JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

TEST -3 EXAMINATION- 2024

B.Tech-5th Semester (ECE)

COURSE CODE (CREDITS): (18B1WEC536) 3 MAX. MARKS: 35

COURSE NAME: Fundamentals of Digital Image Processing

COURSE INSTRUCTORS: Lt. Praggya Gupta MAX. TIME: 2 Hours

Note: *(a) All questions are compulsory.*

(b) The candidate is allowed to make Suitable numeric assumptions wherever required for solving problems

<table>
<tr><th>Q. No</th><th>Question</th><th>CO</th><th>Marks</th></tr>
<tr><td>Q1</td><td>Explain the concepts of spatial resolution and gray-level resolution in digital images. How do these resolutions affect the visual quality of an image? Provide examples of scenarios where:
1. High spatial resolution is essential.
2. High gray-level resolution is more important.</td><td>CO- 1</td><td>5</td></tr>
<tr><td>Q2</td><td>Explain the concepts of gray-level slicing and contrast stretching in image enhancement. How do these techniques differ in their approach to improving image quality? Illustrate each technique with a simple example of pixel intensity transformations.</td><td>CO-2</td><td>5</td></tr>
<tr><td>Q3</td><td>Consider a grayscale image with the following normalized histogram $P_r(r_k)$:
<table><tr><td>Gray Level (r_k)</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr><tr><td>Probability ($P_r(r_k)$)</td><td>0</td><td>0.1</td><td>0.1</td><td>0.3</td><td>0</td><td>0</td><td>0.4</td><td>0.1</td></tr></table>The target histogram $P_z(z_k)$ is:
<table><tr><td>Gray Level (z_k)</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr><tr><td>Probability ($P_z(z_k)$)</td><td>0</td><td>0.1</td><td>0.2</td><td>0.4</td><td>0.2</td><td>0.1</td><td>0</td><td>0</td></tr></table>Perform histogram specification to map the original gray levels r_k to the target gray levels z_k. Show all intermediate steps with a logical explanation and determine the mapping $r_k \rightarrow z_k$.</td><td>CO-5</td><td>5</td></tr>
<tr><td>Q4</td><td>What is image segmentation? Briefly explain its purpose and give two common methods used for image segmentation.</td><td>CO-4</td><td>5</td></tr>
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<tr><td>Q5</td><td>(a). Explain the Butterworth and Gaussian filters in the frequency domain. Compare their characteristics and discuss how each filter affects image processing, particularly in terms of noise reduction and edge preservation. Provide the mathematical expressions for both filters and explain their parameters.

(b). Derive the transfer function of Laplacian in frequency domain.</td><td>CO-3</td><td>3+2</td></tr>
<tr><td>Q6</td><td>What is image restoration, and how does it differ from image enhancement? Discuss the common categories of image degradation encountered in digital imaging. Describe the following noise models along with their characteristics and real-world examples:

1. Gaussian Noise
2. Salt-and-Pepper Noise
3. Exponential noise</td><td>CO-4</td><td>5</td></tr>
<tr><td>Q7</td><td>Explain the concepts of unsharp masking and high-boost filtering in spatial domain image enhancement. Derive the mathematical relationship between the two techniques and discuss how high-boost filtering extends unsharp masking.

Given a 3×3 image region ($f(x,y)$):

<table><tr><td>40</td><td>50</td><td>60</td></tr><tr><td>30</td><td>80</td><td>70</td></tr><tr><td>20</td><td>10</td><td>90</td></tr></table>
Use the 3×3 box filter to compute the smoothed image and then

(a) Apply unsharp masking to calculate the enhanced value of the center pixel.
(b) If the high-boost filter is defined as $f_{HB}(x,y)=(A-1)\cdot f(x,y)+ f_{unsharp}(x,y)$, where A=1.5, compute the high-boost filtered value for the center pixel.</td><td>CO-2 & 6</td><td>5</td></tr>
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