ECE 499 HW2 (Prof. Hirakawa)

## Instructions

- Distributed 9/23/2013.

- Due 10/7/2013 5pm. Turn in Matlab portion to Isidore.

- Reading: class notes.

**Problem 1.** Download image boat.png. This is an 8 bit image. You may reuse bitwidth(f,N) function you designed in Homework 1 as part of this code.

(a) Implement a dithering function in Matlab, as follows:

[g,fhat\_g] = dither(f,N);

where N is the number of bits, g is a quantization with dithering, and fhat\_g is the approximation to f. Show output image with N=3.

(b) Implement a Floyd-Steinberg dithering, as follows (This is hard and slow... You'll need a for-loop):

[h,fhat\_h] = floyd\_steinberg(f,N);

where N is the number of bits, h is a quantization with Floyd-Steinberg dithering, and fhat\_h is the approximation to f.

**Problem 2**. Using the image 'boat.png' again, we will generate half-toning.

(a) Design a histogram half-toning method, as follows:

f = double(imread('boat.png'));

g = HT\_histogram(f);

imshow(g);

Where g(x,y) is 0 if there is a drop of ink, and 1 if there is no drop of ink.

(b) Design a half-toning dithering method, as follows:

f = double(imread('boat.png'));

h = HT\_dithering(f);

imshow(h)

Where h(x,y) is 1 with probability f(x,y)/255, and is 0 with probability 1-f(x,y)/255.

(c) Design a Floyd-Steinberg dithering half-toning by modifying the code from Problem 1(b), as follows:

f = double(imread('boat.png'));

i = HT\_floyd\_steinberg(f,threshold);

imshow(i)

Where i(x,y) is 0 if there is a drop of ink, and 1 if there is no drop of ink. 'threshold' is the threshold used to decide to drop an ink (<threshold) or not drop an ink (>threshold). Try threshold values of 64, 128, and 190.

**Problem 3.**

In-class demonstration showed half-toning in red, green, and blue (RGB) channels. However, real printers use cyan, magenta, and yellow (CMY). Let's figure out how this is really done.

(a) Download f1.png from Isidore. This is a color image. First, convert RGB into CMY by the following...

Cyan = 255-Red;

Magenta = 255-Green;

Yellow = 255-Blue;

(b) Now apply the Floyd Steinberg half-toning from Problem 2 to cyan, magenta, and yellow images separately with threshold=200. Be careful here---1 now means there is ink, 0 means no ink.

(c) Let's simulate inks... implement the following.

ink\_cyan(x,y,:) = [0,1,1] if there is a cyan ink drop at pixel (x,y)

= [1,1,1] if there is no cyan ink drop at pixel (x,y)

ink\_magenta(x,y,:) = [0,1,1] if there is a magenta ink drop at pixel (x,y)

= [1,1,1] if there is no magenta ink drop at pixel (x,y)

ink\_yellow(x,y,:) = [0,1,1] if there is a yellow ink drop at pixel (x,y)

= [1,1,1] if there is no yellow ink drop at pixel (x,y)

(d) Now, save these images as...

imwrite(ink\_cyan,'cyan.png');

imwrite(ink\_magenta,'magenta.png');

imwrite(ink\_yellow,'yellow.png');

Go find a color printer (if you don't have access to one, use one in Keigo's office). Print on the \*same\* paper the three images you saved (i.e. print on top of each other). You should now have a color image. I suggest that you let ink dry between each print. Try to align the images, but don't sweat if it's not perfect.

Problem 4.

Solve problems 3.14 and 3.16 from book.