EECS203A: HOMEWORK #6

Due: May 20, 2021

1. Suppose that $g(x, y)$ is a degraded version of an ideal image $f(x, y)$ with

$$g(x, y) = h(x, y) * f(x, y)$$

where $h(x, y)$ is an ideal bandpass filter with parameters D_0 and W. Can we recover $f(x, y)$ from $g(x, y)$ using inverse filtering? Explain your answer.

2. Suppose that $g(x, y)$ is a noisy version of an ideal image $f(x, y)$

$$g(x, y) = f(x, y) + n(x, y)$$

where the DFT magnitudes have the properties $|N(u, v)| = 1$ and $|F(u, v)|$ decreases as $u^2 + v^2$ increases. Consider the filters H_1 and H_2 defined in the frequency domain by

$$H_1(u, v) = \frac{1}{1 + 0.01(u^2 + v^2)} \quad \text{and} \quad H_2(u, v) = \sqrt{H_1(u, v)}$$

a) Does $H_1(u, v)$ or $H_2(u, v)$ reduce more noise? Explain your answer.
b) Does $H_1(u, v)$ or $H_2(u, v)$ blur the image more? Explain your answer.

3. Suppose that a rectangular area in image $f(x, y)$ with vertices $(x, y) = \{(5, 1), (5, 9), (10, 9), (10, 1)\}$ appears distorted in image $f'(x', y')$ with corresponding vertices $(x', y') = \{(4, 3), (4, 11), (10, 9), (10, 1)\}$. Determine the functions $x'(x, y)$ and $y'(x, y)$ using a bilinear model for the distortion.

Computer Problem: Define the continuous-space Gaussian function by $G(x, y) = Ae^{-(x^2+y^2)/(2\sigma^2)}$. Generate a 31×31 digital filter $g(i, j)$ over $i = -15, \ldots, 0, \ldots, 15$ and $j = -15, \ldots, 0, \ldots, 15$ by sampling $G(x, y)$ so that $g(0, 0) = A$ and $g(7, 0) = Ae^{-0.5}$. Normalize $g(i, j)$ by finding A so that the sum of the $g(i, j)$ mask values equals one. Degrade the triangle image by convolution with $g(i, j)$. Use the inverse filtering method to restore the image. Submit your code, the $g(i, j)$ mask coefficients, the degraded image, and the restored image. You may use Matlab or other available software to compute DFTs.