Question 4

CS663 (Digital Image Processing) Assignment 5

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Contents

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PART I

SECTION 1

Explanation

For the given system of equations:

$$g_1 = f_1 + h_2 * f_2$$
$$g_2 = h_1 * f_1 + f_2$$

Taking the Fourier transform of both equations, we obtain:

$$F(g_1) = F(f_1) + F(h_2) \cdot F(f_2)$$
$$F(g_2) = F(h_1) \cdot F(f_1) + F(f_2)$$

Solving for $F(f_1)$ and $F(f_2)$, we have:

$$F(f_1) = \frac{F(g_2) - F(f_2)}{F(h_1)}$$
$$F(f_2) = \frac{F(g_1) - F(f_1)}{F(h_2)}$$

Upon replacing the $F(f_2)$ term in the second equation with the first and rearranging, we obtain:

$$F(f_1) \cdot \left(1 + \frac{1}{F(h_1) \cdot F(h_2)}\right) = \frac{F(g_2)}{F(h_1)} - \frac{F(g_1)}{F(h_2)}$$

This simplifies to:

$$F(f_1) = \frac{\frac{F(g_2)}{F(h_1)} - \frac{F(g_1)}{F(h_2)}}{1 + \frac{1}{F(h_1) \cdot F(h_2)}}$$

A similar expression can be derived for $F(f_2)$. To find f_1 and f_2 in the spatial domain, take the inverse Fourier transform of $F(f_1)$ and $F(f_2)$.

The division by the Fourier transform of the blur kernels can amplify noise and lead to unstable solutions, which is a characteristic issue of deconvolution known as ill-posedness. This is why regularization techniques are often used in practice to stabilize the inversion process.