

## CEG4311 Digital Image Processing

Fall 2007

### Problem Set 2

Due Nov. 19, 2007, 12:00 noon in STE CEG4311 assignment box

1. The web color *tomato* that we will denote  $[Q]$  is specified by the RGB values 252, 99, 71, respectively, on a scale from 0 to 255. Thus they can be assumed to be  $Q'_R = 0.99$ ,  $Q'_G = 0.39$ ,  $Q'_B = 0.28$  on a scale from 0 to 1. We assume that these are gamma-corrected values, according to the Rec. 709 gamma law (section 3.7.2), and that the primaries are the Rec. 709 RGB primaries, normalized with respect to reference white  $D_{65}$  (section 3.5.3). The goal of this problem is to determine representations of this color in other color coordinate spaces. Determine the following:
    - (a) the tristimulus values  $Q_R$ ,  $Q_G$ ,  $Q_B$  in the Rec. 709 RGB color space;
    - (b) the luminance  $Q_L$  and the chromaticities  $q_R$ ,  $q_G$ ,  $q_B$  in the Rec. 709 space;
    - (c) the XYZ tristimulus values  $Q_X$ ,  $Q_Y$ ,  $Q_Z$  and the corresponding chromaticities  $q_X$ ,  $q_Y$ ,  $q_Z$  (section 3.5.2);
    - (d) the 1976  $U'V'W'$  tristimulus values  $Q_{U'}$ ,  $Q_{V'}$ ,  $Q_{W'}$  and the corresponding chromaticities  $q_{U'}$ ,  $q_{V'}$ ,  $q_{W'}$  (section 3.6.1);
    - (e) the CIELAB coordinates  $Q_{L^*}$ ,  $Q_{a^*}$ ,  $Q_{b^*}$  (section 3.7.1, assume  $D_{65}$  as reference white);
    - (f) the Luma and color differences  $Q_{Y'}$ ,  $Q_{P_B}$ ,  $Q_{P_R}$  (section 3.7.3).
- \* You can visualize this color in any Windows program that lets you specify the RGB values of a color. For example, in Microsoft Word, draw a shape like a rectangle and set the fill color using “More Colors – Custom” and enter the red, green and blue values as integers from 0 to 255 in the boxes.

2. As we have seen in the tutorial, the Bayer color sampling strategy induces a new set of color signals from the original RGB values (assume Rec. 709) as follows:

$$\begin{bmatrix} f_L \\ f_{C1} \\ f_{C2} \end{bmatrix} = \begin{bmatrix} 0.25 & 0.5 & 0.25 \\ -0.25 & 0.5 & -0.25 \\ -0.25 & 0.0 & 0.25 \end{bmatrix} \begin{bmatrix} f_R \\ f_G \\ f_B \end{bmatrix}$$

These can be considered to be tristimulus values with respect to a new set of primaries denoted  $[L]$ ,  $[C1]$ ,  $[C2]$ .

a) Determine and plot the color matching functions for the LC1C2 primaries, denoted  $\bar{l}(\lambda)$ ,  $\bar{c}_1(\lambda)$ ,  $\bar{c}_2(\lambda)$ . The data for the XYZ color-matching functions are given on the course web page.

(b) Express the primaries  $[L]$ ,  $[C1]$ ,  $[C2]$  in terms of the primaries  $[R]$ ,  $[G]$ ,  $[B]$  and in terms of the primaries  $[X]$ ,  $[Y]$ ,  $[Z]$ .

(c) Determine the LC1C2 tristimulus values of the color *tomato* of problem 1 and of the reference white  $D_{65}$ .