CEG4311
Computer Assignment #3
Color Image Manipulation and Still Image Compression

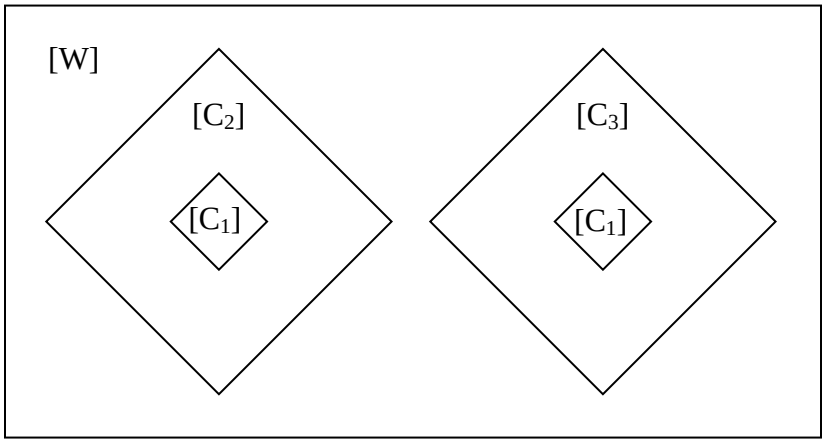
Due date: Your report is due by December 2, 2007 on virtual campus. Results will be demonstrated during the lab periods on November 7, 14, 21 and 28 in STE 2060.

Objectives:

1. Manipulate color images
2. Subsample and interpolate the chrominance component of images.
3. Experiment with some aspects of DCT-based image compression (to come).

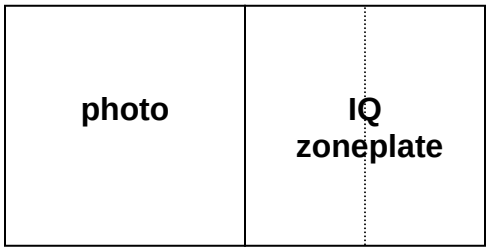
Procedure:

1. Create and display a 512×256 color image as follows:



The *horizontal width* of the small diamonds is 0.3 ph and the *horizontal width* of the large diamonds is 0.85 ph. Here, [W] represents white and [C_1], [C_2], [C_3] are three colors that are specified by their Rec. 709 gamma-corrected RGB values as follows:
[W]: $W_{R'} = 1.0$, $W_{G'} = 1.0$, $W_{B'} = 1.0$; [C_1]: $C_{1R'} = 0.835$, $C_{1G'} = 0.816$, $C_{1B'} = 0.345$;
[C_2]: $C_{2R'} = 0.937$, $C_{2G'} = 0.882$, $C_{2B'} = 0.294$; [C_3]: $C_{3R'} = 0.714$, $C_{3G'} = 0.725$, $C_{3B'} = 0.557$.
The black lines above are for illustration only and are not part of the image. The resulting color image will be of the form A(1:256,1:512,1:3). (Hints: You can generate the three RGB color planes separately, and combine them using the `cat` function. You can initially generate the full constant rectangle, then overlay the diamonds for C_2 and C_3, and finally overlay the diamonds for C_1. You can use the approach shown on pg. 2-68 in the course notes to draw the diamond shaped regions.)
Describe any discrepancies between what you see and what you know you have generated, and comment on it. Modify your program to generate only the small diamonds on the white background.

2. You will find a 512×256 R'G'B' color image `testpattern_lab3_2007_q2.tif` on the course web page. It is arranged as follows :



This R'G'B' image is assumed to be in device space, i.e., gamma-corrected rec. 709 RGB. The IQ zoneplate is defined in luma-chrominance space as follows. First, define

$$z(x, y) = \cos(256\pi((x-1.5)^2 + (y-.5)^2))\text{rect}(x-1.5, y-.5) .$$

The I zoneplate is given by

$$f_{Y'}(x, y) = 0.5$$
$$f_I(x, y) = 0.25z(x, y), 1 \le x \le 1.5$$
$$f_Q(x, y) = 0.0$$

The P_R zoneplate is given by

$$f_{Y'}(x, y) = 0.5$$
$$f_I(x, y) = 0.0$$
$$f_Q(x, y) = 0.25z(x, y), 1.5 \le x \le 2$$

All are assumed to be sampled on a rectangular lattice with equal horizontal and vertical spacing $X = \frac{1}{256}\text{ph}$. The NTSC luma-chrominance components are related to the R'G'B' values by

$$\begin{bmatrix} f_{Y'} \\ f_I \\ f_Q \end{bmatrix} = \begin{bmatrix} .299 & .587 & .114 \\ .596 & -.275 & -.321 \\ .212 & -.523 & .311 \end{bmatrix} \begin{bmatrix} f_{R'} \\ f_{G'} \\ f_{B'} \end{bmatrix}$$

From the $512 \times 256 \times 3$ color image described above, generate three 512×256 images consisting of the *Y*' component, the *I* component (plus 0.5) and the *Q* component (plus 0.5). Visualize these components as if they were black-and-white images. Using the function `imresize` with bicubic interpolation, subsample both the *I* and *Q* components in the horizontal and vertical directions by 2, 4, 8 and 16 respectively (the same subsampling factor for both directions), then with a second use of `imresize` with bicubic interpolation, interpolate them back to the original size. In each case, convert back to R'G'B' and compare with the original. How much chrominance subsampling do you think is acceptable? Base your decision on the *photo* part of the image. However, take note and comment on what happens to the zoneplate part.

3, 4. To come …