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Vellore Institute of Technology

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CHENNAI

Final Assessment Test(FAT) - Apr/May 2025

Programme	B.Tech.	Semester	Winter Semester 2024-25
Course Code	BCSE403L	Faculty Name	Prof. Sridhar R
Course Title	Digital Image Processing	Slot	A1+TA1
		Class Nbr	CH2024250502017
Time	3 hours	Max. Marks	100

Instructions To Candidates

- Write only your registration number in the designated box on the question paper. Writing anything elsewhere on the question paper will be considered a violation.

Course Outcomes

CO1: Ascertain and describe the basics of image processing concepts through mathematical interpretation.
CO2: Acquire the knowledge of various image transforms and image enhancement techniques involved.
CO3: Demonstrate image restoration process and its respective filters required and attain the knowledge of color image processing techniques.
CO4: Experiment the various image segmentation and morphological operations for a meaningful partition of objects.
CO5: Design the various basic feature extraction procedures and illustrate the various image compression techniques and their applications.

Section - I
Answer all Questions (6 × 15 Marks)

01. [a] VIT Chennai campus has to be monitored in night time by humanoid robots in 2030 and VIT Infosystems has been allocated a project to design a 'vision system' for humanoid robots. You are the design team head. The robot should be capable of taking photographs of objects both in spaces outside buildings with lighting and spaces without lighting [like behind bushes too] . The photographs taken would be sent to a server located in CTS in AB1 and would be analyzed the next day to determine 'persons of interest' if any theft happened. Draw the block diagram of the system indicating the various parts and mention the important components of the design. [5 marks] [b] List all the ten 'digital image processing' processes with name, one line explanation, input and output. [5 marks]. [c] Suppose that a given automated imaging application requires a minimum resolution of 5 line pairs per mm to be able to detect features of interest in objects viewed by the camera. The distance between the focal center of the camera lens and the area to be imaged is 1 m. The area being imaged is 0.5*0.5m. You have a 200 mm lens, and your job is to pick an appropriate CCD imaging chip. What is the minimum number of sensing elements and square size, d*d of the CCD chip that will meet the requirements of this application? [5 marks]

[15] (CO1/K3)

02. [a] Sanya, an image processing engineer, is tasked with improving an overexposed photograph captured on a sunny day. The image has a resolution of 64 x 64 pixels, and appears excessively bright. Apply Histogram Equalization to adjust the pixel distribution and improve contrast.

Gray level	0	1	2	3	4	5	6	7
No of pixels	108	216	324	432	540	777	676	1023

Plot the input and Output histogram. [5 marks]

[b] Assume continuous intensity values, and suppose that the intensity values of an image have the PDF

$p_r(r) = 3*r^2/(L-1)^3$ for $0 <= r <= (L-1)$

$= 0$ otherwise

Find the transformation function that will produce an image whose intensity PDF is

$p_Z(z) = 5*z^4/(L-1)^5$ for $0 <= z <= (L-1)$

$= 0$ otherwise [5 marks]

[c] Design a Gaussian filter of size 5*5 with K = 0.5 and σ=5. The coefficients should be accurate upto four decimal places. [5 marks]

[15] (CO2/K3)

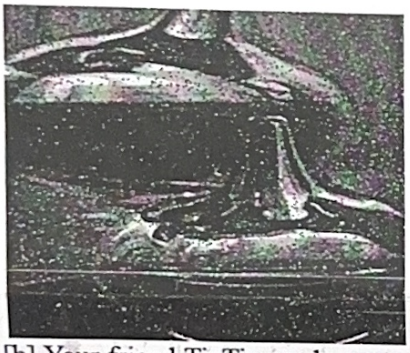
03. [a] A 4*4 image is given here.

1	5	15	9
2	27	27	15
3	33	9	27
5	67	5	5

Calculate the 2-D DFT of the above image using kernel matrix multiplication method [5 marks]
[b] If 2-D DFT of a digital image f(x,y) is F(u,v) and the size of the image is M*N
[i] Find the 2-D DFT of the translated image f(x-x0,y-y0) where x0 and y0 are positive constants. [2.5 marks]
[ii] Find the image for which the Calculated DFT is F(u-(M/2), v-(N/2)) [2.5 marks]
[c] Your friend Tintin is doing a project on 2-D DFT. He is calculating the 2-D DFT of 1024*1024 image using kernel matrix method and he is finding his program very slow. How would you effectively explain this concept to him in a way that ensures clarity and understanding?
[i] What is linear separability ? How it can help him to speed up the calculation? What is the maximum speedup achievable using this method?[2 marks]
[ii] If he wants to achieve further speedup, which method should he use? Explain the principle behind that method. [3 marks]

[15] (CO2/K4)

04. [a] The following picture contains both salt and pepper noise. Suggest the most optimum filter that would remove both and explain its operation. [5 marks]



[b] Your friend TinTin sends you a picture of a rare flower from Alaska. A particular region of the flower has an RGB color value of R=9, G=77, B=66. Your display program processes colors in the HSI format. Convert the given RGB values into their equivalent HSI representation [5 marks]
[c] Your friend Tintin does NOT know how to smooth or sharpen colour images. He knows smoothing process of a greyscale image using Box filter and sharpening of a greyscale image using Laplacian operator.
[i] Explain to him the process of colour image smoothing using Box filter. [2.5 marks]
[ii] Explain to him the process of sharpening a colour image using Laplacian filter [2.5 marks]

[15] (CO3/K5)

05. [a] A greyscale image having only 8 levels are given here.

0	0	2	2	4	4	5	5
0	0	2	2	4	4	5	5
1	1	5	5	4	4	5	5
1	1	5	5	4	4	5	5
5	5	3	3	3	3	5	5
5	5	3	3	3	3	5	5
5	5	5	5	5	5	5	5
5	5	5	5	3	3	5	5

Your friend Vijay wants to segment the image using thresholding technique. He wants to check whether which is the best pixel threshold[T] value among T=2 or T=3 or T=4 for segmentation. Apply OTSU method only for these thresholds and identify the best threshold among them and calculate the goodness of the calculated threshold. [7 marks]
[b] VIT Infosystems has won a contract to monitor an archealogical site in Madhyapradesh. This site has got temples, Kushan style buildings, pillars with Devnagari inscriptions and a Buddhist stupa. It is spread over 5 acres. It is nearby a forest area. Unfortunately miscreants come in, chip away idols from these sites and damage. MP Government has fitted 100 static cameras that take photograph of the area within their range. Recently it has deployed 5 drones that fly over these sites and take aerial photographs too. Both these types of photographs are stored in different directories in the same server. Your engineers are unable to analyze the static camera images

that are taken from vertical angle along with the images taken from drones which are taken from above as their scale and angles are different. Your boss has suggested SIFT algorithm for detecting common features but that is extremely slow. Suggest a better algorithm and describe its steps neatly and outline each step and final output with clear formulae [8 marks]

[15] (CO4/K5)

06. [a] Given a four-symbol source {a, b, c, g} with source probabilities {0.1, 0.2, 0.3, 0.4}, arithmetically encode the sequence gabcb. [5 marks]
[b] Decode the message 0.13524 using the above coding model. [3 marks]
[c] Your company receives a large number of video files daily. Each year, the server storage capacity is expanded to accommodate them. To optimize storage, your boss seeks your help in compressing these files efficiently. Explain to your team, using two block diagrams,
i. How JPEG2000 compression and decompression work? [5 marks]
ii. How this method can be leveraged for effective storage management? [2 marks]

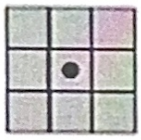
[15] (CO5/K4)

Section - II
Answer all Questions (1 × 10 Marks)

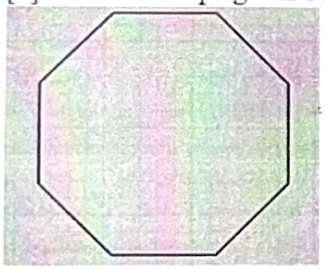
07. [a] An image I is shown here.

Image *I*

Sketch the result of eroding the above image I with the following Structuring Element given below. [5 marks]


Structuring Element

[b] Refer the shape given below.



[i] Represent the boundary of the 'Regular Octagon' figure given above in 8-chain code. Each side of the octagon has 5 segments. The length of the one segment is equal to length of one cell. [3 marks]
[ii] Find the shape number of the above figure [2 marks]

[10] (CO4/K3)

BL-Bloom's Taxonomy Levels - (K1-Remembering,K2-Understanding,K3-Applying,K4-Analysing,K5-Evaluating,K6-Creating)