EE168 **Lab/Homework #1**
Introduction to Digital Image Processing Handout #3

We will be combining laboratory exercises with homework problems in the lab sessions for this course. In the scheduled lab times, begin working the set of material for each week. Complete as much as possible during the scheduled time, and finish the remaining material for homework. Both homework and lab results are to be written up and turned in each week, with electronic submission of data files as needed as we have discussed in class. The class web site is http://ee168.stanford.edu or http://www.stanford.edu/class/ee168.

When you complete the exercise, turn it in using the submit script as described on the web page.

Problem 1 - Raster displays. Start the matlab application on the computer by typing

```
matlab
```

at the prompt. Set the default color table to black and white by entering the command:

```
colormap(gray)
```

Download the text file 'raster' from the class web site—the file is found under the "Homework" tab in the Homework 1 section. Place the file into your leland disk area. Type out the file and note that it is a sequence of 0's and 1's.

This file is a string of data values that will form a recognizable image once it is displayed with the proper row width. Read this file into a matrix and display it on the screen using the matlab commands *imagesc* and *axis*. Information on each command can be found using the matlab *help* command. Save the output file and submit it using the submission script. Experiment with various lengths to see how the image is distorted if the line length is incorrect. In your writeup illustrate the correct and also one incorrect line length value.

Problem 2 - Resolution.

i. Create an array of zeroes 512 points on a side, and display it on axes that are evenly and equally spaced using the *axis* command as before.

ii. Add circles of radius 16 and amplitude 1 to the array with centers at locations (200, 200), (232,200), (200,300), (248, 300), (200,400), and (264,400), and display. You will have to do some matlab programming to do this.

iii. Image this array using an instrument with a resolution of 32 pixels by filtering the array with a box 32 x 32 pixels of value 1, using the matlab command *filter2*. Comment on how well the pairs of points are separated in the output image.

iv. Plot cuts (lines) through the pairs of points for each of the three separations, and include in your writeup.

Problem 3 - Resolution in an image.

i. Download the binary image 'campusdrive' from the class web site. Read the file in matlab using the command *fread*. The data consist of unsigned characters 8 bits in size, and form an image with line length 580 pixels. The image is 435 lines long. Display the image.

ii. Filter this image with boxes 2, 4, 8 and 16 pixels on a side and observe the results. What features do you lose at each resolution size ?

iii. Plot cuts through one recognizable feature in the image for each resolution and examine the minimum obvious structure size in each case.

Problem 4 - Quantization.

i. Read in the original image from the previous problem.

ii. The initial image consists of eight bits of data for each pixel. Create new images using 5, 4, 3, 2 and 1 bit only for each pixel. How many bits are needed to preserve image quality ? Does it change from place to place in the image ? How so ?

Problem 5 - An unknown image.

i. Download the byte file lab1prob5data from the class web site.

ii. Determine the line length and display the image.

iii. Determine the number of actual data bytes in each line, and the size of the header area.

iv. Find any line count information in the header and determine if there are any missing lines.

v. Create a new image with no missing lines by duplication of preceding lines to fill in the data.

EE168 **Lab/Homework #1 Hints**

Introduction to Digital Image Processing

Hints and tips for first exercise

Here are some example solutions to the first two problems from Lab #1, with some hints on the matlab commands needed for the other problems. Use the help command to learn more about these commands.

Problem 1 - Raster displays.

Sample solution code:

```
f=fopen('raster');
[pix,count]=fscanf(f,'%d',[18,3]);
pix=pix';
pix

imagesc(pix);
axis('equal');
axis('image');
```

Problem 2 - Resolution.

Sample solution code:

```
pix=zeros(512,512);

circle=ones(33,33);

for i=1:33,
for j=1:33,
if(sqrt((i-17)^2+(j-17)^2))> 16 circle(i,j)=0; end;
end;
end;

for i=1:33,
for j=1:33,

pix(i+200,j+200)=circle(i,j);
pix(i+232,j+200)=circle(i,j);
pix(i+200,j+300)=circle(i,j);
pix(i+248,j+300)=circle(i,j);
pix(i+200,j+400)=circle(i,j);
pix(i+264,j+400)=circle(i,j);
```

```
end;
end;

h=imagesc(pix');
axis ([0 512 0 512]);
axis image;

## The filtering can be done with lines like the following:  ##

filter=ones(33,33);
pix2=filter2(filter,pix,'same');

h=imagesc(pix2');
axis ([0 512 0 512]);
axis image;
```

Problem 3 - Resolution in an image.

Hints:

You will need to read in a file now in binary format. That is, the data are in integer 8-bit format on the disk, rather than as text or ascii representations. The read command for raw data such as these is:

```
f=fopen('campusdrive.raw');
a=fread(f,[580 inf],'uint8');
```

where, once again, f is a file pointer and a contains the input array. "fread" replaces fscanf, and we do not use a format description such as %d. The [580 inf] parameter tells the program to place the data in an array of line length 580 and the inf argument says to read until it runs out of data. 'uint8' means the dat are stored on disk as unsigned integers of length 8 bits.

You can then filter and display as in the previous problem.

Problem 4 - Quantization.

Hints

In this problem you need to select only the high order bits in the pixels. We can do this with logical and's using the matlab bitand command:

```
b=bitand(b,128+64);
```

which, for example, logically and's every element of matrix b with a number consisting of 1's in the 128 and 64 places of a binary number, thus saving the top two bits of an eight-bit number. Open the binary file as in the previous problem, and display as usual using imagesc and axis.

Problem 5 - An unknown image.

Hints: Try this one yourself!

EE168 - Using the Imaging Lab machines for Matlab and afs file storage

The Imaging Lab in Room 001 Packard, at the foot of the stairs to the basement, is equipped with computers running the Windows operating system. We can use these for our class assignments, but the machines must be set up properly in order to access the proper folders.

Step 1. Log on to one of the workstations.

Press cntrl-alt-delete keys at the same time to display the login prompt. You will be asked to enter your username and password. The username must be specified as

win\username

where the win\ assigns a Windows domain for password checking. Enter your SUNet password in the prompt. After a few moments your desktop will be set up and you will see a Windows desktop.

Step 2. Get Kerberos credentials.

You next need to get Kerberos credentials. This is what is needed to be able to see your home directory on the Stanford computer system. We use a system called afs to access the directories. In the lower right part of the screen, there will be a small arrow pointing upwards. Click on this and there will be several small icons, one of which is called Network Identity Manager. Click this.

One of the options near the top left will have a small yellow star, this is used to obtain new credentials. You will be able to enter a username and password here to get Kerberos credentials. Enter your username in the format username@stanford.edu, and then enter your SUNet password as usual. This will set up your access to afs. If you like you can make this the default so you won't have to type as much next time you log in.

Step 3. Open your network drive to access your files in a directory that you can access from anywhere.

Click the Microsoft icon in the lower left. This brings up a control panel, and on the right hand side select Computer. There will be a button called "Map Network Drive", click this and it will prompt you for the folder name. You will need to enter this using the following format:

\\afs\ir\users\"first letter of your username"\"second letter of your username"\username

For example, for me it is \\afs\ir\users\z\e\zebker.

You then can see this drive on your Computer panel, and click to open it and store your files.