CSCE 5683 – Digital Image Processing  
Midterm Exam – Fall 2010

Instructions:

• This is an in-class midterm exam.
• You are allowed one 8.5x11 page of notes.
• Answer all of the questions below.

Question #1
Assume that you are given an input image that is 640x480 and you want to create an output image that is 320x480.

a) Describe two image interpolation algorithms that could be used for this process.
b) Use diagrams to illustrate how your two methods work.
c) What are the advantages and disadvantages of each method?

Question #2
Assume that you are given grey scale image with pixel intensities between [37..209].

a) What point operation is necessary to map the pixels to the [0..255] range?
b) What point operation is necessary to go from [0..255] back to [37..209]?
c) Do you think you will get the same image back again? Explain.

Question #3
The application of a single geometric operation (translation, rotation, scale, shear) is relatively simple, but combining multiple operations gets more complicated.

a) Give an example where the order of application of two geometric operations A and B will result in different images.
b) Show the mapping function for A followed by B.
c) Show the mapping function for B followed by A.

Question #4
Consider the 5x5 image below.

a) Calculate the intensity histogram for this image h(i).
b) Calculate the cumulative intensity histogram for this image H(i).
c) Describe how the histogram equalization algorithm uses this information to enhance an image. You do not need to perform the actual equalization for this image.

```
2 2 3 9 9
2 2 3 9 9
3 3 3 9 9
9 9 9 9 9
9 9 9 9 8
```
**Question #5**
Consider the 8x8 image below. Overall, the values increase gradually from left-right and from top-bottom, but there are several pixels that are significantly brighter or darker than their neighbors.

a) Describe how you could correct these pixels using either *outlier removal* or *k-nearest neighbors* using a 3x3 neighborhood.

b) Describe how the algorithm works, and illustrate the algorithm with several 3x3 neighborhoods below.

```
0 0 0 0 1 2 4 6
0 5 0 0 1 2 4 1
0 0 0 0 9 2 4 6
0 0 0 0 1 2 4 6
1 1 1 1 1 2 4 6
3 3 3 3 3 2 4 6
5 5 5 5 5 5 1 6
7 7 0 7 7 7 7 6
```

**Question #6**
Frequency domain filtering is an important image processing technique.

a) Describe how *ideal low pass filtering* works.

b) Draw diagrams of the image and the filter in the frequency domain to illustrate how your method works.

c) How does the output image change as you *increase* the cutoff frequency in this filter?

d) Why does this technique introduce *ringing artifacts* in the output image?