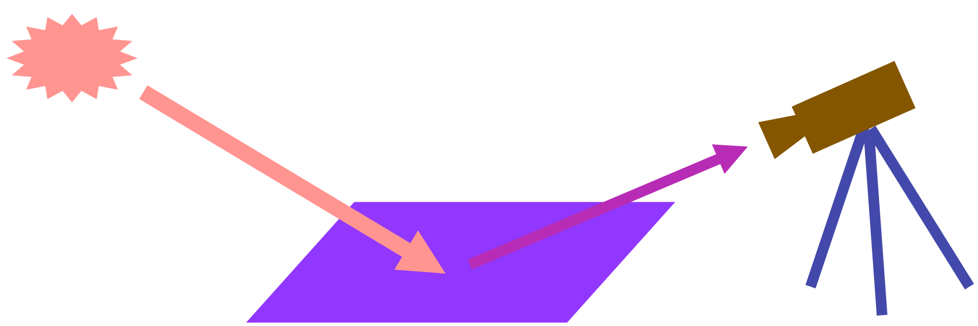
Color imaging summary

To get the color at a pixel, which is a particular outgoing direction with respect to the surface the pixel sees, we can add up the contributions of light rays reaching the surface.

For each contribution we have $E(\lambda)$ and $S(\lambda)$ and we can assume we know $R^{(k)}(\lambda)$.

We get the value of each channel by $C_k = \int E(\lambda)S(\lambda)R^{(k)}(\lambda)d\lambda$



Imaging system

In $C_k = \int E(\lambda)S(\lambda)R^{(k)}(\lambda)d\lambda$

$L(\lambda) = E(\lambda)S(\lambda)$ is about the world

The integration of $L(\lambda)$ against the senstivity functions
is a property of the **imaging** system.

This is a good model for cameras, and for human color matching experiments.

However, notice the implicit assumption that every pixel behaves the same.

Naive Color Model

Now consider "white" light (255, 255, 255)

- This is **relative** to the camera!
- We like to think of this as the color of perfect diffuse, uniform, reflector
- To make this all true, you can adjust the camera to compensate for the light.

Suppose that a surface has color (R_S, G_S, B_S) under white light

- Naively, this is the "color of the surface"
- (Naïve, because surfaces don't have color until you turn on the light, and it matters what the color of the light is!)
- The albedo in each channel is $\rho_R = \frac{R_S}{255} \quad \rho_G = \frac{G_S}{255} \quad \rho_B = \frac{B_S}{255}$

Naive Color Model (2)

Naive value for the color of the surface under a **different** light, (R_L, G_L, B_L) is given by:

$$(R,G,B) = (\rho_R R_L, \rho_G G_L, \rho_B B_L)$$

This is naïve because we assume that the part of the light that stimulates one channel, does **not** interact with the albedo of any other channel.

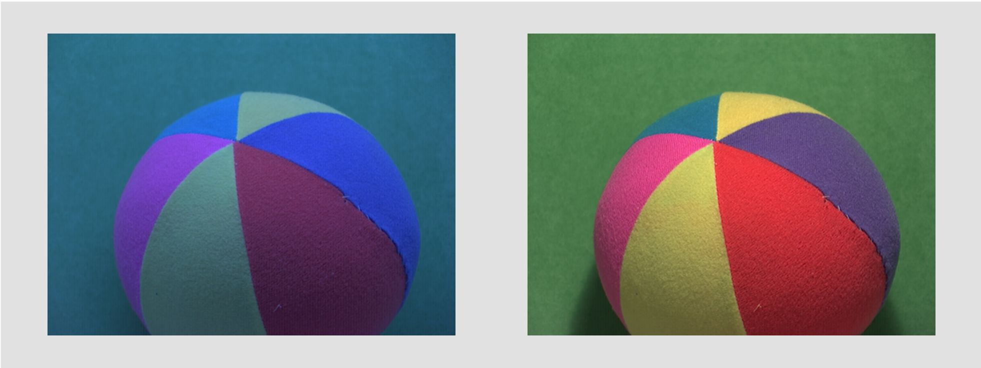
Alternatively, everything about the surface color can be captured in these 3 numbers.

This is the “diagonal model” for illumination change.

Diagonal Model for Color

(Same scene, but different illuminant)

Light color
(R_{L1}, G_{L1}, B_{L1})

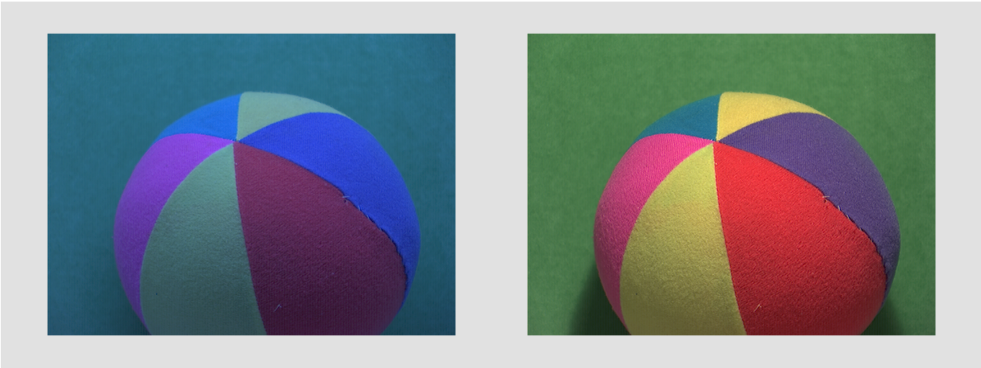


Light color
(R_{L2}, G_{L2}, B_{L2})

Diagonal Model for Color

(Same scene, but different illuminant)

Light color
(R_{L1}, G_{L1}, B_{L1})

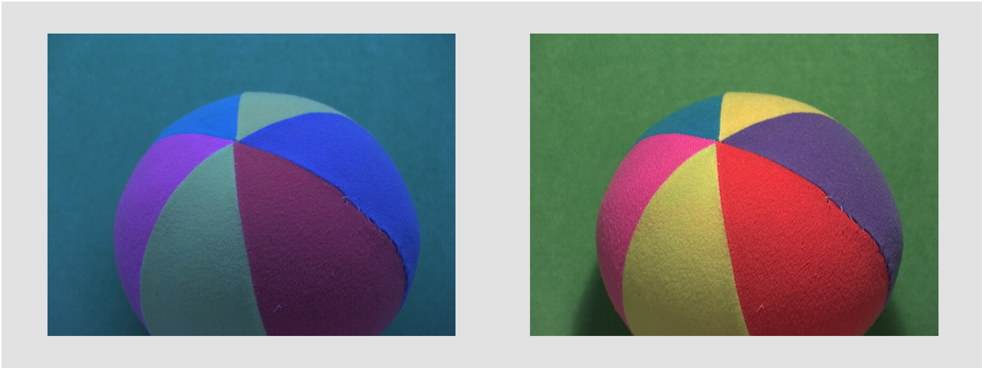


Light color
(R_{L2}, G_{L2}, B_{L2})

Diagonal model assumes that all the (R,G,B) in the left image change by the ratio of the lights

$$R_2 = \frac{R_{L2}}{R_{L1}} * R_1 \qquad G_2 = \frac{G_{L2}}{G_{L1}} * G_1 \qquad B_2 = \frac{B_{L2}}{B_{L1}} * B_1$$

Light color
(R_{L1}, G_{L1}, B_{L1})



Light color
(R_{L2}, G_{L2}, B_{L2})

Diagonal model assumes that all the (R,G,B) in the left image change by the ratio of the lights

$$R_2 = \frac{R_{L2}}{R_{L1}} * R_1 \qquad G_2 = \frac{G_{L2}}{G_{L1}} * G_1 \qquad B_2 = \frac{B_{L2}}{B_{L1}} * B_1$$

One way to understand the above equations

Estimates of the albedos for each channel

Diagonal Model for Color

- In matrix form

$$\begin{pmatrix} R_2 \\ G_2 \\ B_2 \end{pmatrix} = \begin{vmatrix} \frac{R_{L2}}{R_{L1}} & & \\ & \frac{G_{L2}}{G_{L1}} & \\ & & \frac{B_{L2}}{B_{L1}} \end{vmatrix} \begin{pmatrix} R_1 \\ G_1 \\ B_1 \end{pmatrix}$$

- Note that this says $\frac{R_2}{R_{L2}} = \frac{R_1}{R_{L1}}$ (etc, for G, B)

(albedo estimate for the channel)