ECE 5273
Test 1

Wednesday, April 10, 2013
4:30 PM - 5:45 PM

Spring 2013 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**. Scaling, rotation, and translation are examples of geometric image operations.
X		(b) **2 pts**. The full-scale contrast stretch is an example of linear point operation.
X		(c) **2 pts**. X-ray computed tomography (CT scan) is an example of absorption imaging.
X		(d) **2 pts**. Because of the inherent periodicity of the 2D DFT and IDFT equations, the original image is always implied to be periodic.
X		(e) **2 pts**. Frame differencing is usually an effective technique for detecting motion in a video sequence.
X		(f) **2 pts**. For binary images, OPEN and CLOSE are dual operations with respect to complementation, *i.e.*, NOT[OPEN($\mathbb{I}$,$\mathbb{B}$)] = CLOSE[NOT($\mathbb{I}$),$\mathbb{B}$]. See Below
X		(g) **2 pts**. A binary CLOSE-OPEN filter tends to link neighboring objects together.
X		(h) **2 pts**. When constructing a log-magnitude DFT spectrum, the reason for adding one to the DFT magnitude is to prevent any errors from occurring when the log function is called.
X		(i) **2 pts**. Any real-valued digital image $\mathbb{I}$ has a DFT $\widetilde{\mathbb{I}}$ that is conjugate symmetric.
X		(j) **2 pts**. While an image is generally multidimensional, the image histogram function $H_{\mathbb{I}}$ is always a 1-D function.
X		(k) **2 pts**. The zoom feature found on most cameras works by changing the focal length of the lens system.
X		(l) **3 pts**. Santa Claus does not really live at the North Pole.

(f): NOT OPEN(II) = NOT DILATE ERODE (II) = NOT DILATE NOT DILATE (NOT II) (ERODE (II))

= NOT NOT ERODE [NOT NOT DILATE (NOT II)]

= ERODE [DILATE (NOT II)] = CLOSE [NOT (II)] ✓

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

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

Construct a new image $\mathbb{J}$ by applying the histogram flattening algorithm to $\mathbb{I}$. Show the new image $\mathbb{J}$ and its histogram $H_{\mathbb{J}}$ in the spaces provided below:

$$\mathbb{J} = \begin{array}{|c|c|c|c|}\hline 15 & 12 & 9 & 8 \\ \hline 12 & 15 & 8 & 5 \\ \hline 12 & 9 & 8 & 3 \\ \hline 15 & 5 & 3 & 3 \\ \hline \end{array}$$

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

$J(i,j) = \text{INT}[(K-1)J_1(i,j) + 0.5]$
$= \text{INT}[15 J_1(i,j) + 0.5]$

Work Space:

$\mathbb{J}_1 =$

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

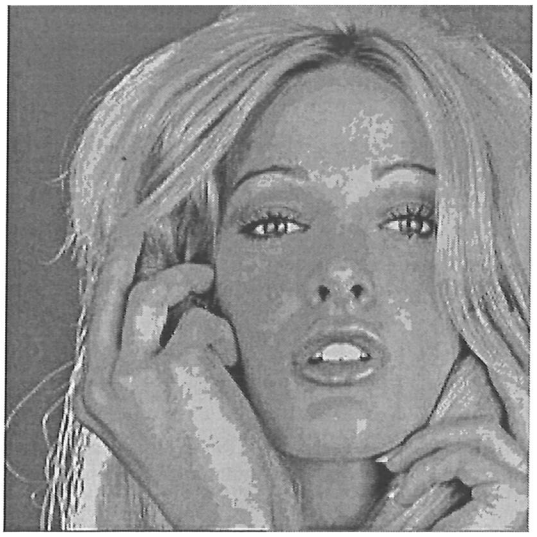
$I(i,j)$	$J_1(i,j)$	$J(i,j)$
0	3/16	3
1	5/16	5
2	8/16	8
13	10/16	9
14	13/16	12
15	16/16	15

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

$\sum_{m=0}^{k} p(m)$ → 3/16 5/16 8/16 8/16 8/16 . . . . . 8/16 10/16 13/16 16/16

3. **25 pts**. The gray scale image $\mathbb{I}_1$ shown below has 8-bit pixels. This image was thresholded to obtain the binary image $\mathbb{I}_2$, which is also shown below. In $\mathbb{I}_2$, the pixel value 255 (WHITE) represents LOGIC ONE and the pixel value zero (BLACK) represents LOGIC ZERO.

$\mathbb{I}_1$



$\mathbb{I}_2$

Binary morphological OPEN and CLOSE operations where performed on the image $\mathbb{I}_2$ using a 5×5 diamond-shaped structuring element. The resulting images are shown as $\mathbb{J}_1$ and $\mathbb{J}_2$ below.

$\mathbb{J}_1$ = CLOSE

$\mathbb{J}_2$ = OPEN

Determine which image is the result of the OPEN operation and which is the result of the CLOSE operation. Explain your answer.

Workspace for Problem 3...

CLOSE removes small holes and gaps of LOGIC ZERO pixels. But it does not remove small structures composed of LOGIC ONE pixels. In $\mathbb{J}_1$, notice that fine black details of Tiffany's hair are removed, but fine white details of her eyes are preserved.

$$\Longrightarrow \quad \mathbb{J}_1 = \text{CLOSE}\left[\mathbb{I}_2, \mathbb{B}\right]$$

OPEN removes small objects and peninsulas of LOGIC ONE pixels. But it does not remove small structures composed of LOGIC ZERO pixels. In $\mathbb{J}_2$, notice that both eyebrows are preserved, but the fine white details of her eyes are removed.

$$\Longrightarrow \mathbb{J}_2 = \text{OPEN}\left[\mathbb{I}_2, \mathbb{B}\right]$$

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