Concordia University

Department of Computer Science & Software Engineering

COMP 478/6771 Image Processing

Assignment 3 - Due Date: *Nov 15, 2022*

Part I: Theoretical questions

1. (**10 points**) Given a 3x3 spatial mask that averages the four closest neighbors of a point (*x, y*) but excludes the point itself from the average (the central point). Find the equivalent filter *H(u,v)* in the frequency domain. For this question, please use Property 3 of Table 4.4 in the textbook, which summarizes the property of spatial translation for an image:

3)	Translation (general)	$f(x,y)e^{j2\pi(u_0x/M + v_0y/N)} \Leftrightarrow F(u-u_0, v-v_0)$ $f(x-x_0, y-y_0) \Leftrightarrow F(u,v)e^{-j2\pi(ux_0/M + vy_0/N)}$

2. (**16 points**) Prove the validity of the following properties of the Radon transform:

$$g(\rho,\theta) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} f(x,y)\delta(x\cos\theta + y\sin\theta - \rho)\,dx\,dy$$

(a) (**8 points**) *Linearity:* The Radon transform is a linear operator (use definition of linearity).
(b) (**8 points**) *Translation property:* The radon transform of $f(x - x_0, y - y_0)$ is $g(\rho - x_0\cos\theta - y_0\sin\theta, \theta)$.

Part II: Programming questions (24 points)

1. (**6 points**) Let I_A , I_B be two completely different gray level images, and F_A , F_B be the Fourier transforms of I_A and I_B respectively. The Fourier transform F_A of I_A consists of its magnitude $|F_A|$ and phase $\Omega(F_A)$. Similarly, the Fourier transform F_B of I_B consists of the magnitude $|F_B|$ and phase $\Omega(F_B)$. We want to reconstruct the image I_A in the following experiment: a new image I_1 is obtained by inverse Fourier transform using the of magnitude $|F_A|$ of image *A* and phase $\Omega(F_B)$ of image *B*. Similarly, a new image I_2 is obtained by inverse Fourier transform using the magnitude $|F_B|$ of image *B* and phase $\Omega(F_A)$ of image *A*. In your opinion, which one of the two reconstructed images I_1 and I_2 is the better reconstruction of the original image I_A .

   Please use the two images in the assignment package to justify for your answer.

2. (**18 points**) Download the image "*house.tif*" from the assignment package then perform edge detection using existing MATLAB functions (with the parameter choices of your own) for:
   a) Laplacian of Gaussian (Marr-Hildreth) edge detector
   b) Canny edge detector

   1) (**4 points**) Briefly list the steps involved in implementing the edge detectors.
   2) (**4 points**) Explain how edge linking (the final step of the **Canny algorithm**) was implemented. Does the first method need this step?
   3) (**4 points**) List the parameters that determine the performance of the algorithms. What parameter values did you use and why?
   4) (**6 points**) Show and compare the results obtained by the two methods (give some comments).