Spring 2024 **CSCE 763: DIGITAL IMAGE PROCESSING**

Homework #4

Due 2:20pm, Wednesday, Feb. 28

1. As we discussed in class, the image sharpening by unsharp masking consists of three steps. Design a 3x3 filter for performing a *highboost* filtering with k=3 in a single pass through an image – a single 3x3 highboost filter performing image sharpening. Assume that the average image is obtained using the filter shown below:

$$\frac{1}{9}\begin{bmatrix}1 & 1 & 1\\ 1 & 1 & 1\\ 1 & 1 & 1\end{bmatrix}$$

   (10 pts)

2. Perform Fourier Transform on the function $f(t) = \begin{cases} 14 & -2w \le t \le 0 \\ 3 & 0 \le t \le 2w \\ 0 & otherwise \end{cases}$. (20 pts)

3. The white bars in the test pattern shown in Figure 1 are 7 pixels wide and 210 pixels high. The separation between bars is 17 pixels. What would this image look like after application of a 9x9 filter of
   (a) Arithmetic mean filter
   (b) Geometric mean filter
   (c) Harmonic mean filter
   (d) Contraharmonic mean filter with Q=1
   (e) Contraharmonic mean filter with Q=0
   (f) Contraharmonic mean filter with Q=-1
   (g) Median filter
   (h) Max filter
   (i) Min filter
   (j) Midpoint filter

Hints: you can assume the black background has intensity of 0 and white bars have intensity of 255. You can either write a program to implement these filters or represent the image as an array with numbers and show the results after filtering. You may need to pay attention to the corners of the white bars. (30 pts)

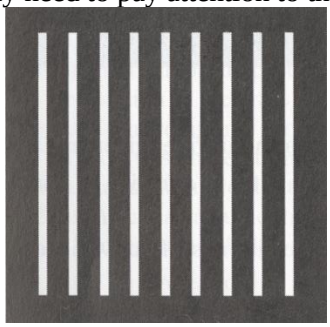

Figure 1

4. During acquisition, an image undergoes uniform linear motion in the horizontal direction (y-direction) for a time interval T_1. The direction of motion then switches to the vertical direction (x-direction) for a time interval T_2. Assuming that the time it takes the image to change directions is negligible, and that shutter opening time and closing time are also negligible, give an expression for the blurring function, $H(u, v)$. (Hint: you can refer to the example that the blurring function for the motion during acquisition is $H(u, v) = \int_0^T e^{-j2\pi[ux_0(t)+vy_0(t)]}$). (20 pts)

5. Assuming that $H(u, v) = 2\pi\sigma^2 e^{-2\pi^2\sigma^2(u^2+v^2)}$ and the ratio of power spectra of the noise and undegraded signal is a constant *K*, give the expression for a Wiener filter. (20 pts)