

Elex-7815 April 2013

Midterm EXAM

 Name:	 Marks Obtained:	
Instructor: John Dian, Ph. D., P. Eng.	Maximum Marks: 100	Time: 1hour.
 Please confirm that this Exam has 8 The Invigilator may check alphanum Attempt all questions. You MUST express your ASSUMPTI 	questions. eric Calculators.	

- 1. The images of size 64x64 shown below are quite different, but their histograms are the same. The gray pixels have an intensity value of 200, and the black ones have an intensity value of zero. In the right image, each square has a size of 16x16. Suppose that each image is blurred with a 3x3 averaging mask.
 - a) Find the histogram of these images. (5 points)
 - b) What is the histogram of the left image after blurring? Consider that the Symmetric padding is used. (10 points)
 - c) Would the histograms of the blurred images still be equal? Explain.(5 points)



2. Let f(x, y) be a 2-D image whose Fourier transform F(u, v) is given



- a) For the case of uniform sampling, find the minimum sampling intervals Dx and Dy for which an aliasing-free reconstruction of f(x, y) is possible. (5points)
- b) Sketch the Fourier transform of the sampled f(x, y) which is sampled with the following sampling function. (10 points)

sampling function =
$$\sum_{n} \delta(x-n/4) \sum_{n} \delta(y-m/4)$$

A sharpening method used by printing industry is called high-boost filtering with the following steps:

- a. Smooth (blur) the original image f(x, y) and call the blurred image as $\overline{f}(x, y)$
- b. Subtract the smoothed image from the original image $g_{mask}(x, y) = f(x, y) \bar{f}(x, y)$ and call the result image as a mask
- c. Add the mask image to the original image

For the original signal showing below, explain how High-boost filtering sharpen the image (10 points)

3. The figure shows four histograms, one for an image with low contrast, one which is easy to threshold into object and background, one for a dark image, and one for a bright image. Explain which belong to which image! (5 points)



4. An image of size 64×64 with intensity levels in the range of [0, ..., 7], has the following histogram values, find the Transformation function and the equalized histogram. (10 points)

,	
r_k	n_k
0	750
1	500
2	900
3	600
4	400
5	206
6	550
7	190

5. Edges in the image often are ramp-like transitions in intensity. Compare using First order derivation with the second order derivation for image sharpening. Which one produces better edges and why? (5 points)



- 6. Below is a 2D figure with four known sample values A = 3, B = 4, C = 0.5, D = 1.5, and one unknown, marked "?",
 - a. What is the result of interpolation using bilinear interpolation? (8 points)
 - b. What is the result of interpolation using nearest neighborhood? (2 point)



7. Below a test image f(x, y) and the absolute value of its Fourier transform /F(u, v)/ is shown. In addition, a scaled and translated version of the test image, g(x, y) is shown.



a) Calculate the Fourier transform of the image f(x,y) (15 points) $f(x,y) = \Pi\left(\frac{x}{10}\right) \cdot \Pi\left(\frac{y}{20}\right)$

b) How does the absolute value of the Fourier transform of g(x, y), i.e. /G(u, v)/, looks like? Choose one of the following options a - f and justify your choice with a brief statement in which the words *translation theorem* and *scaling theorem* are included. (10 points)

