Homework 2 solution
CMPSCI 370 Spring 2019, UMass Amherst
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1 Light

(a) Formula for S_{TOTAL}.

$$S_{\text{TOTAL}} = \frac{3}{5}S_{\text{LED}} + \frac{2}{5}S_{\text{INC}}$$

(b) Tristimulus theory.

(1) Value of the matrix R

$$R = \begin{bmatrix} 0.0114 & 0.0564 & 0.1551 \\ 0.0264 & 0.1841 & 0.1225 \\ 0.2305 & 0.0553 & 0.0052 \end{bmatrix}$$

(2) Coefficient for the colors
turquoise: b_1: 2.1739, b_2: 4.4402, b_3: 0.0928
goldenrod: b_1: 0.4831, b_2: 0.0169, b_3: 5.4819

2 White balance

1. Proof for the formula of L. The notation j denotes the index of pixel and $i_r(j)$ and $c_r(j)$ denote the pixel values at the pixel location j. The notation N is the total number of pixels. For red channel, we can derive l_r as follow:

$$\begin{aligned} r_{ave} &= \frac{1}{N}\sum_j i_r(j) \\ &= \frac{1}{N}\sum_j l_r \times c_r(j) \\ &= \frac{l_r}{N}\sum_j c_r(j) \\ &= l_r \times 128 \\ \implies & \; l_r = \frac{r_{ave}}{128} \end{aligned}$$

Similarly, we can derive the expressions for l_g and l_b.

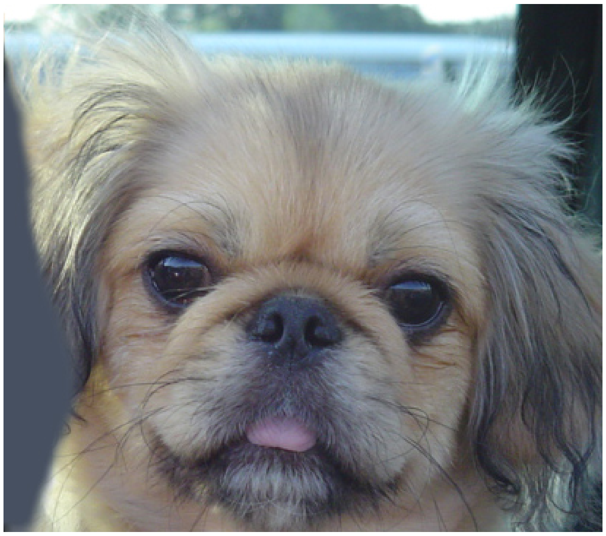
2. Value of L.

Light l_r: 0.7951, l_g: 0.8745, l_b: 1.1960

Figure 1: Output for the white balance

3 Hybrid images

σ_1 = ______4______, σ_2 = ______10______



dog image

cat image

Figure 2: Source images.

Figure 3: Output of hybid image of the dog and cat. The image was created with $\sigma_1 = 4$ and $\sigma_2 = 10$.

3.a Solution code

3.a.1 tristimulusTheory.m

```
lambda = linspace(380, 780, 10);
% Flashlight spectrum
F1 = [ 0.00, 0.01, 0.01, 0.02, 0.01, 0.02, 0.07, 0.29, 0.35, 0.12 ];
F2 = [ 0.00, 0.01, 0.02, 0.11, 0.20, 0.25, 0.21, 0.10, 0.01, 0.00 ];
```

```
F3 = [ 0.03, 0.10, 0.25, 0.27, 0.13, 0.02, 0.01, 0.01, 0.00, 0.00 ];

% Eye absorbtion specturm
Sr = [ 0.16, 0.26, 0.28, 0.15, 0.10, 0.03, 0.02, 0.00, 0.00, 0.00 ];
Sg = [ 0.00, 0.00, 0.04, 0.23, 0.34, 0.23, 0.15, 0.01, 0.00, 0.00 ];
Sb = [ 0.00, 0.00, 0.00, 0.00, 0.01, 0.04, 0.08, 0.23, 0.35, 0.29 ];

% Plot the power specturm
figure(1); clf;
subplot(3,1,1);
bar(lambda, F1);
xlabel('Wavelength(nm)','FontSize',16);
ylabel('Fraction of power','FontSize',16);
title('Flashlight 1','FontSize',16);

subplot(3,1,2);
bar(lambda, F2);
xlabel('Wavelength(nm)','FontSize',16);
ylabel('Fraction of power','FontSize',16);
title('Flashlight 2','FontSize',16);

subplot(3,1,3);
bar(lambda, F3);
xlabel('Wavelength(nm)','FontSize',16);
ylabel('Fraction of power','FontSize',16);
title('Flashlight 3','FontSize',16);

F = [F1; F2; F3];
S = [Sr; Sg; Sb];


%% Solution to the first part
R = S*F';

%% Matching colors

Ctur = [0.2896; 0.8862; 0.7471];
Cglr = [0.8567; 0.6874; 0.1408];

(R^-1)*Ctur
(R^-1)*Cglr
```

3.a.2 grayworld.m

```
function [L, C] = grayworld(I)
mI = squeeze(mean(mean(I,1),2));
L = mI/128;
C = I;
C(:,:,1) = I(:,:,1)/L(1);
C(:,:,2) = I(:,:,2)/L(2);
C(:,:,3) = I(:,:,3)/L(3);

figure(1); clf;
subplot(1,2,1);
```

```
imagesc(I); axis image off;
title('input');

subplot(1,2,2);
imagesc(C); axis image off;
title('output');
```

3.a.3 hybridImage.m

```
function im = hybridImage(im1, im2, sigma1, sigma2)
im1 = im2double(im1);
im2 = im2double(im2);
f1 = fspecial('Gaussian', 6*sigma1 + 1, sigma1);
f2 = fspecial('Gaussian', 6*sigma2 + 1, sigma2);
blurry1 = conv2rgb(im1, f1);
blurry2 = conv2rgb(im2, f2);
im = blurry1 + im2 - blurry2;

imwrite(blurry1, sprintf('dog-blurry-%d.jpg', sigma1));
imwrite(blurry2, sprintf('cat-blurry-%d.jpg', sigma2));
imwrite(im2-blurry2, sprintf('cat-sharp-%d.jpg', sigma2));


function imf = conv2rgb(im, f)
imf = zeros(size(im));
for ch = 1:size(im, 3),
    imf(:,:,ch) = conv2(im(:,:,ch), f, 'same');
end
```