tags: 影像處理

Image Processing Homework 3

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1 Technical description

HSI

RGBHSI
基本上就按照講義的提供的公式寫出來

$$H = \begin{cases} \theta, & \text{if } B \le G, \\ 360 - \theta, & \text{if } B > G, \end{cases}$$

$$\theta = \cos^{-1}\left\{ \frac{\frac{1}{2}[(R-G)+(R-B)]}{[(R-G)^2+(R-B)(G-B)]^{1/2}} \right\},$$

$$S = 1 - \frac{3}{(R+G+B)}[\min(R,G,B)],$$

$$I = \frac{1}{3}(R+G+B),$$

分母部分為了防止/0的發生所以有加一個不影響圖片的offset
H=acosd(a./(b+0.0000001));

挑整I，之後轉換回去

HSI2RGB部分則是參考此公式

- *RG sector* $(0^\circ \le H < 120^\circ)$:

$$B = I(1-S), \tag{6.2-8}$$

$$R = I\left[1+\frac{S\cos H}{\cos(60^\circ - H)}\right], \tag{6.2-9}$$

$$G = 3I-(R+B). \tag{6.2-10}$$

- *GB sector* $(120^\circ \le H < 240^\circ)$:

$$H = H - 120^\circ. \tag{6.2-11}$$

Then the RGB components are:

$$R = I(1-S), \tag{6.2-12}$$

$$G = I\left[1+\frac{S\cos H}{\cos(60^\circ - H)}\right], \tag{6.2-13}$$

$$B = 3I-(R+G). \tag{6.2-14}$$

- *BR sector* $(240^\circ \le H \le 360^\circ)$:

$$H = H - 240^\circ. \tag{6.2-15}$$

Then the RGB components are:

$$G = I(1-S), \tag{6.2-16}$$

$$B = I\left[1+\frac{S\cos H}{\cos(60^\circ - H)}\right], \tag{6.2-17}$$

$$R = 3I-(G+B). \tag{6.2-18}$$

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Lab

RGB沒辦法直接轉成Lab，因此使用(sRGB,D65) to XYZ的轉換公式轉成，之後照講義公式進行轉換。

0.4124564 0.3575761 0.1804375

0.2126729 0.7151522 0.0721750

0.0193339 0.1191920 0.9503041

```
% rgb2xyz(sRGB,D65)
X = 0.4124564 * ImageR + 0.3575761 * ImageG + 0.1804375 * ImageB;
Y = 0.2126729 * ImageR + 0.7151522 * ImageG + 0.0721750 * ImageB;
Z = 0.0193339 * ImageR + 0.1191920 * ImageG + 0.9503041 * ImageB;
```

- The $L^*a^*b^*$ color components are:

$$L^* = 116 \bullet h\left(\frac{Y}{Y_W}\right) - 16, \tag{6.5-9}$$

$$a^* = 500\left[h\left(\frac{X}{X_W}\right) - h\left(\frac{Y}{Y_W}\right)\right], \tag{6.5-10}$$

$$b^* = 200\left[h\left(\frac{Y}{Y_W}\right) - h\left(\frac{Z}{Z_W}\right)\right], \tag{6.5-11}$$

where

$$h(q) = \begin{cases} \sqrt[3]{q}, & q > 0.008856, \\ 7.787q + {}^{16}\!/_{116}, & q \le 0.008856, \end{cases} \tag{6.5-12}$$

```
% Xyz2Lab
for i = 1:m
    for j = 1:n
        % preProcess
        X(i,j) = X(i,j)/Xn;
        Y(i,j) = Y(i,j)/Yn;
        Z(i,j) = Z(i,j)/Zn;
        L(i,j) = 116.0 * HFunction(Y(i,j)) - 16;
        A(i,j) = 500.0 * ( HFunction( X(i,j) ) - HFunction( Y(i,j) ) );
        B(i,j) = 200.0 * ( HFunction( Y(i,j) ) - HFunction( Z(i,j) ) );
    end
end
```

```
function [result] =  HFunction(x)
    Qn = 0.008856;
    if(x > Qn)
        result = x ^ (1.0/3.0);
    else
        result = 7.787 * x + (16.0/116.0);
    end
end
```

調整L之後，轉成 XYZ 再轉回rgb
參考這下列公式
LAB to XYZ

From CIELAB to CIEXYZ [edit]

The reverse transformation is most easily expressed using the inverse of the function *f* above:

$$X = X_{\mathrm{n}} f^{-1}\left(\frac{L^\star + 16}{116} + \frac{a^\star}{500}\right)$$
$$Y = Y_{\mathrm{n}} f^{-1}\left(\frac{L^\star + 16}{116}\right)$$
$$Z = Z_{\mathrm{n}} f^{-1}\left(\frac{L^\star + 16}{116} - \frac{b^\star}{200}\right)$$

where

$$f^{-1}(t) = \begin{cases} t^3 & \text{if } t > \delta \\ 3\delta^2\left(t - \frac{4}{29}\right) & \text{otherwise} \end{cases}$$

and where $\delta = \frac{6}{29}$.

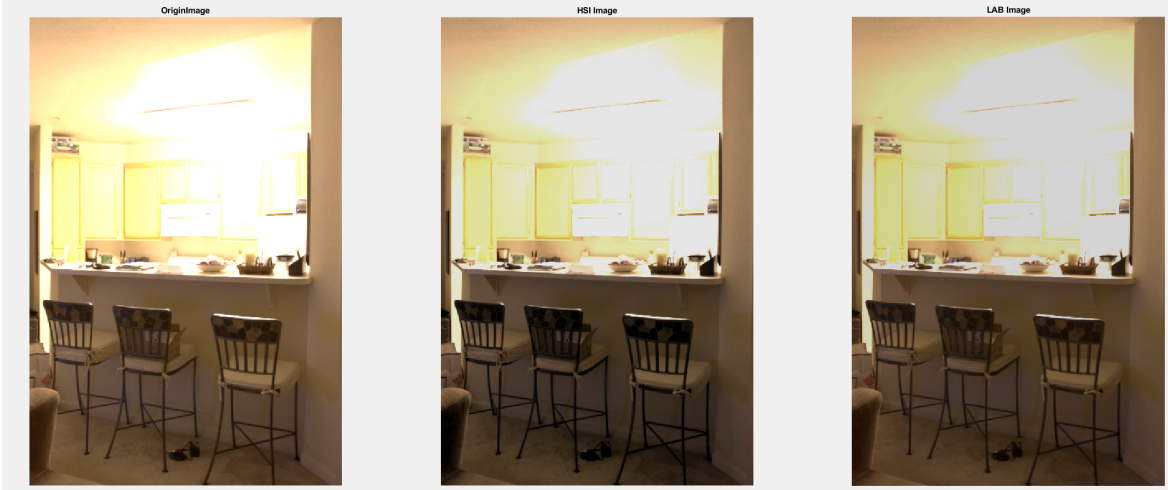
```
% LAB to XYZ
for i = 1:m
    for j = 1:n
        % prepare fx,fy,fz
        fy = (ImageL(i,j) + 16.0)/116.0;
        fz = fy - ImageB(i,j)/200.0;
        fx = ImageA(i,j)/500 + fy;
        % Y transformation
        if(fy ^3.0 > En)
            Y(i,j) = (fy^3);
        else
            Y(i,j) = (fy - (16.0/116.0))/7.787;
        end
```

XYZ to rgb(sRGB,D65)
3.2404542 -1.5371385 -0.4985314
-0.9692660 1.8760108 0.0415560
0.0556434 -0.2040259 1.0572252

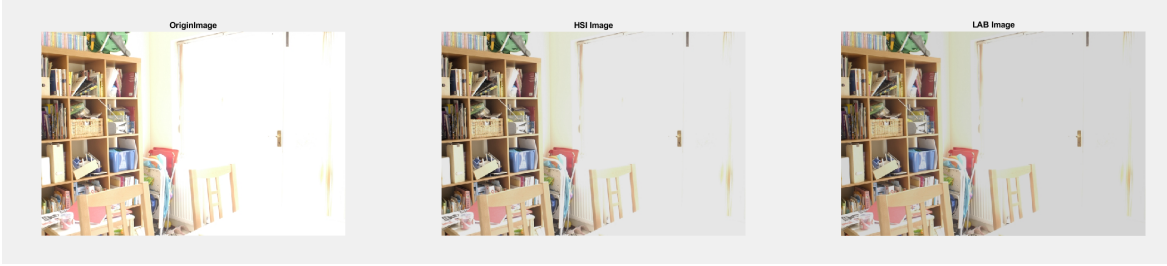
```
% xyz2rgb(sRGB,D65)
R =  3.2404542 * X - 1.5371385 * Y - 0.4985314 * Z;
G = -0.9692660 * X + 1.8760108 * Y + 0.0415560 * Z;
B =  0.0556434 * X - 0.2040259 * Y + 1.0572252 * Z;
```

2 Experimental results

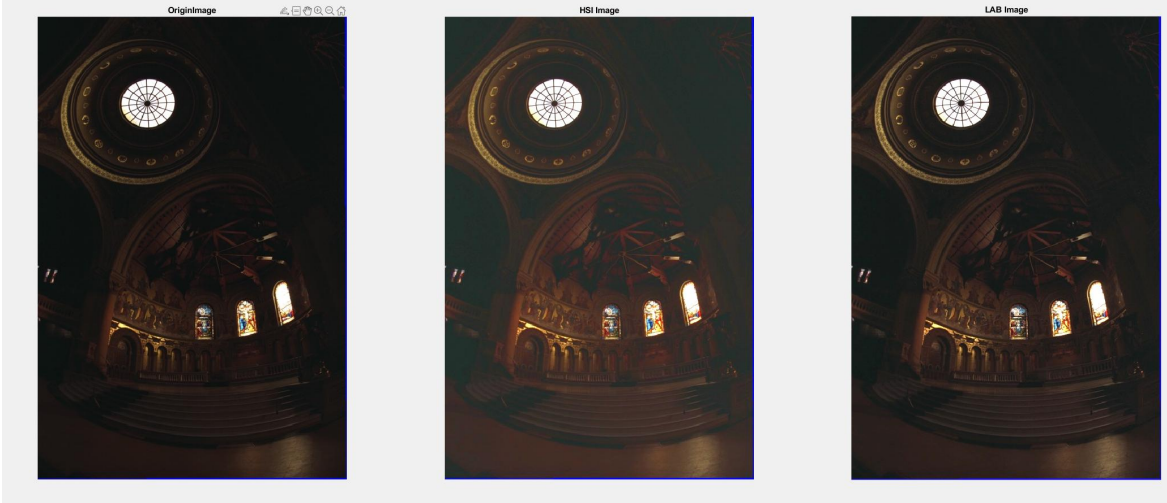
kitchen.jpg



house.jpg



church.jpg



aloe.jpg

3 Discussions

在kitchen這張圖來說LAB的部分比較好一些，像是色彩部分就沒甚麼跑掉，修正後後方的櫃子也看得到了。
house部分，因為白色面積太大了修正的效果不是很好。
church和aloe對亮度作正修正，效果都不錯，細節也有展現出來，但是經實驗如果再修正多一點的話，可以更多細節，不過有噪點增加跟明亮處會有過曝的感覺。LAB的效果比HSI更好，色彩的感覺都沒有跑掉，而HSI部分則有點跑掉。

4 References and Appendix

powerpoint on ecourse2
https://en.wikipedia.org/wiki/SRGB
https://en.wikipedia.org/wiki/CIELAB_color_space
http://www.brucelindbloom.com/index.html?Eqn_Lab_to_XYZ.html
https://www.mathworks.com/matlabcentral/mlc-downloads/downloads/submissions/55098/versions/2/previews/Plant%20Disease_MutiSVM/Leaf_Disease_Detection_code/rgb2hsi.m/index.html