Question 3

CS663 (Digital Image Processing) Assignment 1

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Contents

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PART

I

Problem 1

Consider two images I and J whose intensity values (in each location) are randomly drawn from the known probability mass functions (PMFs) $p_I(i)$ and $p_J(j)$ respectively. Derive an expression for the PMF of the image $I + J$. The expression resembles which operation that we are currently studying in class ? (will be studying very soon) [15+5=20 points]

Section 1

Derivation of PMF of $I + J$

Given two images I and J whose intensity values (in each location) are randomly drawn from the known probability mass functions (PMFs) $p_I(i)$ and $p_J(j)$, the image $I + J$ represents the image in which the intensity at each location is **sum** of the intensities from I and J. So, we have

$$p_{I+J}(k) = P(I + J = k)$$

$$p_{I+J}(k) = \sum_{i=-\infty}^{\infty} P(I = i, J = k - i)$$

Since the values of intensities of I and J are drawn randomly, we can say that they are independent of each other. So we can write the inner expression as -

$$P(I = i, J = k - i) = P(I = i) \cdot P(J = k - i)$$

$$P(I = i, J = k - i) = p_I(i) \cdot p_J(k - i)$$

Therefore, the final PMF expression for image $I + J$ is -

Answer

$$p_{I+J}(k) = \sum_{i=-\infty}^{\infty} p_I(i) \cdot p_J(k - i)$$

Section 2

Operation Resemblance

Answer The above expression of $p_{I+J}(k)$ resembles the **1D Convolution** operation acting on the PMFs of image I and J