ECE 5273
Test 1

Wednesday, April 9, 2014
4:30 PM - 5:45 PM

Spring 2014 Name: SOLUTION

Dr. Havlicek Student Num: _____

Directions: This is an open notes test. You may use the official course lecture notes and a calculator. Other materials are not allowed. You have 75 minutes to complete the test. All work must be your own.

SHOW ALL OF YOUR WORK for maximum partial credit!

GOOD LUCK!

SCORE:

1. (25) _____
2. (25) _____
3. (25) _____
4. (25) _____

_____

TOTAL (100):

_____

On my honor, I affirm that I have neither given nor received inappropriate aid in the completion of this test.

Name: _____ Date: _____

1. **25 pts**. True or False. Mark *True* only if the statement is **always** true.

TRUE	FALSE	
____	X	(a) **2 pts**. MRI is a type of absorption imaging.
____	X	(b) **2 pts**. The main reason that digital image proccessing is useful in so many scientific fields is that an image fully captures all of the 3D information in the camera field of view.
____	X	(c) **2 pts**. Any digital image can be exactly reconstructed from its histogram.
X	____	(d) **2 pts**. In generating a binary image from a gray scale image, threshold selection is easiest when the histogram is bimodal with well separated peaks.
X	____	(e) **2 pts**. When thresholding is applied to generate a binary image from a gray scale image in "real-world" applications, some kind of region correction is usually required after thresholding.
X	____	(f) **2 pts**. For a given structuring element or window, the binary Median and Majority filters are identical.
____	X	(g) **2 pts**. Blob coloring is a simple method for generating the histogram of a color image.
____	X	(h) **2 pts**. If a binary morphological dilation filter is applied over and over again enough times, it will eventually reduce any binary image **I** to an image of all zeros.
X	____	(i) **2 pts**. The binary OPEN and CLOSE filters generally do not affect the overall sizes of objects.
X	____	(j) **2 pts**. Run-length coding is used in baseline JPEG to code the DCT coefficients.
X	____	(k) **2 pts**. A geometric image operation generally requires a spatial mapping of image coordinates followed by interpolation.
____	X	(l) **3 pts**. The magazine *Better Homes and Gardens* once tried to sue the IEEE for copyright infringement over use of the *Lena* image.

2. **25 pts.** Consider the 4×4 image **I** shown below, where the allowable range of gray levels is $0 \leq I(i,j) \leq 15$:

$$\mathbf{I} = \begin{array}{|c|c|c|c|} \hline \mathbf{15} & \mathbf{14} & \mathbf{13} & \mathbf{2} \\ \hline \mathbf{14} & \mathbf{15} & \mathbf{2} & \mathbf{1} \\ \hline \mathbf{14} & \mathbf{13} & \mathbf{2} & \mathbf{0} \\ \hline \mathbf{15} & \mathbf{1} & \mathbf{0} & \mathbf{0} \\ \hline \end{array}$$

Construct a new image **K** by applying the histogram shaping algorithm to make the histogram more "ramp like." The **desired** histogram shape is given by:

k	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
$H_{\mathbf{K}}(k)$	1	0	0	2	0	0	0	3	0	0	0	4	0	0	0	6

Show the new image **K** and its histogram $H_{\mathbf{K}}$ in the spaces provided below. Don't forget to apply a full-scale contrast stretch to get the final result.

$$\mathbf{K} = \begin{array}{|c|c|c|c|} \hline 15 & 15 & 10 & 10 \\ \hline 15 & 15 & 10 & 5 \\ \hline 15 & 10 & 10 & 0 \\ \hline 15 & 5 & 0 & 0 \\ \hline \end{array}$$

k	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
$H_{\mathbf{K}}(k)$	3	0	0	0	0	2	0	0	0	0	5	0	0	0	0	6

Work space is provided on the next page.

Workspace for Problem 2:

$J =$

16/16	13/16	10/16	8/16
13/16	16/16	8/16	5/16
13/16	10/16	8/16	3/16
16/16	5/16	3/16	3/16

$K =$

15	15	11	11
15	15	11	7
15	11	11	3
15	7	3	3

Histogram of I

k	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
H(k)	3	2	3	0	0	0	0	0	0	0	0	0	0	2	3	3
p(k)	3/16	2/16	3/16	0	0	0	0	0	0	0	0	0	0	2/16	3/16	3/16
P(k)	3/16	5/16	8/16	8/16	8/16	8/16	8/16	8/16	8/16	8/16	8/16	8/16	8/16	10/16	13/16	16/16

Desired Histogram

k	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
H(k)	1	0	0	2	0	0	0	3	0	0	0	4	0	0	0	6
p(k)	1/16	0	0	2/16	0	0	0	3/16	0	0	0	4/16	0	0	0	6/16
P(k)	1/16	1/16	1/16	3/16	3/16	3/16	3/16	6/16	6/16	6/16	6/16	10/16	10/16	10/16	10/16	16/16

final $K =$

15	15	10	10
15	15	10	5
15	10	10	0
15	5	0	0

For full scale stretch,

$\min K = 3 = A$

$\max K = 15 = B$

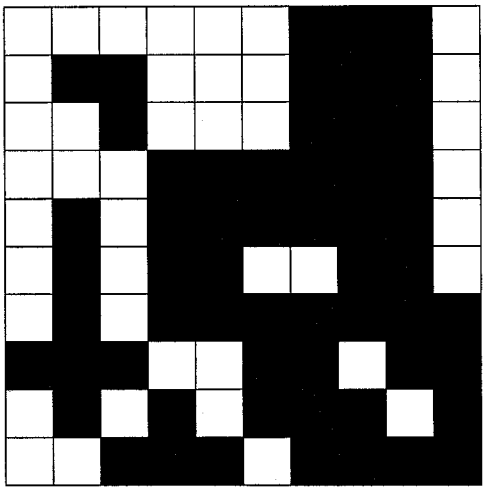
$$\text{final } K = \frac{15}{15-3}\left[K(i,j) - 3\right]$$

$$= \frac{15}{12}\left[K(i,j) - 3\right]$$

$K(i,j)$	final $K(i,j)$
3	$\frac{15}{12} \cdot 0 = 0$
7	$\frac{15}{12} \cdot 4 = 5$
11	$\frac{15}{12} \cdot 8 = 10$
15	$\frac{15}{12} \cdot 12 = 15$

3. **25 pts.** Consider the 10×10 binary image $\mathbf{I}$ shown below, where BLACK = LOGIC ONE and WHITE = LOGIC ZERO.

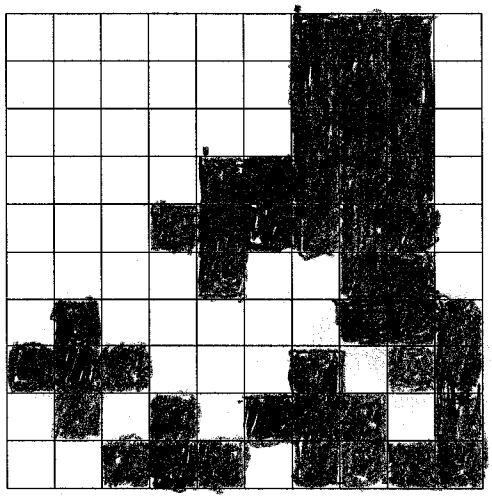
$\mathbf{I}$ =



Form a new binary image $\mathbf{J} = \text{OPEN}(\mathbf{I}, \mathbf{B})$ by applying a binary morphological OPEN filter with structuring element $\mathbf{B} = \text{CROSS}(5)$. Handle edge effects by replication.

Show the new image $\mathbf{J}$ in the space provided below:

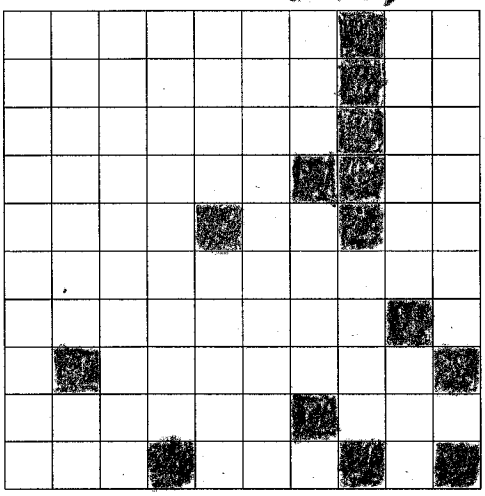
$\mathbf{J}$ =



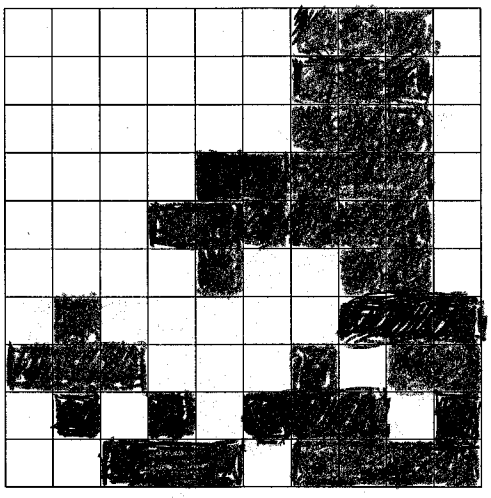
There is work space on the next page.

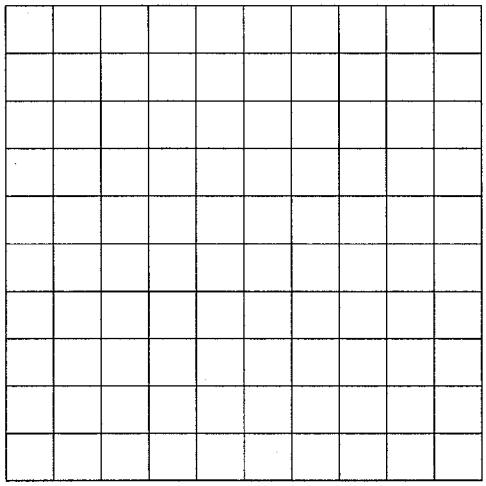
Workspace for Problem 3:

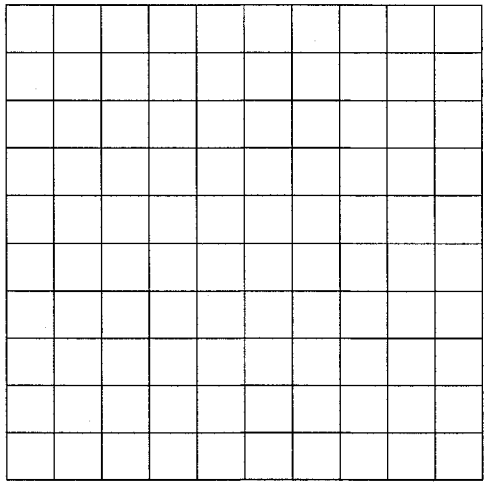
ERODE(I, B)



J = DILATE[ERODE(I, B), B]







4. **25 pts.** Draw lines to match the images with their log-magnitude DFT spectra.