

Color Reproduction Lab

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Team 4

Project 7

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Step 1

```
%a) Real RGBs
CM_XYZ_Lab = importdata("munki_CC_XYZs_Labs.txt");
Real_Lab = CM_XYZ_Lab(:,5:7);

%b) Display RGBs
cam_rgbs = [88, 214, 86, 77, 130, 126, 222, 51, 195, 54, 171, 238, 16, 61, ...
148, 237, 169, 36, 235, 184, 134, 80, 33, 10; 59, 153, 111, 91, 124, ...
204, 123, 63, 76, 34, 198, 175, 30, 120, 40, 208, 67, 107, 231, 183, ...
135, 81, 35, 11; 47, 134, 142, 53, 174, 184, 53, 142, 83, 60, 80, 60, ...
97, 57, 41, 59, 122, 142, 221, 178, 130, 77, 35, 13];
%Convert to doubles
cam_rgbs = double(cam_rgbs);
%Normalize by dividing by 255
cam_rgbs = cam_rgbs./255;

%c)Calculate Labs of the display RGBs
C = makecform('srgb2lab');
disp_Lab = applycform(cam_rgbs', C);

%d) Use deltaEab function
labs_diff = deltaEab(Real_Lab', disp_Lab');

%e)Summarize the differences
print_uncalibrated_workflow_error(Real_Lab', disp_Lab', labs_diff);
```

Uncalibrated workflow color error
camera->RGB_cam->display

Real vs. displayed ColorChecker Lab values

patch #	real			displayed			dEab
	L	a	b	L	a	b	
1	37.1865	14.9985	15.2592	28.0565	11.9808	12.8674	9.9087
2	65.8188	16.8695	18.0267	68.9262	21.7871	19.5749	6.0197
3	49.9949	-3.1841	-23.5159	45.7774	-3.1740	-20.2090	5.3594
4	42.6411	-15.3251	20.0423	36.6805	-11.0567	20.0235	7.3313
5	54.6852	9.6978	-26.7126	54.0068	10.8002	-25.8942	1.5315
6	71.2441	-33.1391	-0.5010	76.5779	-28.6024	2.0074	7.4379
7	62.2558	34.1094	57.7774	62.2258	35.7037	53.8702	4.2201
8	39.5890	9.9980	-43.6388	29.2587	15.7386	-46.3439	12.1239
9	51.8424	48.1403	16.0636	49.3108	48.8795	22.1305	6.6154
10	29.4495	22.4255	-21.7661	16.7047	14.0010	-12.9142	17.6567
11	71.6264	-24.3441	57.6850	76.0874	-21.9913	54.2495	6.1024
12	72.2288	20.6039	69.0149	76.0870	16.3375	64.7294	7.1731
13	28.6402	18.5907	-51.4092	14.2328	16.3934	-42.2486	17.2139
14	54.6309	-39.5493	32.8341	45.2905	-30.4128	28.1248	13.8887
15	42.5988	54.6049	25.7315	34.4867	45.4863	27.2827	12.3029
16	82.4265	3.8689	78.8570	84.1347	-0.3980	72.2889	8.0165
17	51.5476	49.5154	-14.3758	44.2766	46.8573	-9.3590	9.2250
18	49.3892	-26.5473	-28.6645	42.1103	-13.2249	-26.0856	15.3987
19	95.4458	-0.4414	0.0244	91.7526	0.1345	5.3864	6.5362
20	80.0339	0.1309	-0.9345	74.3867	-0.3017	2.6797	6.7186
21	66.0107	-0.0004	-1.1463	56.1129	-1.0971	2.5593	10.6254
22	50.5546	-0.6207	-0.9616	34.2588	-1.0463	2.2098	16.6071
23	35.1532	-0.0632	-0.9708	13.5009	-0.9467	-0.3359	21.6796
24	20.3224	-0.2858	-0.5603	3.0005	-0.0566	-0.9485	17.3278

min 1.5315
max 21.6796
mean 10.2925

Step 2

%a) Real RGBs

```
CM_XYZ_Lab = importdata("munki_CC_XYZs_Labs.txt");
Real_Lab = CM_XYZ_Lab(:,5:7);
```

%b) Display RGBs

```
cam_rgbs = [88, 214, 86, 77, 130, 126, 222, 51, 195, 54, 171, 238, 16, 61, ...
148, 237, 169, 36, 235, 184, 134, 80, 33, 10; 59, 153, 111, 91, 124, ...
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97, 57, 41, 59, 122, 142, 221, 178, 130, 77, 35, 13];
```

% c)

```
cam_XYZs = camRGB2XYZ('cam_model.mat', cam_rgbs);
```

%d)

```
cie = loadCIEdata;
XYZn_D50 = ref2XYZ(cie.PRD, cie.cmf2deg, cie.illD50);
disp_RGBs = XYZ2dispRGB('display_model.mat', cam_XYZs, XYZn_D50);
```

```
%e)
disp_RGBs = double(disp_RGBs)./255;
Cal_disp_Lab = applycform(disp_RGBs', C);

%f)
cal_Labs_diff = deltaEab(Real_Lab', Cal_disp_Lab');

%g)
print_calibrated_workflow_error(Real_Lab', Cal_disp_Lab', cal_Labs_diff);
```

Calibrated workflow color error

camera->RGB_cam->camera_model->XYZ_est->display_model->RGB_disp->display

Real vs. displayed ColorChecker Lab values							
patch #	real			displayed			dEab
	L	a	b	L	a	b	
1	37.1865	14.9985	15.2592	44.5314	14.7766	10.2588	8.8883
2	65.8188	16.8695	18.0267	71.2260	19.5365	13.9703	7.2667
3	49.9949	-3.1841	-23.5159	53.9203	-6.0112	-19.3775	6.3662
4	42.6411	-15.3251	20.0423	48.7409	-13.5377	18.2325	6.6088
5	54.6852	9.6978	-26.7126	58.3064	8.9497	-23.2264	5.0820
6	71.2441	-33.1391	-0.5010	72.5476	-33.3434	-0.7667	1.3458
7	62.2558	34.1094	57.7774	61.2838	38.1766	68.5270	11.5343
8	39.5890	9.9980	-43.6388	40.0983	12.5336	-44.5109	2.7293
9	51.8424	48.1403	16.0636	51.1131	54.2169	16.5405	6.1388
10	29.4495	22.4255	-21.7661	35.7878	20.9185	-17.0555	8.0395
11	71.6264	-24.3441	57.6850	73.8437	-22.5400	58.6737	3.0247
12	72.2288	20.6039	69.0149	74.2364	19.0492	68.3136	2.6343
13	28.6402	18.5907	-51.4092	29.2701	11.0417	-46.9945	8.7678
14	54.6309	-39.5493	32.8341	50.8162	-46.7260	30.7728	8.3849
15	42.5988	54.6049	25.7315	43.4882	56.7567	21.0113	5.2632
16	82.4265	3.8689	78.8570	81.3344	6.2289	76.1069	3.7849
17	51.5476	49.5154	-14.3758	48.9868	50.7242	-13.4531	2.9783
18	49.3892	-26.5473	-28.6645	49.0129	-21.6112	-26.0654	5.5912
19	95.4458	-0.4414	0.0244	95.7985	-0.2439	0.9668	1.0254
20	80.0339	0.1309	-0.9345	77.3177	-0.1221	0.5059	3.0849
21	66.0107	-0.0004	-1.1463	62.7578	-0.3636	-0.1344	3.4259
22	50.5546	-0.6207	-0.9616	48.3132	-0.4696	-1.3892	2.2868
23	35.1532	-0.0632	-0.9708	32.0909	-0.9217	-1.6356	3.2491
24	20.3224	-0.2858	-0.5603	15.3945	0.4523	10.2066	11.8641
min							1.0254
max							11.8641
mean							5.3902

Step 3

```
%a)
img_orig = imread('CC_chart_orig.jpg');

[r,c,p] = size (img_orig);
pix_orig = double(reshape(img_orig,[r*c,p]));

pix_XYZ_Cal =camRGB2XYZ('cam_model.mat',pix_orig);
pix_RGBs_Cal = XYZ2dispRGB('display_model.mat', pix_XYZ_Cal, XYZn_D50);

img_cal = reshape(pix_RGBs_Cal', [r,c,p]);

%b)
imwrite(img_cal, 'calibrated CC chart.tiff');

%c)
figure
dim = [.445 .5 .01 .5];
str = 'Uncalibrated Image';
s = annotation('textbox',dim,'String',str,'FitBoxToText','on');
s.FontSize = 12;
imshow(img_orig)

figure
dim = [.445 .5 .01 .5];
str = 'Calibrated Image';
s = annotation('textbox',dim,'String',str,'FitBoxToText','on');
s.FontSize = 12;
imshow(img_cal)
```





Feedback

```
%Max did step 1 and part of step 2, Malcolm did part of step 2 and step 3.  
% Max also updated the format and added titles to the images. This lab was  
% relatively easy, compared to what the normal final assingment would have  
% been. Malcolm had some issues with the XYZ2dispRGB function.
```

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