EE262 **Handout # 4**
Homework # 1 (120 points)
Due Wednesday, Jan. 16, through Canvas

In some of the following exercises you are asked to submit files electronically to the class directory so that we may view them. The class web site is www.stanford.edu/class/ee262. Submit via Canvas.

1. Download the file "image1" from the class web site. The link is on the class homework page, under hw1. This file is composed of a sequence of bytes, each representing intensity at one point in the picture. Each line has header bytes followed by image data.

a) Find the line length in the file.
b) Find the number of header bytes.
c) The line number is present in the header. Determine the location (the line number) of any missing lines.

2. Plot a histogram of the image region (exclusive of header) for the image in (1).

a) What are the mean and standard deviation of the image as recorded on the disk ?
b) Derive a transformation that yields a mean of 128 and a standard deviation of 80 for the processed image.
c) Stretch the image according to your transformation, print it, and submit electronically in tiff format. Make sure you account for pixels falling "off the ends" of the distribution.
d) Comment on the original and processed images.

3. Open the image from problem 1 again. Derive a transformation of the form

   out(i,j) = in(i,j)^p

   where in(i,j) is the original image, out(i,j) is the output image, and p is an arbitrary real number. Note that you will have adjust the scales of the input or output images, or both, to produce a high quality image. What value of p gives the “best” image? Submit this best image electronically in tiff format.

4. Generate a 10 x 10 array of 100 digits from the expression

   integer_part(0.5+10*fractional_part(1000*sin(n/10)) mod 10)

   for n=0 to 99. If n/10 is taken to be in degrees, the first row of the array will begin 0, 7, 5, … and the tenth row will end with 5, 2, 9. Smooth this random array by replacing each value by the sum of the nine digits centered on that value, and

assigning zeros to those of the nine that are outside the array. The new array will be 12x12 because of the zeros assigned to the edge values.

(a) Draw contours for levels 10, 20, 30, 40, and 50.
(b) Locate all of the tops, how many are there?
(c) Comment on any other features you find.

5. The following array presents microwave data of the sun's radio temperature as it appeared on March 10, 1970. Each number refers to the point midway between the units and tens digits, and the unit of the measurement is 1000 Kelvins.

(a) Superpose contours on this map (by hand) at 20, 40, 60, …
(b) Indicate tops with small triangles.
(c) Indicate the concave region by shading.
(d) Knowing that the map represents the sun, estimate the element spacing in minutes of arc.

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 0  0  0  0  1  2  4  7 10 12 12 12 14 17 20 18 19 22 21 12  3 -1  0  0  0
 1  0  0  0  1  6 17 27 29 24 19 20 24 26 25 21 21 26 26 16  4 -1  0  0  0
 2  1  4  1  6 14 34 57 67 54 39 34 37 38 35 29 29 28 24 12  2 -3 -1 -1  0
 6  4  4  8 15 25 46 72 87 73 52 41 41 41 38 35 35 32 23 12  4  0 -1 -1  0
10  9  9 16 27 37 47 61 68 52 36 30 42 49 47 43 40 37 29 20 13  6  1 -1  0
11 13 16 29 53 50 47 43 36 25 22 33 53 70 73 65 50 41 33 28 20 12  4  1 -1
10 14 24 40 55 58 50 38 28 25 34 48 66 84 96 91 68 47 35 31 29 26 15  5 -3
 9 15 30 47 58 57 50 42 35 39 41 46 50 69 90 94 77 53 36 27 34 46 40 19 -4
 7 14 31 46 54 53 49 45 45 41 29 17 19 38 62 73 62 43 29 23 44 75 80 44  3
 7 16 33 43 48 51 52 49 42 33 31 39 51 50 53 56 53 27 25 21 44 85103 71 19
 8 18 38 47 49 51 54 53 45 43 80145195162104 69 63 55 40 37 53 82 96 70 26
13 25 47 57 56 53 54 55 56 56112223316274162 86 80 81 68 60 66 75 74 54 22
13 23 56 70 70 62 51 49 60 62 98190292278168 83 70 79 69 65 73 74 60 36 14
 6 24 56 75 76 67 50 43 54 58 60 94157168110 54 41 46 45 50 61 66 53 33 15
-6  9 41 71 74 68 50 40 41 50 45 41 56 66 55 35 24 23 25 34 45 49 41 27 14
-10 -5 21 51 60 54 45 41 35 38 36 33 35 42 45 38 28 25 28 36 35 31 24 16  9
-6 -9  5 29 43 42 38 38 35 32 30 31 34 41 51 50 40 33 34 35 29 20 14  7  4
-1 -5  1 11 24 27 28 31 33 31 30 30 32 37 45 43 35 27 28 27 20 11  6  3  2
 0 -1  2  5 11 16 20 25 28 29 31 32 31 30 29 26 22 19 13 14  8  4  2  1  1
 0  0  1  2  4  7 10 17 22 26 26 25 24 23 18 13  8  7  7  5  3  1  0  0  0
 0  0  1  0  1  2  4  7 11 15 14 13 12 12  9  7  4  4  3  1  0  0  0  0  0
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Figure 2-56 Digital map of the solar brightness at 9.1-cm wavelength on March 10, 1970.

6. Download the file "delays" from the class directory. This file consists of a sequence of delay measurements of a laser altimeter in orbit around the Earth, where each delay is given in nanoseconds. A constant value corresponding to the delay from the orbit radius to a perfect sphere of radius 6378140 m has been subtracted from each measurement.

   The orbit radius is 42270426.73 m. The time between samples is 20 s. Assume that the nominal Earth is a perfect sphere with radius 6378140 m.

   What are the period and velocity of the satellite orbit?

   Assuming that the delays represent a continuous profile starting at location 0 degrees latitude and 0 degrees longitude, derive a map of the topography of the Earth. The pixel spacing in your map should be 0.5 degrees in both latitude and longitude, so that the final image is 720 by 360 points. Store the result as a byte file, or 8 bits/sample, and list the scale factor to convert from your data numbers to meters of elevation.

   Now, using your map, estimate the altitude of the Tibetan plateau, of the center of Greenland, and Madrid, Spain.

*Extra credit (+5 points): Display the results from (6) as a shaded relief image.