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Calculate normalized RGB values

Using Readings from Jenee's 15" 2010 matte Macbook Pro

```
%Manual entry of RGB values taken from photoshop
cam_RGBs = [101,71,57;216,166,143;98,127,169;82,108,63;148,140,197;...

 120,219,199;216,120,44;57,73,160;214,88,100;82,42,95;169,213,74;...
    242,184,61;29,33,124;55,140,66;188,42,57;245,229,63;206,75,153;...
    31,129,166;233,238,232;194,200,196;151,153,152;105,109,108;...
    62,63,65;31,32,36]';

%Normalize RGB values
cam_RGBs = cam_RGBs./255;
fprintf('cam_RGBs = \n');
disp(cam_RGBs);

%Grab final 'row' of RGB values for colorchecer chart
%Sort from black to white
cam_gray_rgbs = cam_RGBs(:,19:24);
cam_gray_rgbs = fliplr(cam_gray_rgbs);
fprintf('cam_gray_rgbs = \n');
disp(cam_gray_rgbs);

cam_RGBs =
  Columns 1 through 7

    0.3961    0.8471    0.3843    0.3216    0.5804    0.4706    0.8471
    0.2784    0.6510    0.4980    0.4235    0.5490    0.8588    0.4706
    0.2235    0.5608    0.6627    0.2471    0.7725    0.7804    0.1725

  Columns 8 through 14

    0.2235    0.8392    0.3216    0.6627    0.9490    0.1137    0.2157
    0.2863    0.3451    0.1647    0.8353    0.7216    0.1294    0.5490
    0.6275    0.3922    0.3725    0.2902    0.2392    0.4863    0.2588

  Columns 15 through 21

    0.7373    0.9608    0.8078    0.1216    0.9137    0.7608    0.5922
```

```
        0.1647      0.8980      0.2941      0.5059      0.9333      0.7843      0.6000
        0.2235      0.2471      0.6000      0.6510      0.9098      0.7686      0.5961

    Columns 22 through 24

        0.4118      0.2431      0.1216
        0.4275      0.2471      0.1255
        0.4235      0.2549      0.1412

cam_gray_rgbs =
        0.1216      0.2431      0.4118      0.5922      0.7608      0.9137
        0.1255      0.2471      0.4275      0.6000      0.7843      0.9333
        0.1412      0.2549      0.4235      0.5961      0.7686      0.9098
```

Lab Step 4 - Calculate normalized Y values

```matlab
%Calculate normalized Y values for patches 19-24
munki_values = importdata('munki_CC_XYZs_Labs.txt');
munki_gray_Ys = fliplr(munki_values(19:24,3)'./100);

fprintf('munki_gray_Ys = \n');
disp(munki_gray_Ys);

munki_gray_Ys =
    0.0307      0.0858      0.1889      0.3534      0.5674      0.8868
```

Graph RGB Versus Grey Y values

```matlab
clf;
hold on;
plot(munki_gray_Ys, cam_gray_rgbs(1,:));
plot(munki_gray_Ys, cam_gray_rgbs(2,:));
plot(munki_gray_Ys, cam_gray_rgbs(3,:));
title('original greyscale Y to RGB relationship');
xlabel('munki gray Ys');
ylabel('camera grey RGBs');
hold off;
```

original greyscale Y to RGB relationship
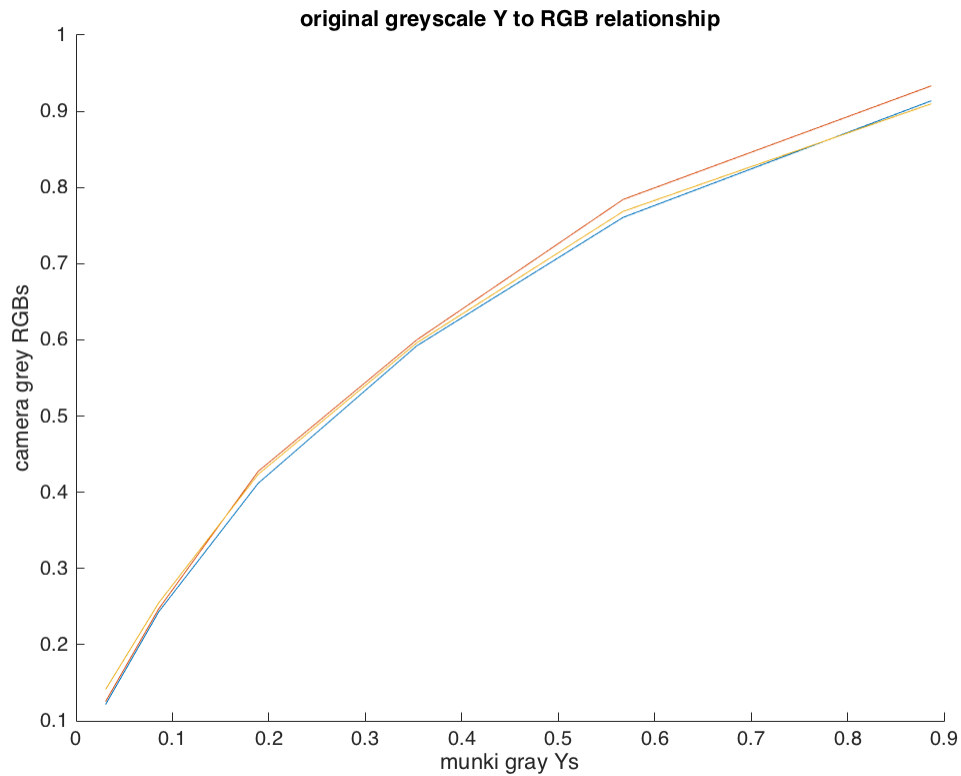
Linearize Camera RGB Output and Plot

```
r = 1; g = 2; b = 3;
% fit low-order polynomial functions between the camera gray rgbs
% and the munki gray Ys
cam_polys(r,:)=polyfit(cam_gray_rgbs(r,:),munki_gray_Ys,3);
cam_polys(g,:)=polyfit(cam_gray_rgbs(g,:),munki_gray_Ys,3);
cam_polys(b,:)=polyfit(cam_gray_rgbs(b,:),munki_gray_Ys,3);

% use the functions to linearize the camera RGB data
cam_rgbs_lin(r,:) = polyval(cam_polys(r,:),cam_RGBs(r,:));
cam_rgbs_lin(g,:) = polyval(cam_polys(g,:),cam_RGBs(g,:));
cam_rgbs_lin(b,:) = polyval(cam_polys(b,:),cam_RGBs(b,:));

% clip out of range values
cam_rgbs_lin(cam_rgbs_lin<0) = 0;
cam_rgbs_lin(cam_rgbs_lin>1) = 1;

% Fetch gray values of linearized cam RGBs
cam_rgbs_gray_lin = fliplr(cam_rgbs_lin(:,19:24));

clf;
hold on;
plot(munki_gray_Ys, cam_rgbs_gray_lin(1,:));
plot(munki_gray_Ys, cam_rgbs_gray_lin(2,:));
```
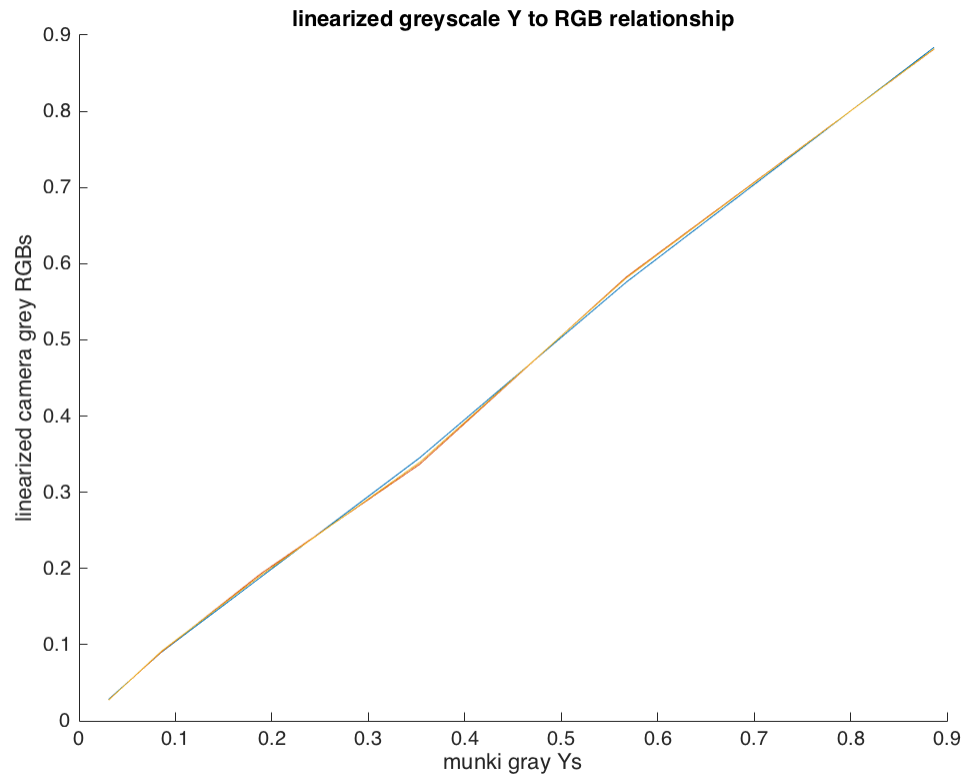
```
plot(munki_gray_Ys, cam_rgbs_gray_lin(3,:));
title('linearized greyscale Y to RGB relationship');
xlabel('munki gray Ys');
ylabel('linearized camera grey RGBs');
hold off;
```

linearized greyscale Y to RGB relationship

Camera RGB Visualization

```
% visualize the original camera RGBs
pix = permute(cam_RGBs, [3 2 1]);
pix = reshape(pix, [6 4 3]);
pix = imrotate(pix, -90);
pix = flipdim(pix,2);
figure;
image(pix);
title('original camera patch RGBs');

% visualize the linearized camera RGBs
pix = permute(cam_rgbs_lin, [3 2 1]);
pix = reshape(pix, [6 4 3]);
pix = imrotate(pix, -90);
pix = flipdim(pix,2);
figure;
image(pix);
title('linearized camera patch RGBs');
```

original camera patch RGBs

linearized camera patch RGBs
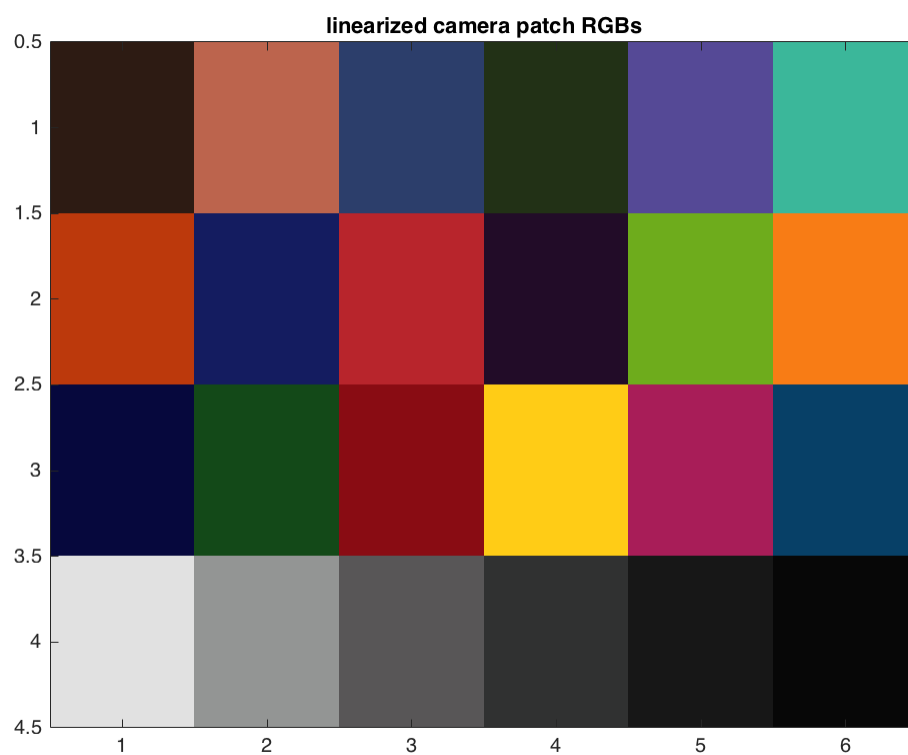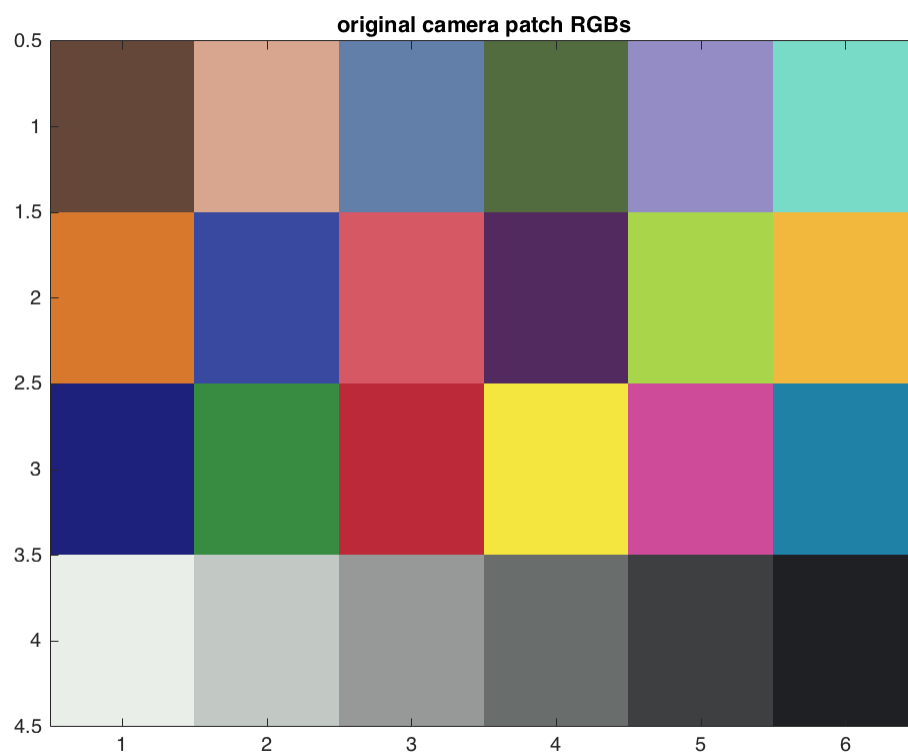
Derive 3x3 Transformation Matrix

```
% use the linearized camera rgbs and munki-measured XYZs
% to derive an rgb to XYZ transformation matrix
% pinv finds the matrix that provides the a least squares
% linear solution for relating the rgbs and XYZs
munki_data = importdata('munki_CC_XYZs_Labs.txt');
munki_XYZs = munki_data(:,2:4)';
cam_matrix = munki_XYZs * pinv(cam_rgbs_lin);

fprintf('cam_matrix = \n');
disp(cam_matrix);

% estimate the CC XYZs from the linearized camera rgbs using
% the camera model matrix
cam_XYZs = cam_matrix * cam_rgbs_lin;

fprintf('cam_XYZs = \n');
disp(cam_XYZs);

cam_matrix =
    37.6725    28.3424    17.6664
    18.4793    54.9651    13.5832
     0.4202     1.7343    70.9941

cam_XYZs =
  Columns 1 through 7

    11.0731    44.2390    20.7674    11.9588    31.0797    39.7690    34.8852
    10.1954    39.3439    22.2907    14.1347    29.9476    51.9954    26.5213
     5.5525    22.5015    30.2462     6.5960    42.3935    44.1033     3.9504

  Columns 8 through 14

    12.8033    34.2098     9.1787    37.2383    51.8260     5.9432    12.6876
    12.6901    23.4996     7.2726    46.4579    45.7617     5.2992    18.4954
    26.8451    12.6750    11.3985     9.2373     7.1541    16.9077     7.1969

  Columns 15 through 21

    22.9340    61.9260    34.1731    15.3098    73.8783    48.4625    28.5559
    13.6066    63.7064    23.1884    19.7956    76.7818    50.5468    29.5096
     5.6017     8.0188    24.8715    29.1177    64.5216    42.5128    24.8204

  Columns 22 through 24

    15.9825     7.6036     2.3267
    16.7258     7.9118     2.4045
    13.9976     6.7093     1.9934
```

Calculate CIELab and DeltaEAB of ColorChecker for Estimated XYZs

```
cie = loadCIEData();
XYZn_D50 = ref2XYZ(cie.illE,cie.cmf2deg,cie.illD50);
RGB_Labs = XYZ2Lab(cam_XYZs, XYZn_D50);

ColorMunki_CieLabs = munki_data(:, 5:7)';

deltas = deltaEab(RGB_Labs, ColorMunki_CieLabs);
```

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