بسم الله الرحمن الرحيم

HW 1

Electrical Engineering Department
EE 410 Digital Image Processing (052)
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Due Monday, March 13th, 2006

Q 1: In the following statements, write True [T] or False [F] in the spaces provided.
Correct Answer = 2.0 point, No Answer = 0.0 point, Wrong Answer = -1 point.

T	(1) Spatial resolution of a digital image is determined mainly by the sampling factor.
T	(2) In general, selecting a suitable value for spatial and gray level resolutions depends on the amount of activity, details, and application of the image
T	(3) The masking operation on an image is a neighborhood processing technique.
T	(4) In image averaging technique, the availability of more images helps in decreasing the variability of pixel values at each location.
F	(5) In a digital image, reduction in spatial resolution results in false contours while reduction in quantization levels can exhibit a checkerboard appearance.

Q 2: Compute the number of bits that represents an image that has 64 gray levels and a size of 512×512 pixels? What is the time (in seconds) required to transmit this image over a 14.4 kbits/sec modem?

64 gray levels can be represented by 6 bits. So, image size is equal to:

$$= 512 \times 512 \times 6 = 1572864 bits = 192 Kbyte$$

Transmitting the image <u>without start and end bits</u> (since this is not mentioned in the question) will take:

$$= \frac{size}{bitrate} = \frac{1572864}{14400} = 109.23 \sec = 1.82 \min$$

Q 3

(a) Discuss the effects of applying the following 3×3 masks to the given image.
(b) Discuss the different effects between applying a 3×3 smoothing and a 3×3 median filters to the image. Show your work.

Mask 1

-1	-1	-1
0	0	0
1	1	1

Mask 2

-1	0	1
-1	0	1
-1	0	1

Image

1	1	1	10	10	10
1	1	1	10	10	10
1	1	1	10	10	10
1	1	1	10	10	10

(a) The first mask will convert the whole image to zeros since it checks the change in the vertical direction, where there is no change. The second mask will convert the image to zeros except the two columns in the middle will be of value 27 since it checks the change in the horizontal direction at an edge which resulted in a double line due to the derivative nature of a step.

Result of mask 1

0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0

Result of mask 2

0	0	27	27	0	0

0	0	27	27	0	0
0	0	27	27	0	0
0	0	27	27	0	0

(b) Smoothing filter will smooth the transition from 1 to 10 in two columns. While the median filter in this case will not change the image as shown below. This is due to the nature of smoothing filter to average the neighborhood while the median will result in the most likely value of the pixels under the region covered. Thus, an edge or a step may not be modified by a median filter.

Smoothing filter

1	1	4	7	10	10
1	1	4	7	10	10
1	1	4	7	10	10
1	1	4	7	10	10

Median filter

1	1	1	10	10	10
1	1	1	10	10	10
1	1	1	10	10	10
1	1	1	10	10	10

Q 4: Give **a brief** definition for False Contouring and Checkerboard pattern and indicate their origin.
False contouring is due to insufficient quantization for gray levels. It appears in the image as contours of gray levels but in the actual image they are not.

Checkerboard effects are due to insufficient sampling. It appears as blocks and ridges in the image. Thus, a curve may appear as a stair.

Q 5: A 5×5 smoothing mask is applied to a rectangular shape of size 4×2 pixels in the middle of an image. What would be the blurring size (in pixels) of this shape in the smoothed image?

The size of blurred area will be: 8×6

Q 6: Determine if the two regions shown R_1 and R_2 , (R_1 is the left region surrounded by the dotted line, and R_2 is the right region surrounded by the dotted line.), are 4-, 8-, and/or m-connected, for the cases, **Explain and justify your answers**:

(i) V={0,1,2} , (ii) V={1}

(1)	2	1	2	2	1	1	2	1
1	2	1	2	(1)	1	1	2	1
1	2	1	2	2	0	1	2	1
1	2	1	2	0	2	1	2	1
1	2	1	2	2	2	1	2	1

Consider V={0,1,2} Compute D_e , D_4 , *and* D_8, between the two circled pixels shown?

To determine if they are connected or not, consider the line between the two subsets and determine that from the elements on the edge of the two subsets if they belong to the subset V. Then apply the rule and conditions of 4, 8, and m:

(i) V= {0,1,2}

If we look to the two ones at the edge, we will find that, the two subsets are 4, 8 and m connected.

(ii) V= {1}

If we look to the two ones at the edge, we will find that, the two subsets are 4, 8 and m connected.

Consider V={0,1,2} Compute D_e , D_4 , *and* D_8, between the two circled pixels shown? Note that since V covers all gray levels, we do not worry about the connectivity and thus the three distance measures apply.

$$D_e = \left[(x-s)^2 + (y-t)^2 \right]^{\frac{1}{2}} = \left[4^2 + 1^2 \right]^{\frac{1}{2}} = 17^{\frac{1}{2}} = 4.1$$

$$D_4 = |x-s| + |y-t| = 4+1 = 5$$

$$D_8 = \max\left(|x-s|, |y-t| \right) = 4$$