104

SEMESTER: I

Type of course: Design and simulation of various image processing algorithms suitable for various applications .

Prerequisite: Physics and fundamentals of signal processing

Rationale: The students need to learn various operators for processing an input image which leads to design and development of robust and complex mathematical system. The students need to know various level of processing like low , middle and high level processing. The low level processing includes enhancement, restoration, interpolation and filtering operations. Middle level of processing includes various image processing operations like edge detection, segmentation; color based processing, region and boundary detection, morphological operations. The high level of processing includes representation and description of regions, pattern detection and classification, visual feature detection and matching, recognition. This is the first course by which students get exposure to digital image processing in detail with enhanced knowledge in various application areas

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks						Total Marks
L	T	P		Theory Marks		Practical Marks				
			ESE (E)	PA (M)	PA (V)		PA (I)			
					ESE	OEP	PA	RP		
3	2#	2	5	70	30	20	10	10	10	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	Image sensing and acquisition, image sampling and quantization, image types, neighbors of pixel, adjacency connectivity, regions and boundaries, distance measures	5	12
2	Image enhancement in spatial domain: intensity transformation functions, histogram processing and function plotting, spatial filtering. Image enhancement in frequency domain: 2 D discrete fourier transform, filtering in the frequency domain, smoothing and sharpening frequency domain filters	13	31
3	Image Restoration: noise models, restoration in the presence of noise only- spatial filters, periodic noise reduction, modeling the degradation function, direct inverse filtering, wiener filtering, constrained list squares filtering, geometric transformation and image registration.	5	12
4	Morphological image processing: dilation, erosion, combining dilation and erosion, labeling connected components, Morphological reconstruction, gray scale morphology	6	14
5	Image segmentation: point, line and edge detection, line detection using	6	14

	hough transform, thresholding, region based segmentation, segmentation using watershed transform		
6	Image processing applications: target detection, object recognition, feature extraction and matching, writer identification system, digital watermarking, medical and Industrial applications, Image Morphing and Image Fusion	7	17

Reference Books:

1. R.C.Gonzalez, R.E.Woods, "Digital Image Processing", 3/e Pearson Education.
2. S. Jayaraman , S.Esakkirajan, "Digital Image Processing", McGraw Hill.
3. Horst Bunke, Abraham Kandel, "Applied Pattern Recognition", Springer International Edition, Springer.
4. Frank Y.Shih, "Image Processing and Mathematical Morphology", CRC Press

Course Outcome:

After learning the course the students should be able to explain about digital images, spatial and gray level resolutions, image enhancement operations, image restoration operations and image segmentation operations. The student should be able to develop a new algorithm for various automatic applications like counting the no. of objects in an image, extracting the feature of the objects form an input image, recognizing the objects from the input image based on the extracted features from the image database. They should be able to design a new image processing algorithm. The student should be able to compare the developed the algorithms with the existing ones. At the end they should be able to develop a real time system based on the input images.

List of Simulation Studies and Implementation:

1. A) Introduction to image formats.
B) Introduction to MATLAB 7, image processing toolbox
2. A) Write a MATLAB program for image conversions (IM2BW, RGB2GRAY, GRAYTHRESH)Correlation and Auto correlation
B) Write a MATLAB program to find the connectivity of a given image matrix
C) Write a MATLAB program to find the distance (city block, chessboard, Euclidean) of a given image matrix
3. A) Write a MATLAB program to zoom the input image using bilinear interpolation, nearest neighbor interpolation and bicubic interpolation and compare the images
B) Write a MATLAB program to shrink the input image using bilinear interpolation, nearest neighbor interpolation and bicubic interpolation and compare the images
4. A) Write a MATLAB program to implement contrast stretching on input image (IMADJUST)
B) Write a MATLAB program to implement bit-plane slicing on input image (BITGET).
C) Write a MATLAB program to generate and plot histogram
D) Write a MATLAB program to implement histogram equilization
5. A) Write a MATLAB program to implement smoothing spatial filters: 1. Averaging , 2. Max filter
3. Min filter and 4. Weighted average filter (IMFILTER).
Also show the effect of mask size variation on the smoothing action
B) Write a MATLAB program to implement various arithmetic and logical operators
6. A) Write a MATLAB program to implement inverse filter and Wiener filter on degraded image using motion blur effect. Compare the results obtained.
B) Write a MATLAB program to convert the image from spatial domain representation into frequency domain representation. Do not use inbuilt MATLAB function (FFT2)
7. A) Write a MATLAB program to

- Convert the image from spatial domain representation into frequency domain representation using MATLAB function (FFT2)
 - Convert the image from frequency domain representation into spatial domain representation using MATLAB function (FFTSHIFT, IFFT2)Fast Fourier Transform
- B) Write a MATLAB program to implement various low pass filter and high pass filters in the frequency domain. Also show the effect of cut off frequency on the filtering results
8. A) Write a MATLAB program to apply various morphological operators on an input image. (dilate, erode, open, close)
 - B) Write a MATLAB program to detect the object based on pixel connectivity and pixel labeling
 - Frequency response of LTI systems
 - C) Write a MATLAB program to implement point and line detectors. Also compare the results by varying threshold
 9. A) Write a MATLAB program to implement various edge detectors: Roberts, Prewitt, Sobel, Canny using MATLAB functions (IMFILTER, EDGE)
 - B) Write a MATLAB program to implement Hough transform for edge linking
 - C) Write a MATLAB program to implement various region based segmentation: region growing, region splitting and merging
 10. A) Design and develop an algorithm for car number plate detection and segmentation
 - B) Design and develop a face recognition system using feature extraction and template matching algorithm
 - C) Design and develop an algorithm for writer identification
 - D) Design and develop an algorithm for digital watermarking on an input image
 - E) Design and develop an algorithm for image morphing
 - F) Design and develop an algorithm for image fusion

Major Equipments and Software:

1. Computing and Simulation Stations
2. High performance simulation software

List of Open Source Software/learning website:

1. <http://www.scilab.org/>
2. <http://www.imageprocessingplace.com/>
3. <http://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/video-lectures/>
4. <http://imagingbook.com/>

Design based Problems (DP)/ Open Ended Problem:

1. Design an algorithm for performing the various point operators on an input image.
2. Design an algorithm for transforming the input image into frequency domain and than apply low pass filter for performing the smoothing operation on the input image.
3. Design an algorithm for performing the boundary detection of an input image using morphological operator.
4. Design an algorithm for extracting the features of different objects present in an input image.
5. Design an algorithm for point, line and edge detection operations on an input image.
6. Design an algorithm for segmentation of region using region growing technique.
7. Design an algorithm for detecting the human face from an input image. (Input image may contain one or more human faces)

8. Design an algorithm for extracting the features of fingerprint image.
9. Design an algorithm for performing the image stitching operation on two input images. (both images contain few common pixels)
10. Design an algorithm for signature identification system.