Credits

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Contents

Step 1 - Initialize

```
clear
disp("Certifiable Jim Moment", newline)
```

```
Certifiable Jim Moment
```

Step 2 - Import Camera Data

```
%a)
cie = loadCIEdata;
load('display_model.mat')
Camera.RGB = importdata('CameraRGB.txt',' '); % Read in RGBs of CC image [3x24] [R;G;B]
Camera.RGB = uint8(Camera.RGB*255);
% RGB's were calculated as averaged over a span of 255, meaning they're imported
% normalized to 255 [RGB/255 built in]

%b)
Camera.RGBNorm = double(Camera.RGB) * 100/255; % Turn to double, divide by 255, multiply 100
Camera.RGBNorm = uint8(Camera.RGBNorm); % convert back to uint8

%c) Creating the table4ti1 matrix
table4ti1 = ones(30, 4);
table4ti1(:, 1) = 1:30;
table4ti1(1:24, 2:4) = Camera.RGBNorm';
table4ti1(25:27, 2:4) = 0;
table4ti1(28:30, 2:4) = 100;

%d) Made workflow_test_uncal.ti1
%e) used ColorMunki and made workflow_uncal_test.ti3
%f) create data structure that contains the displayed XYZs
%g) Extract XYZ, whitepoint, blackpoint
uncal_XYZs = importdata('workflow_test_uncal.ti3',' ',20);

uncal_CC.XYZ = uncal_XYZs.data(1:24,5:7);           % Extract XYZs of color
uncal_CC.XYZk = mean(uncal_XYZs.data(25:27,5:7));  % Extract Whitepoint
uncal_CC.XYZw = mean(uncal_XYZs.data(28:30,5:7));  % Extract Blackpoint
```

```
%h) Calculate Lab values
uncal_CC.Lab = XYZ2Lab(uncal_CC.XYZ', uncal_CC.XYZw');

%i) Load the real Colormuki values
load("loadMunkiData");

%j) Calculate differences between Real patch and displayed Patch
dEabLab = deltaEab(Munki.Lab, uncal_CC.Lab);

%k) Print differences
print_uncalibrated_workflow_error(Munki.Lab, uncal_CC.Lab, dEabLab)
```

```
Uncalibrated workflow color error
camera->RGB_cam->display

               Real vs. displayed ColorChecker Lab values
                     real                     displayed
patch #      L        a        b        L        a        b       dEab
      1   37.1865  14.9985  15.2592  29.8742  16.2989  19.4323   8.5191
      2   65.8188  16.8695  18.0267  75.6815  17.4614  23.3487  11.2227
      3   49.9949  -3.1841 -23.5159  54.9321  -0.8514 -23.5229   5.4605
      4   42.6411 -15.3251  20.0423  37.0305 -13.9409  28.3826  10.1467
      5   54.6852   9.6978 -26.7126  61.1919  10.5869 -27.0322   6.5750
      6   71.2441 -33.1391  -0.5010  78.3906 -29.0364   2.6745   8.8311
      7   62.2558  34.1094  57.7774  68.6107  31.0839  63.8047   9.2663
      8   39.5890   9.9980 -43.6388  43.9440  12.9739 -49.4663   7.8602
      9   51.8424  48.1403  16.0636  61.0421  49.5810  22.6561  11.4093
     10   29.4495  22.4255 -21.7661  26.8158  20.9975 -24.6292   4.1441
     11   71.6264 -24.3441  57.6850  82.1446 -24.8756  76.4793  21.5439
     12   72.2288  20.6039  69.0149  79.5481   9.8380  73.1175  13.6494
     13   28.6402  18.5907 -51.4092  27.2084  20.8820 -52.7247   3.0051
     14   54.6309 -39.5493  32.8341  55.2819 -40.7925  46.6986  13.9353
     15   42.5988  54.6049  25.7315  47.6993  55.0102  35.8164  11.3086
     16   82.4265   3.8689  78.8570  90.5624  -8.8413  82.1891  15.4546
     17   51.5476  49.5154 -14.3758  60.5965  50.8798 -14.0499   9.1570
     18   49.3892 -26.5473 -28.6645  55.0682 -12.6504 -28.8409  15.0136
     19   95.4458  -0.4414   0.0244  97.4131  -1.0454   3.8483   4.3425
     20   80.0339   0.1309  -0.9345  86.2196  -1.1566   4.6309   8.4199
     21   66.0107  -0.0004  -1.1463  69.7412   0.0344   3.0708   5.6304
     22   50.5546  -0.6207  -0.9616  49.9007  -1.7089   3.0768   4.2333
     23   35.1532  -0.0632  -0.9708  25.7664   0.0056   0.4712   9.4972
     24   20.3224  -0.2858  -0.5603   4.7518   0.9161  -3.1545  15.8309

                                                       min      3.0051
                                                       max     21.5439
                                                       mean     9.7690
```

Step 2 - Calibrated Workflow

```
%a) Camera.RGBNorm - Same as Step 1.a
Camera.RGB;

%b) Put our Camera's RGB thru RGB2XYZ
CalCamera.XYZ = camRGB2XYZ('cam_model.mat', Camera.RGB);
```

```
%c)
%CalCamera.XYZn_D50 = catBradford(CalCamera.XYZ, XYZw, cie.illD50);
CalCamera.XYZn_D50 = ref2XYZ(cie.PRD,cie.cmf2deg,cie.illD50);
CalCamera.RGB_DC = XYZ2dispRGB('display_model.mat',CalCamera.XYZ,CalCamera.XYZn_D50);

%d)
CalCamera.RGBNorm = double(CalCamera.RGB_DC) * 100/255;
CalCamera.RGBNorm = uint8(CalCamera.RGBNorm);

%e) Creating the table4ti1 matrix - But for step 2
%   NOTE: Does override the table in step 1
table4ti1 = ones(30, 4);
table4ti1(:, 1) = 1:30;
table4ti1(1:24, 2:4) = CalCamera.RGBNorm';
table4ti1(25:27, 2:4) = 0;
table4ti1(28:30, 2:4) = 100;

%f) Make "workflow_test_cal.ti1

%g) Use colormunki - dispread -P 1,0,2 -v workflow_test_cal

%h) Load the measured XYZs
cal_XYZs = importdata('workflow_test_cal.ti3',' ',20);

%i) Extract XYZ data
cal_CC.XYZ = cal_XYZs.data(1:24,5:7);           % Extract XYZs of color
cal_CC.XYZk = mean(cal_XYZs.data(25:27,5:7));  % Extract Whitepoint
cal_CC.XYZw = mean(cal_XYZs.data(28:30,5:7));  % Extract Blackpoint

%j) Calculate Lab values
cal_CC.Lab = XYZ2Lab(cal_CC.XYZ', cal_CC.XYZw');

%k) Load the real Colormuki values - Previously done
%load("loadMunkiData");

%l) Calculate differences between Real patch and displayed Patch
dEabLab = deltaEab(Munki.Lab, cal_CC.Lab);

%m) Print differences
print_calibrated_workflow_error(Munki.Lab, cal_CC.Lab, dEabLab)
```

```
Calibrated workflow color error
camera->RGB_cam->camera_model->XYZ_est->display_model->RGB_disp->display

               Real vs. displayed ColorChecker Lab values
                     real                      displayed
patch #       L        a        b        L        a        b       dEab
      1   37.1865  14.9985  15.2592  40.5835   6.5386  15.1865   9.1168
      2   65.8188  16.8695  18.0267  68.1864  17.4855  15.3790   3.6049
      3   49.9949  -3.1841 -23.5159  52.1230   1.4922 -20.5226   5.9461
      4   42.6411 -15.3251  20.0423  43.6653 -11.9942  19.5343   3.5216
      5   54.6852   9.6978 -26.7126  55.9860  14.1669 -25.7440   4.7543
      6   71.2441 -33.1391  -0.5010  72.3120 -33.3137   0.6076   1.5492
      7   62.2558  34.1094  57.7774  62.2950  28.8702  59.1092   5.4060
      8   39.5890   9.9980 -43.6388  43.0032  17.4891 -40.9529   8.6595
```

```
     9   51.8424  48.1403  16.0636  53.2634  45.2668  15.3821   3.2772
    10   29.4495  22.4255 -21.7661  35.0518  19.2716 -17.8754   7.5147
    11   71.6264 -24.3441  57.6850  72.7212 -31.4567  62.4342   8.6221
    12   72.2288  20.6039  69.0149  71.9644  12.6305  67.2492   8.1709
    13   28.6402  18.5907 -51.4092  26.4145  19.7680 -50.0016   2.8846
    14   54.6309 -39.5493  32.8341  53.2584 -38.8467  26.4036   6.6128
    15   42.5988  54.6049  25.7315  43.4387  50.7935  22.4711   5.0855
    16   82.4265   3.8689  78.8570  81.9677  -2.2929  75.5607   7.0032
    17   51.5476  49.5154 -14.3758  50.1481  50.9792 -15.7627   2.4546
    18   49.3892 -26.5473 -28.6645  50.8335 -11.3080 -26.9398  15.4044
    19   95.4458  -0.4414   0.0244  96.0875  -0.8868   0.3125   0.8325
    20   80.0339   0.1309  -0.9345  81.1341  -0.9826   1.7478   3.1057
    21   66.0107  -0.0004  -1.1463  64.1971  -2.3459   0.0365   3.1921
    22   50.5546  -0.6207  -0.9616  50.0690  -2.4896  -0.2417   2.0608
    23   35.1532  -0.0632  -0.9708  38.2900  -1.1487   0.1242   3.4953
    24   20.3224  -0.2858  -0.5603  20.2337   0.7088  12.0015  12.6015

                                                      min      0.8325
                                                      max     15.4044
                                                      mean     5.6199
```

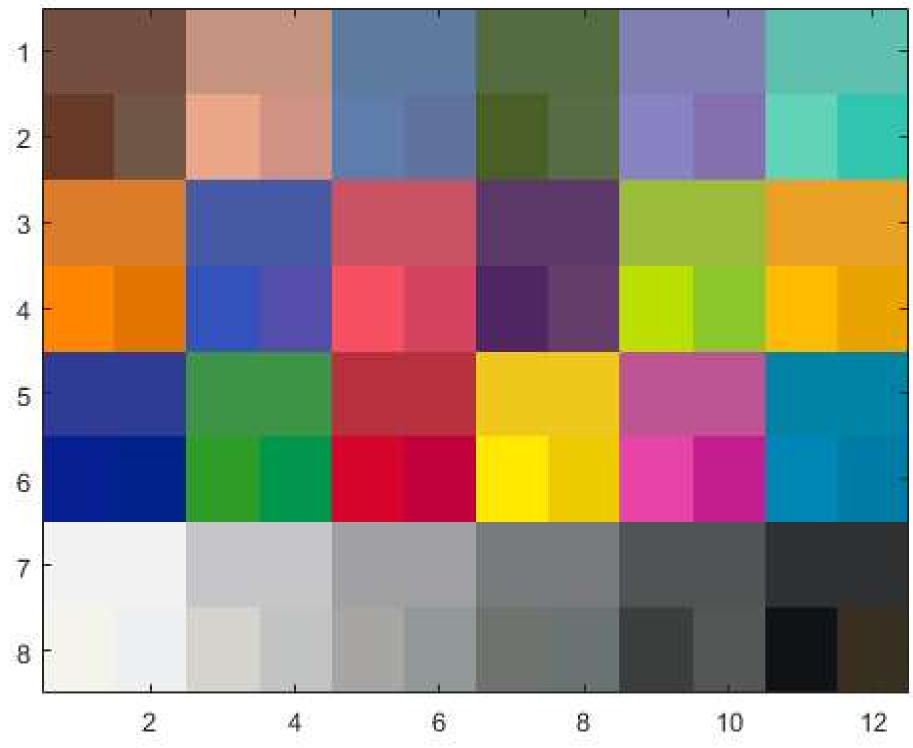
Step 3 - Visualize the differences

... Between ground-truth, uncalibrated, and calibrated renderings of the ColorChecker chart

```
%a) Load the real Colormuki values - Previously done
%load("loadMunkiData");

%b) Use "cform" to calculate RGB from XYZ
Munki.RGB = applycform(Munki.XYZ', makecform('XYZ2sRGB', 'AdaptedWhitePoint', CalCamera.XYZn_D50'));

%c)
Munki.RGB = uint8(Munki.RGB * 255)';
% RGBs are given 0-1 by the function

%d) Create workflow diffs
% Uncalibrated: Camera.RGB
% Calibrated: CalCamera.RGB_DC
% Ground-truth: Munki.RGB

G_truth = flip ( imrotate( reshape(Munki.RGB', [6 4 3]), 90 ) );
Uncalibrated = uint8 ( flip ( imrotate( reshape(Camera.RGB', [6 4 3]), 90 ) ) );
Calibrated = flip ( imrotate( reshape(CalCamera.RGB_DC', [6 4 3]), 90 ) );

% Array to reform - Convert to uint8 to be read 0-255
workflow = uint8(ones(8, 12, 3));

% Ground Truth
workflow(1:2:7, 1:2:11, :) = G_truth;
workflow(1:2:7, 2:2:12, :) = G_truth;

% Uncalibrated
workflow(2:2:8, 1:2:11, :) = Uncalibrated;

% Calibrated
workflow(2:2:8, 2:2:12, :) = Calibrated;
```

```
% Show image
figure
workflow_image = image(workflow)

%e)
workflow_image = imresize(workflow, [768 1024], 'nearest');

%f)
imwrite(workflow_image, "sillychart.jpg")
```

```
workflow_image = 

  Image with properties:

           CData: [8×12×3 uint8]
    CDataMapping: 'direct'

  Use GET to show all properties
```



Step 4 - Color Accurate Imaging

load your original CC image

```
img_orig = imread("ColorChecker.jpg");
% reshape the image into a pixel vector
[r,c,p] = size(img_orig);
pix_orig = reshape(img_orig,[r*c,p])';
```

```
% process the pixels through your camRGB2XYZ and
% XYZ2dispRGB functions to calc color-calibrated
% DCs
pix_XYZ = camRGB2XYZ('cam_model.mat', pix_orig);
pix_DCs_calib = XYZ2dispRGB('display_model.mat', pix_XYZ, CalCamera.XYZn_D50);

% reshape the pixels back into an image
img_calib = reshape(pix_DCs_calib', [r,c,p]);

%b)
imwrite(img_calib, "DaColourChecker.png");

%c)
figure
imshow("ColorChecker.jpg")
figure
imshow("DaColourChecker.png")
```

Step 5 - Feedback

```
%i)
% Cooper & Gian-Mateo both worked on the project. Cooper wrote step 2,
% Gian-Mateo wrote step 3, the remainder was written together
%ii)
% Spatial reasoning matrices
%iii)
% Combining parts of a larger array with a smaller one / catination
%iv)
% It was alright, no improvements.
```

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