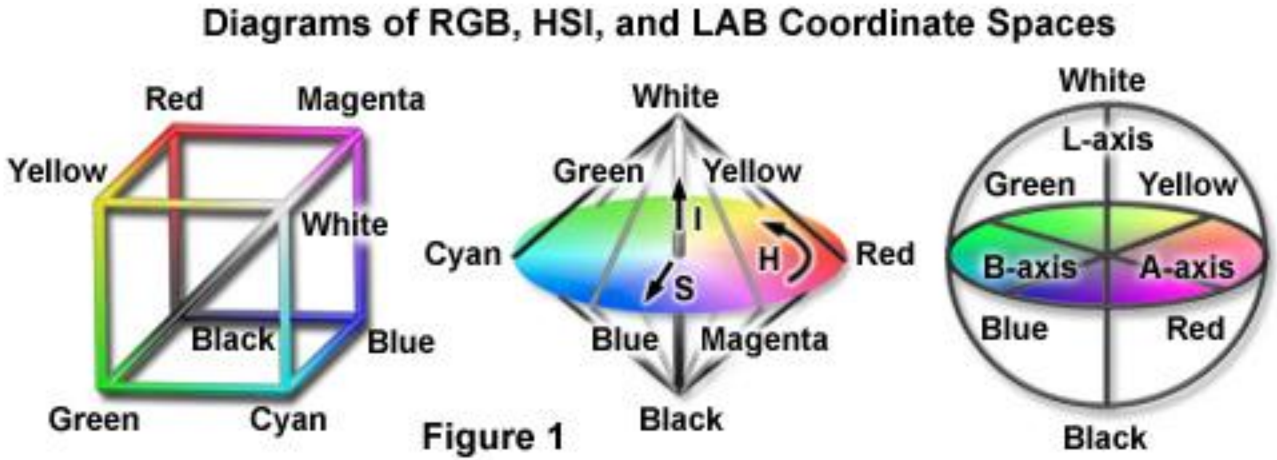
COLOR SPACES



CONTENT

1. Image Presentation

2. Color Spaces (YCbCr, RGB, HSV, Lab)

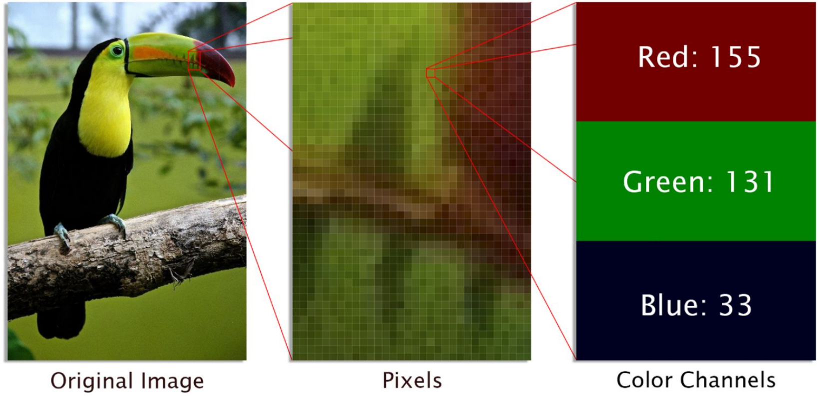
1. Image Presentation

Introduction

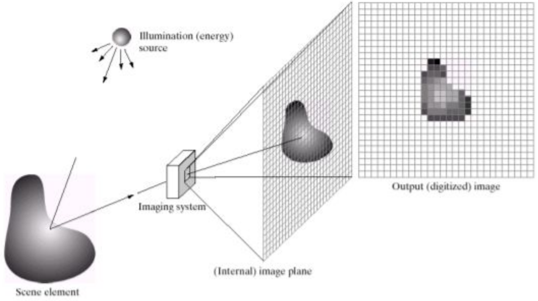
- An image is an array of numerical values called pixels.
- Images are generally organized in two dimensions with the array starting at the top-left where the index is 0 and flows from left-to-right and top-to-bottom.
- In a color image, each pixel represents a color made up of three distinct numerical values. These distinct numerical values represent the intensity of Red, Green and Blue light.
- The combination of these three intensity values gives each pixel its color

1. Image Presentation

Depict



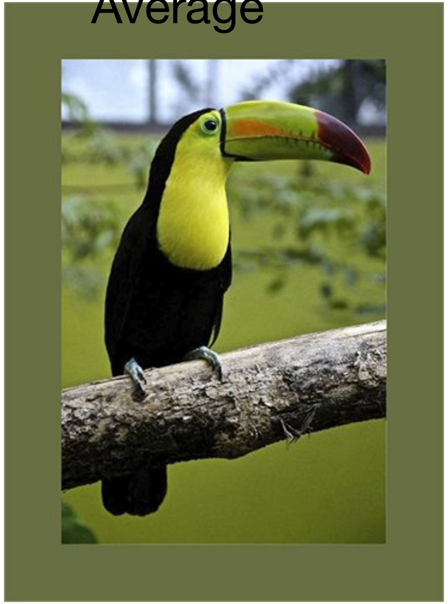
An image is a function of the space.



1. Image Presentation

Image Average

Depict



Lighten Image

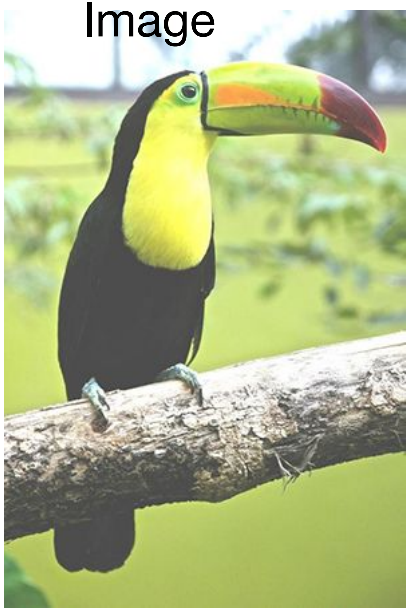
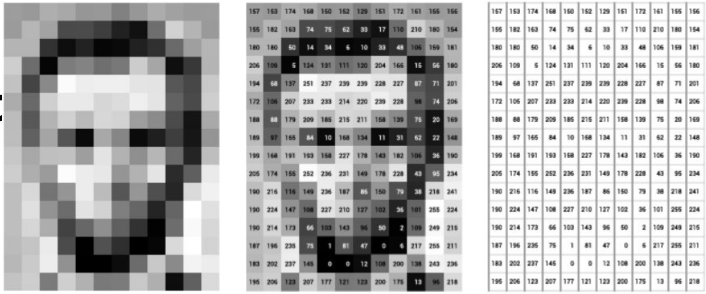


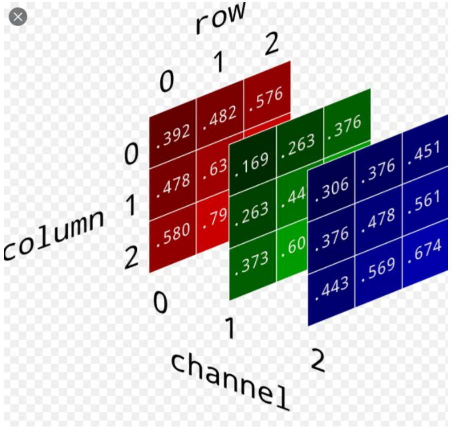
Image Negative

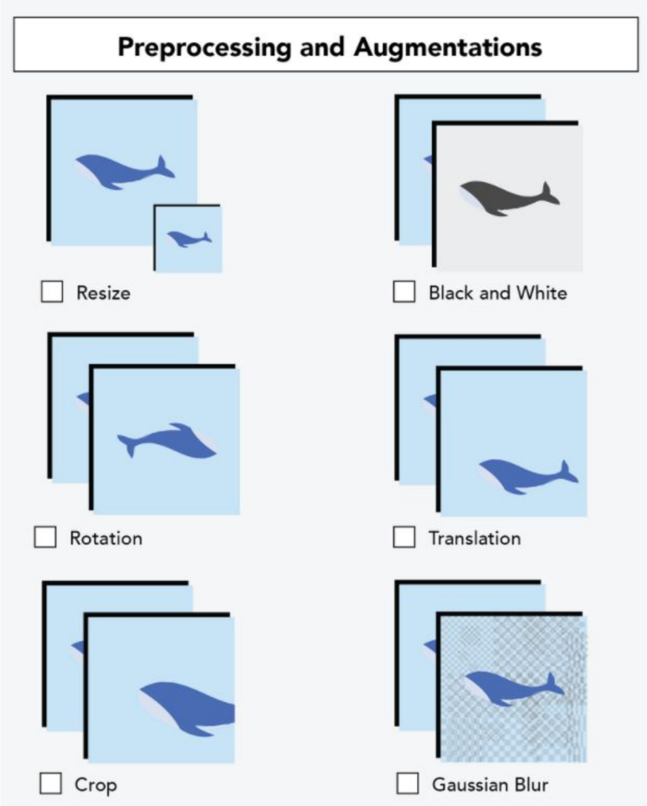
Converting Color to Grayscale

1. Image Presentation

Depict



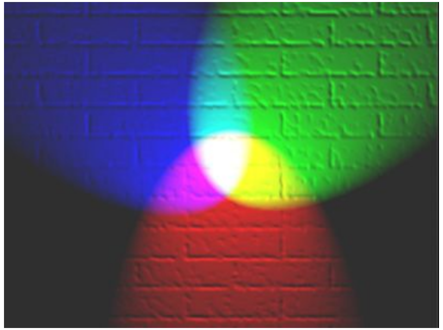


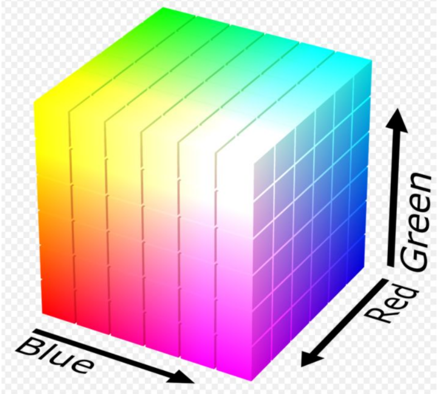


2. Color Spaces

Introduction

- The RGB color model is an additive color model in which red, green, and blue light are added together in various ways to reproduce a broad array of colors.
- The name of the model comes from the initials of the three additive primary colors, red, green, and blue.



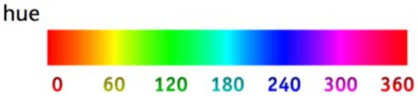


2. Color Spaces

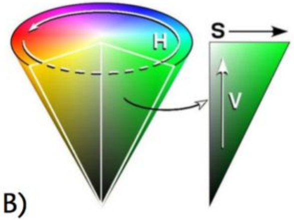
Hue
In HSV, hue represents color. In this model, hue is an angle from 0 degrees to 360 degrees.

Saturation
Saturation indicates the range of grey in the color space. It ranges from 0 to 100%. Sometimes the value is calculated from 0 to 1. When the value is ‘0,’ the color is grey and when the value is ‘1,’ the color is a primary color. A faded color is due to a lower saturation level, which means the color contains more grey.

Value
Value is the brightness of the color and varies with color saturation. It ranges from 0 to 100%. When the value is ‘0’ the color space will be totally black. With the increase in the value, the color space brightness up and shows various colors.



- colour cone
  - H = hue / colour in degrees $\in [0,360]$
  - S = saturation $\in [0,1]$
  - V = value $\in [0,1]$



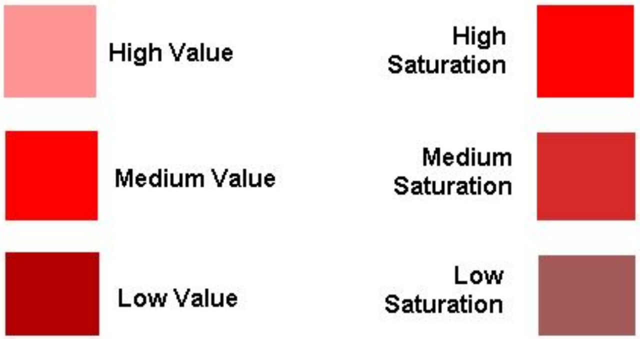
- conversion RGB → HSV
  - $V = \max = \max(R, G, B)$, $\quad \min = \min(R, G, B)$
  - $S = (\max - \min) / \max \quad$ (or $S = 0$, if $V = 0$)
  - $H = 60 \times \begin{cases} 0 + (G - B) / (\max - \min), & \text{if } \max = R \\ 2 + (B - R) / (\max - \min), & \text{if } \max = G \\ 4 + (R - G) / (\max - \min), & \text{if } \max = B \end{cases}$

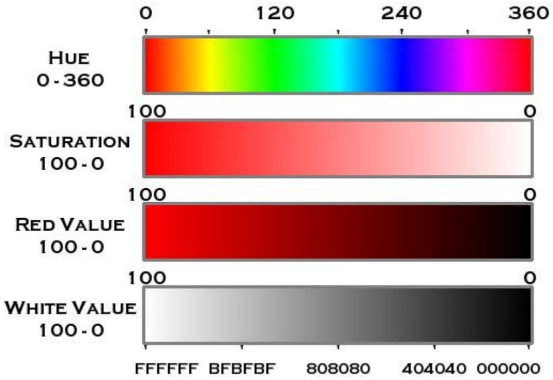
  $H = H + 360$, if $H < 0$

2. Color Spaces

Applications of HSV

- The HSV color space is widely used to generate high quality computer graphics. In simple terms, it is used to select various different colors needed for a particular picture.
- An HSV color wheel is used to select the desired color. A user can select the particular color needed for the picture from the color wheel. It gives the color according to human perception





2. Color Spaces

YCbCR

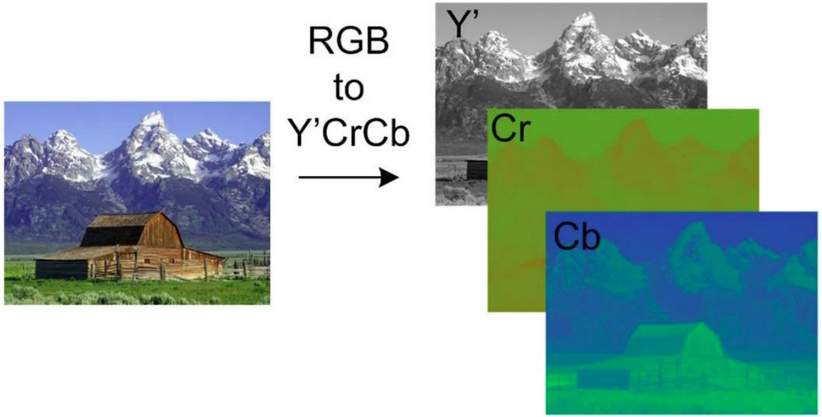
- Y — luminance, U or Cb — Chrominance-blue, V or Cr — Chrominance-red, which translates as "luminance — Blue color — Red color" (format for representing color video image data)
- The Y component shows the same picture, only in black(Brightness low) and white(Brightness high).
- Usually, according to the formula for calculating component Y, the image is converted to shades of gray and, the picture is clear, although in gray tones.
- Images of color components Cb and Cr carry the blue and red components of the image.

$$Y = 0.299\times \mathbf{R} + 0.587\times \mathbf{G} + 0.114\times \mathbf{B}$$

$$Cb = -0.1687\times \mathbf{R} - 0.3313\times \mathbf{G} + 0.5\times \mathbf{B} + 128$$

$$Cr = 0.5\times \mathbf{R} - 0.4187\times \mathbf{G} - 0.0813\times \mathbf{B} + 128$$

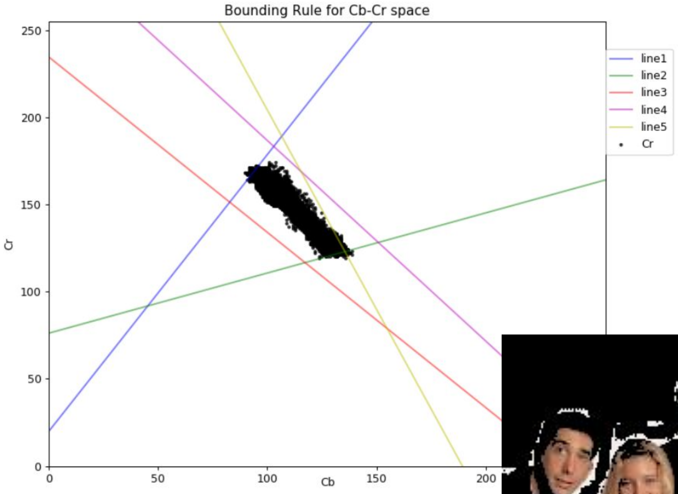
the range of each input (R, G, B) is the full 8-bit range of [0…255]



2. Color Spaces

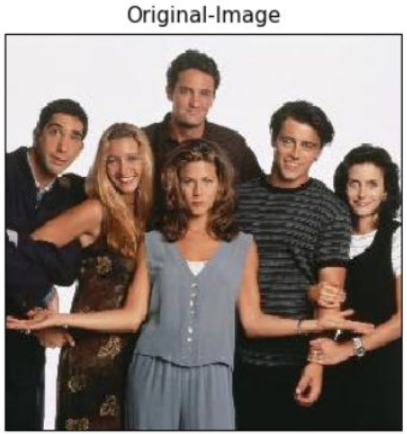
Skin thresholding Algorithm

$$
\begin{aligned}
Cr &\leq 1.5862 \times Cb + 20 \\
Cr &\geq 0.3448 \times Cb + 76.2069 \\
Cr &\geq -4.5652 \times Cb + 234.5652 \\
Cr &\leq -1.15 \times Cb + 301.75 \\
Cr &\leq -2.2857 \times Cb + 432.85
\end{aligned}
$$



2. Color Spaces

Skin thresholding Algorithm



- Uniform daylight illumination:(Rule1)

$R > 95 , G > 40 , B > 20,$

$(Max \{ R , G , B \} - min \{ R , G , B \})> 15,$

$|R - G| > 15 , R > G , R > B$

- Flashlight or daylight lateral illumination:(Rule2)

$R > 220 , G > 210 , B > 170,$

$|R - G| \leq 15 , B < R , B < G .$

we need a logical OR to combine both Rule1 and Rule2. The final rule is defined as follows: (‘U’ means ’OR’)

$RGB\_Rule = (Rule\_1) \; U \; (Rule\_2)$

2. Color Spaces

CIELAB

- The color of (coated) objects is visualized and quantified by using the CIELAB color space. The 3-dimensional color space is built-up from three axes that are perpendicular to one another.

- The L*-axis gives the lightness: a white object has an L* value of 100 and the L* value of a black object is 0. The so-called achromatic colors, the shades of grey, are on the L*-axis.

- Chromatic (‘real’) colors are described by using the two axes in the horizontal plane. The a*-axis is the green-red axis and the b*-axis goes from blue (-b*) to yellow (+b*).

- Each color is represented by a color point (L*, a*, b*) in the color space; L*, a* and b* are the color coordinates of the color point.

- The asterisk (*) symbol of L*, a* and b* indicates that this is the new color system; it is the follow-up of the older CIELAB system. The new system is now universally used for the quantification of colors, even though often the simplified notation of the Lab-values, without the * symbol, is used.

LAB Color Space