

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