Final Examination: ESE 558 Digital Image Processing

Date: 5/14/2002, Duration: 2 hours, Spring 2001

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You can refer to only the prescribed text books and journal papers. No other reference materials are allowed. Show all steps to get full credit.

1. *(5 points) GW, Ch 4, Color Models*
   The Red, Green, and Blue color points of a computer monitor are specified on the CIE Chromaticity diagram (see Figure 6.5 on page 288 in the GW text book) as (0.7,0.2), (0.1,0.8), and (0.2,0.1) respectively. Describe a computational algorithm to find the relative proportions of the three primary colors of the computer monitor that need to be combined additively to produce pink color specified by the point (0.5.0.3) on the CIE chromaticity diagram.

2. *(3 points) GW, Ch. 6, Image compression*
   In the JPEG sequential baseline system of compression, find the encoding of the following 1-D DCT block. Show all steps for deriving each entry to demonstrate your understanding. Just writing correct answer is not sufficient. Assume that the DC coefficient of the previous block is -10.
   `[ -22 4 0 -2 0 0 0 -5 EOB ]`

3. *(3+1 points) GW, Ch. 6, Huffman-Shift code*
   A 3 bits/pixel 100x100 image is compressed by Huffman-shift coding the gray level values. Derive the best possible Huffman-shift code with a total of 5 symbols including one shift symbol. The histogram of the image is given below.

Gray value	:	0	1	2	3	4	5	6	7
Frequency count	:	1600	2000	2400	1500	1200	200	600	500

   (b) What is the total size of the compressed image? (excluding the Huffman-shift code table).

4. *(5 points) RK Ch 7 : Image Restoration*
   On page 271 in the text book by Rosenfeld and Kak, the transfer function for motion blur in photography is derived. The derivation assumes that the shutter of the camera requires negligible time to change from closed to open and vice versa. Replace this assumption with a new one as follows: The area of the shutter increases linearly from 0 to 1 unit during the time -T/2 to 0, and then decreases linearly from 1 to 0 during the time 0 to T/2. Derive a new transfer function using the new assumption.

5. *(3 points) RK Ch 8 : Image Reconstruction*
   The value of a function $f(x, y)$ is 1 inside an outer square of diagonal length 4 except inside an inner square of diagonal length 2 where the value is 2. Both squares are centered at the origin and the diagonals are along the x and y axes. $f(x, y) = 0$ outside the outer square. Find the Radon transform $P_0(t)$ of $f(x, y)$ (i.e. find the projection onto the x-axis).