No.1

Seminar I on Agricultural Process Engineering
農産加工学演習　I

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農学研究科　地域環境科学専攻

近藤　直・清水　浩

Seminar I on Agricultural Process Engineering

(Machine vision systems and image processing for bioproduction)

Lectures on optical instrumentation for agricultural products and practices using an image processing software are performed. Classes are held all in English.

Keywords:

Nature, Plant, Animal, Fish, Agriculture, Engineering

Measurement, Light, Color, Texture

Image, Vision, Robot, Sensor

Objective of this class

Because Images contain many kinds of information, imaging technologies have been widely distributed and are common techniques. Image processing can be applied to various uncertain shape biological objects such as plants, animals and soil, and be a useful technique in our research fields (in our own research projects).

We learn English technical terms and a presentation ability on machine vision and image processing so that we can discuss on our own projects with oversea researchers.

Our goal

1. To learn technical terms on machine vision, image processing, and instrumentation regarding biological objects and nature.

2. To understand physical properties of biological objects and rules in natural lives.

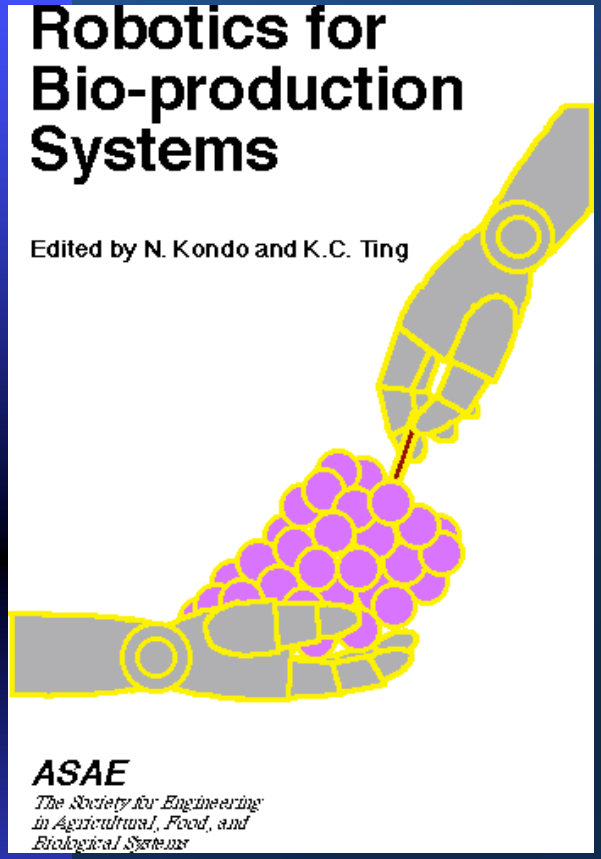
3. To learn structure of images, machine vision, and instrumentation systems.

4. To nourish the ability to apply imaging technologies to your own research project in case of measurement of biological objects and nature in it.

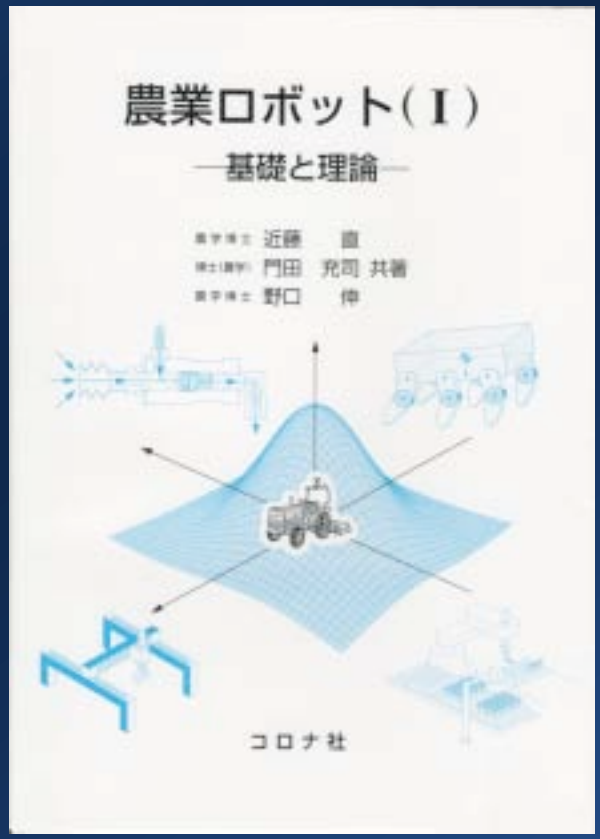
Schedule of this class

1. What is color?
2. Illumination
3. Lighting method
4. Camera
5. Spectral reflectance of biological objects
6. Applications as robotic eyes
7. Practice - Color analysis -
8. Practice - Size measurement and shape analysis –
9. Practice - Defect detection –
10.

Reference books



Published from ASAE., 1998
Edited by Naoshi Kondo and K.C. Ting
ISBN: 0-929355-94-6



（株）コロナ社
「農業ロボット(I)－基礎と理論－」
（近藤　直他編）

Method of Grading

Assignments, and report of practices are evaluated.

Office hour:

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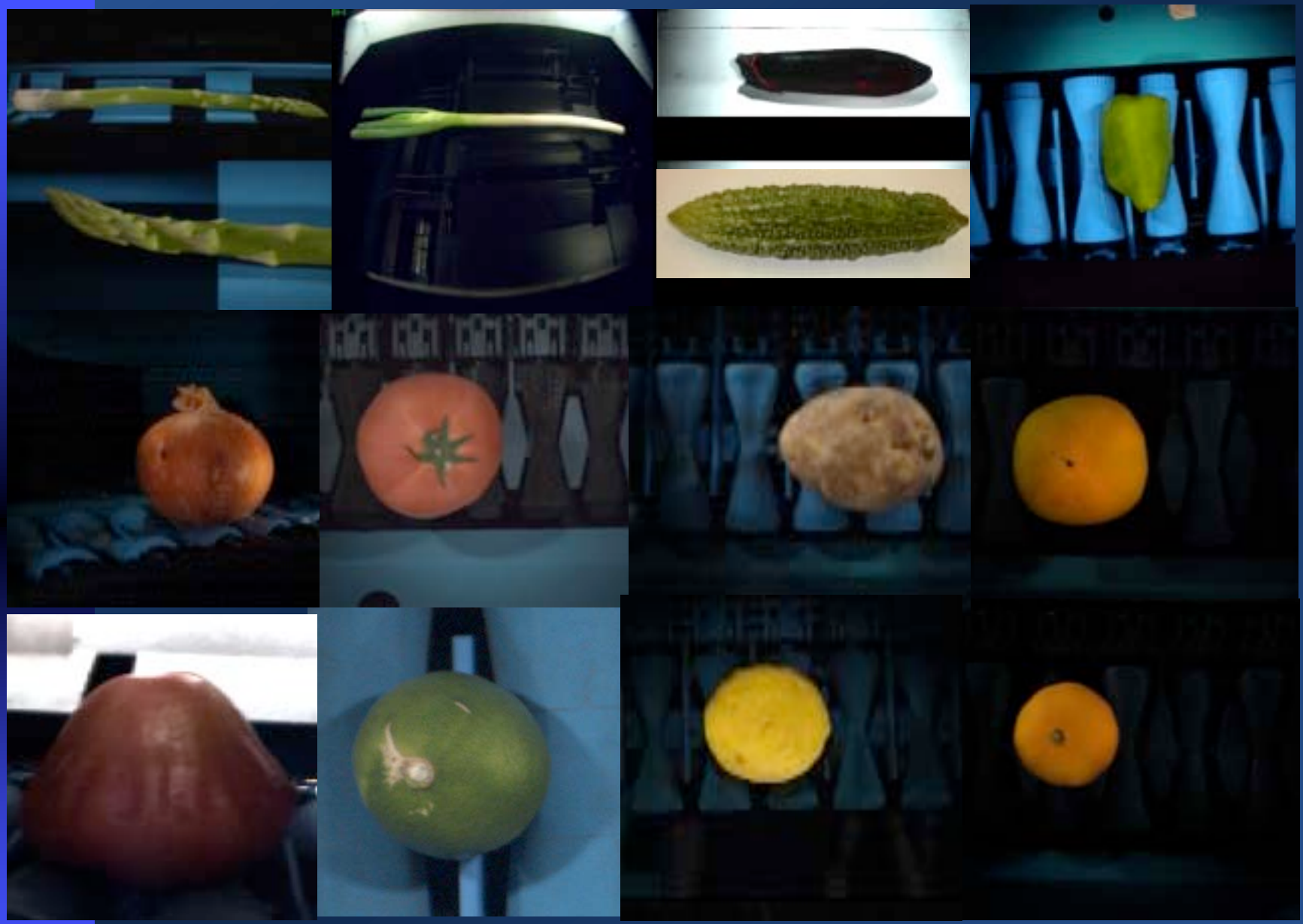
First Assignment

Write your curious phenomenon in nature or in living lives.

Or

Write what you want to learn on imaging technology and on instrumentation for nature and living lives.

Do not forget your grade, student number, and name.



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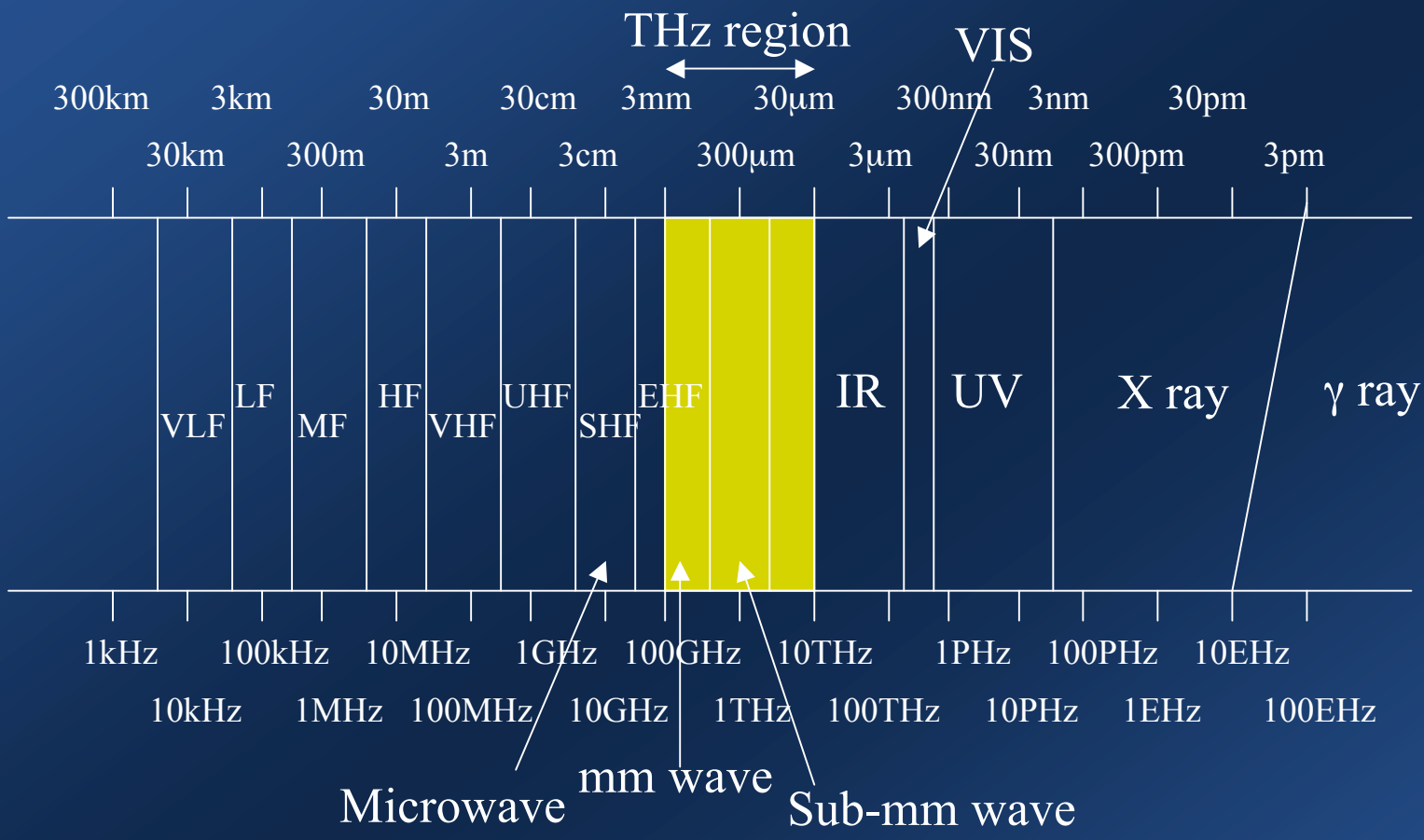
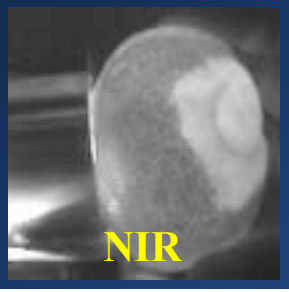
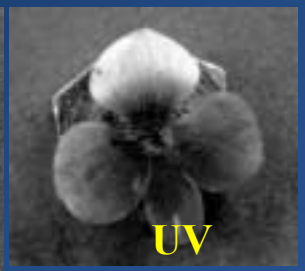
Various fruits and vegetables colors

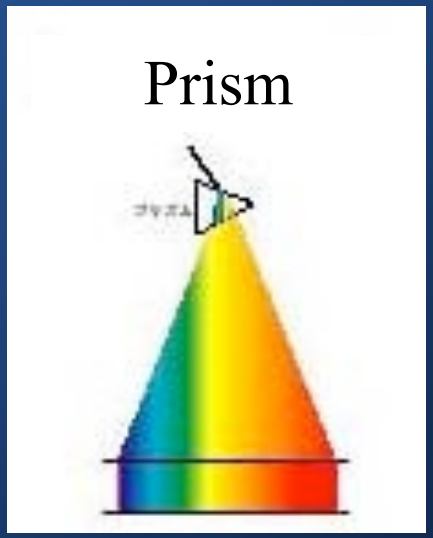
KYOTO 京都大学 UNIVERSITY

Frequency map for electromagnetic waves









What is color?

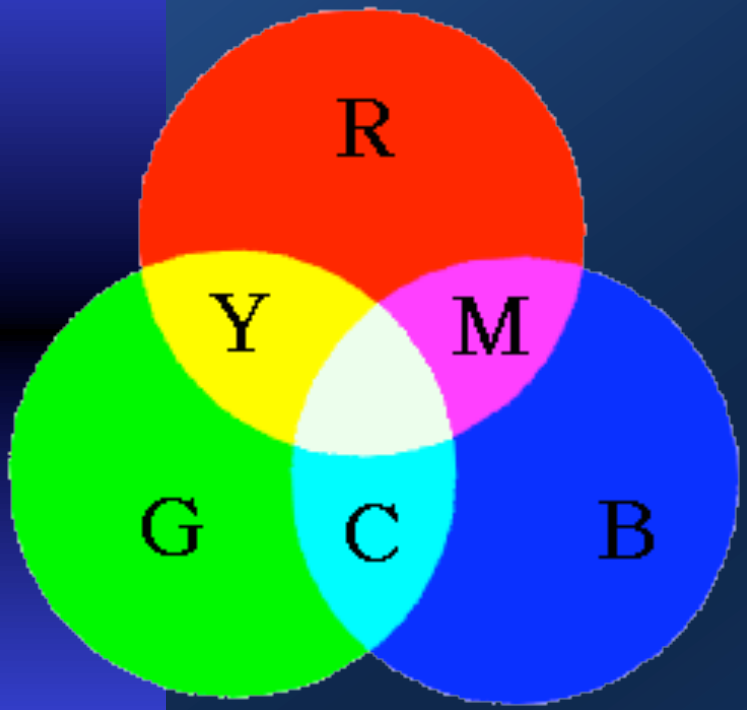
UV Violet Blue BG Green YG Yellow Orange Red IR
紫外 青紫 青 青緑 緑 黄緑 黄 橙 赤 赤外

400 470 485 500 550 575 590 600 610 630 700
Wavelength波長 (nm)

Purple

495c 530c 570c

Three primary colors



Complementary colors

R-C
G-M
B-Y

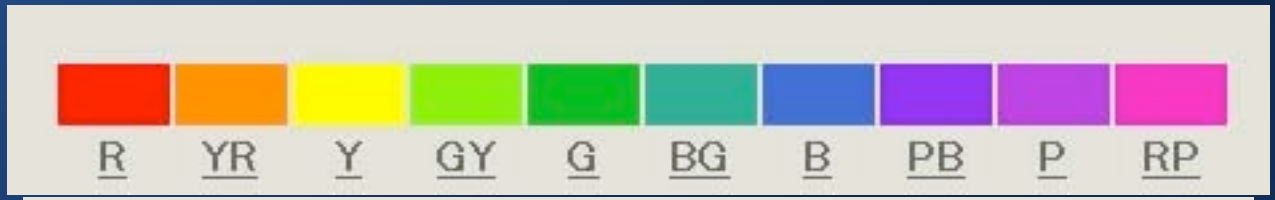
Color Coordinate systems

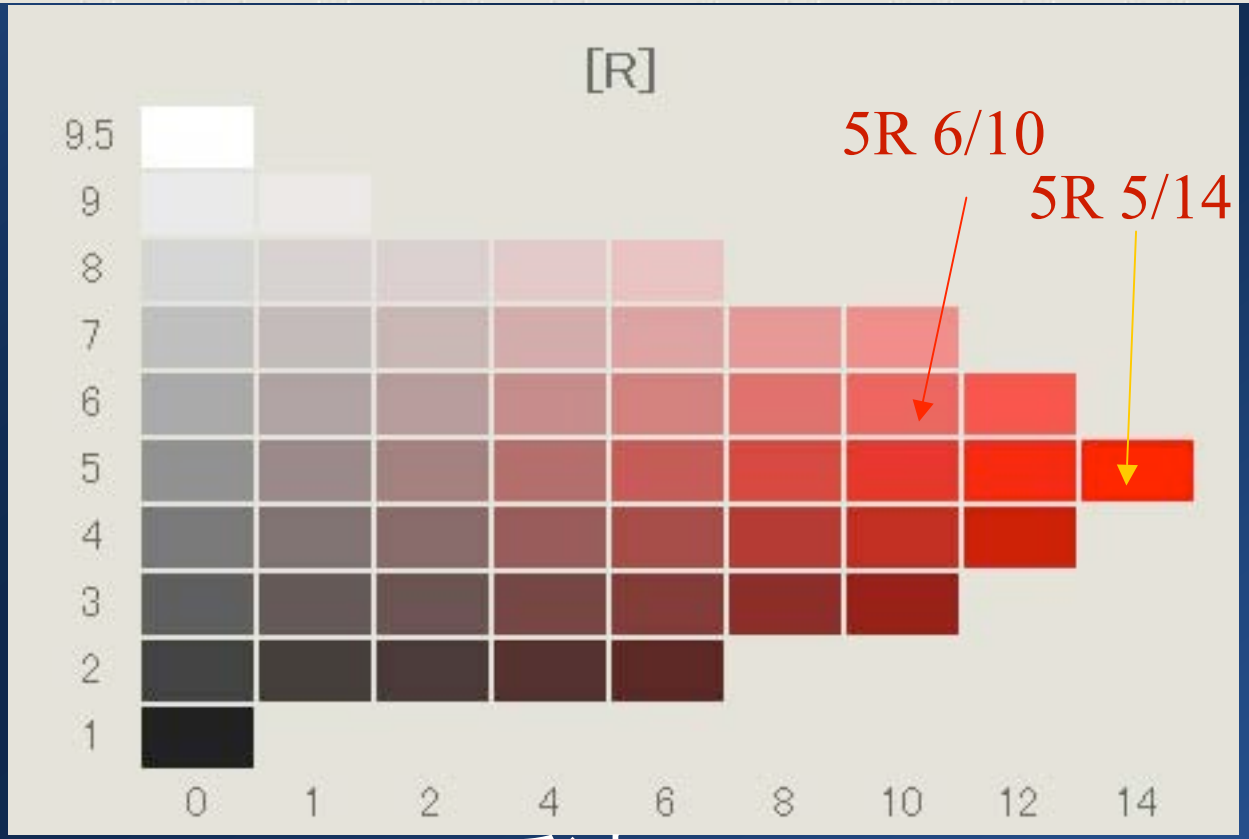
1. Munsell Renotation
2. Chromaticity (XYZ color coordinate system
   : R, G, B ratios)
3. L*a*b*
4. HSI (Hue, Saturation, and Intensity)

Munsell Renotation

By Albert H. Munsell

(Hue)色相

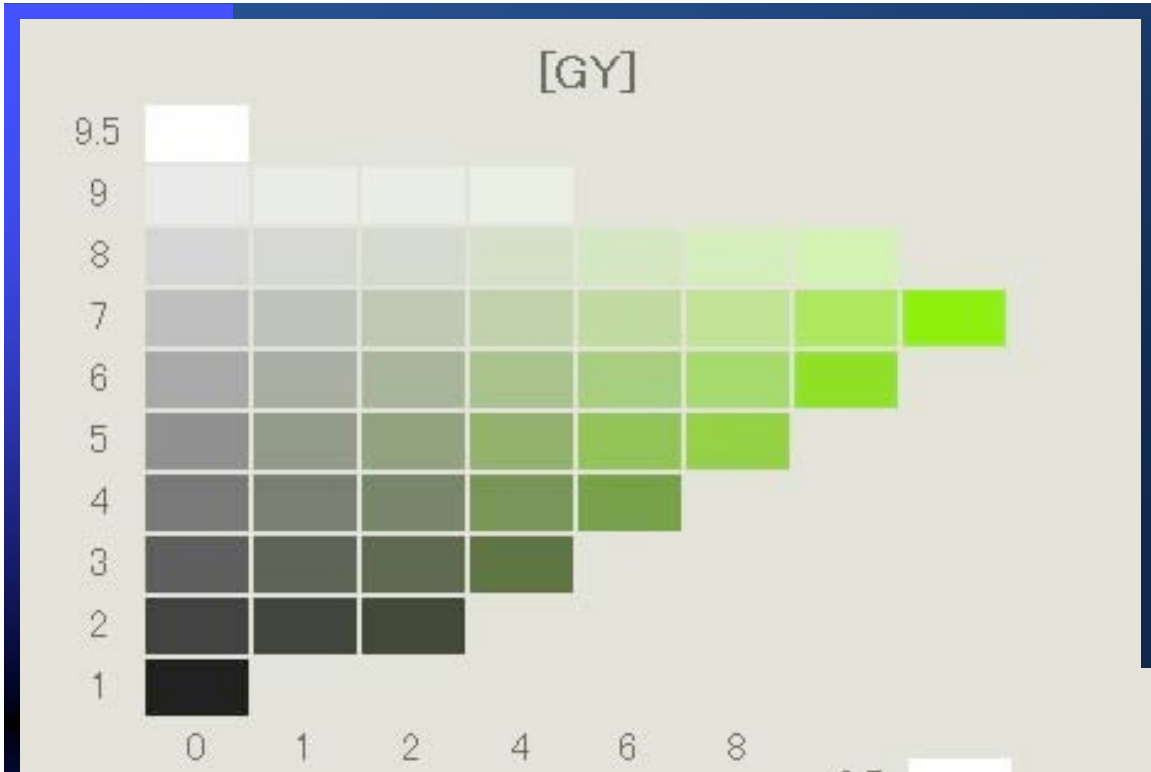




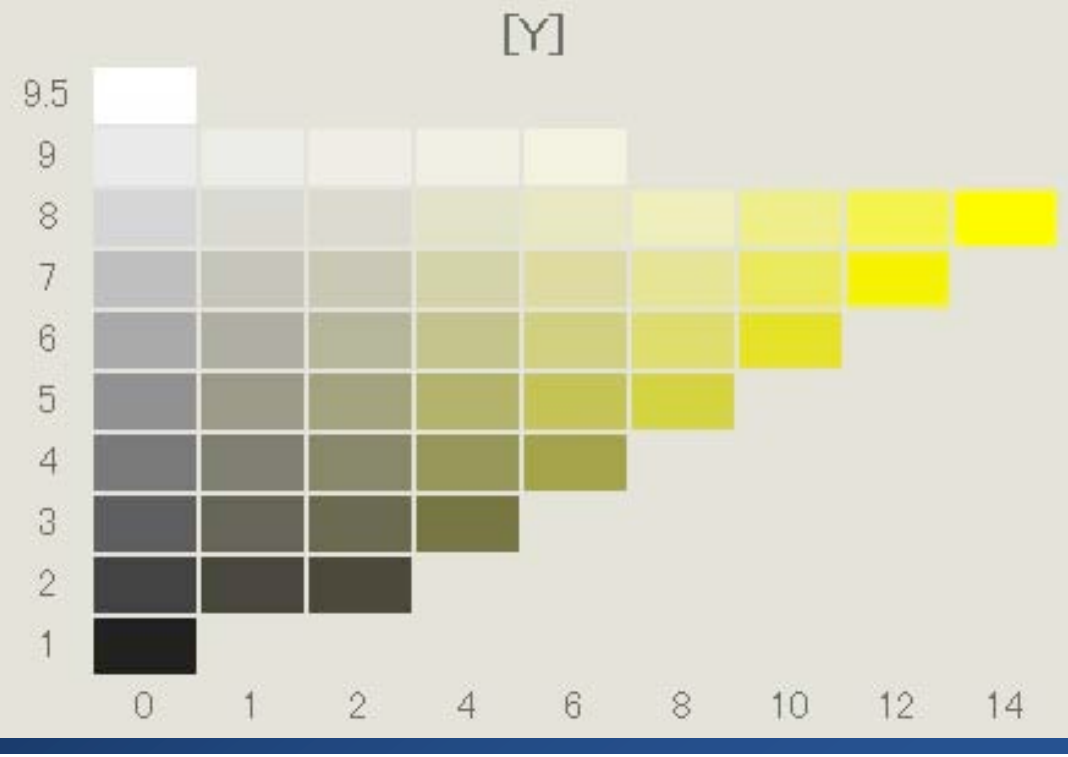
(Intensity)
明度

Perfect Black:0
Perfect White: 10

彩度 (Saturation)



Munsell Color solid



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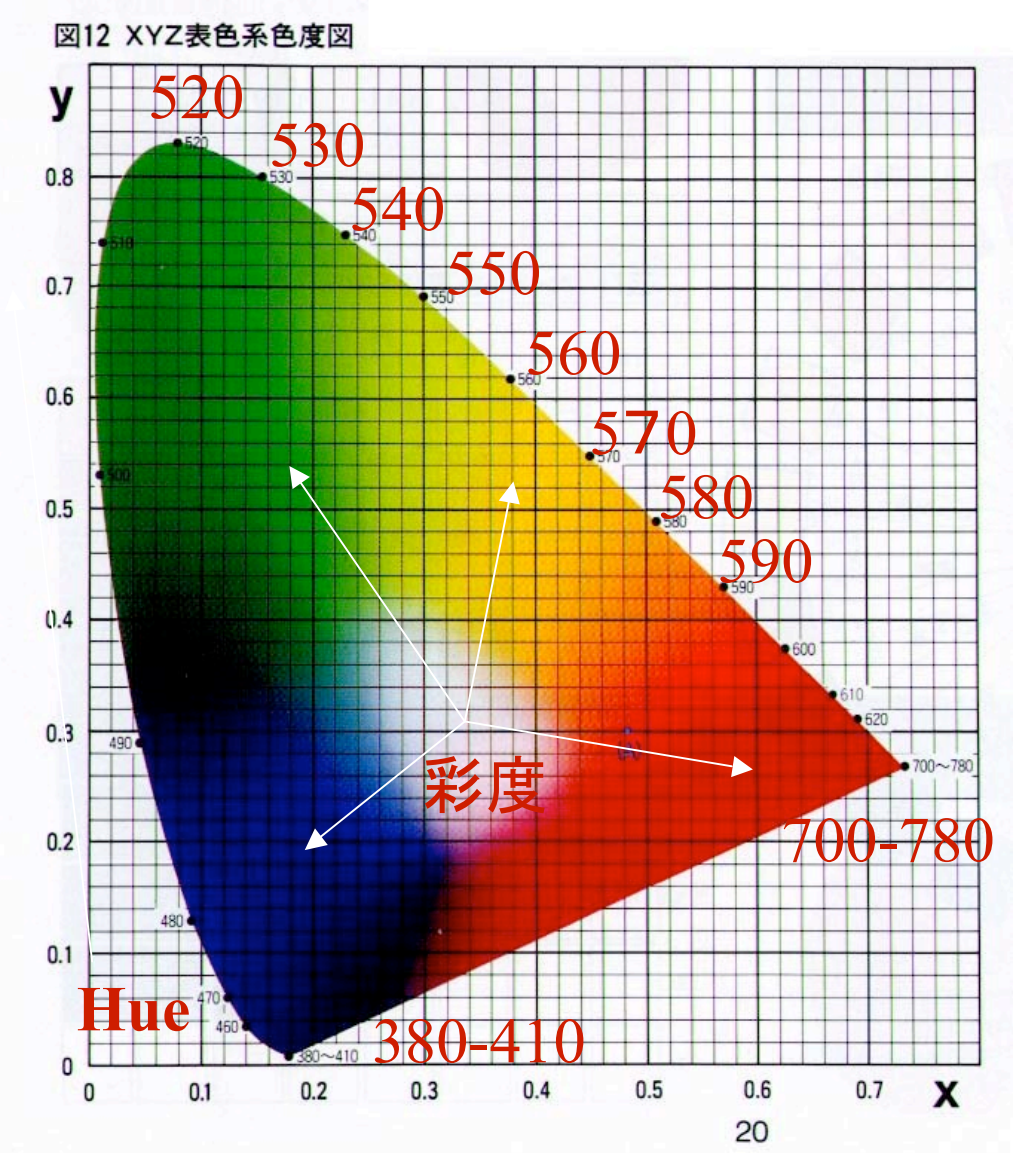


Chromaticity

$x = X / (X+Y+Z)$

$y = Y / (X+Y+Z)$

$z = Z / (X+Y+Z) = 1-x-y$

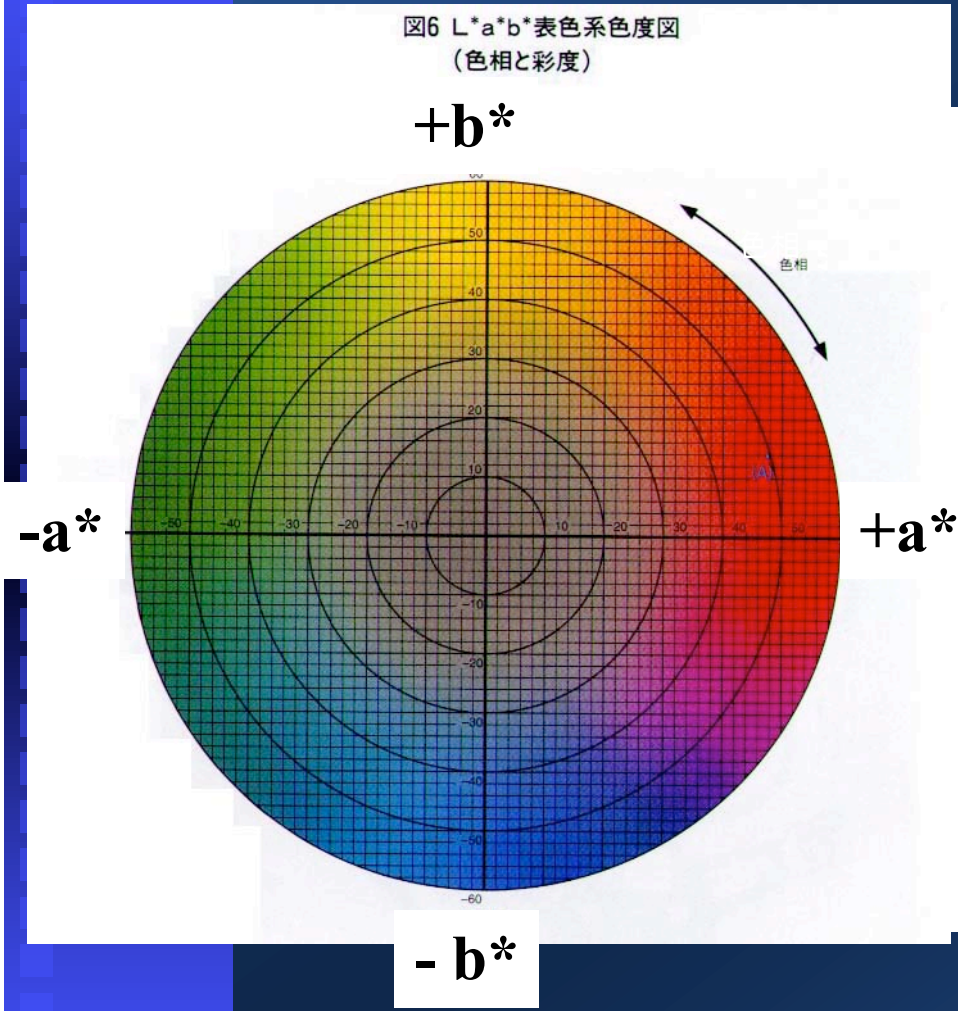
$X = 2.7690R+1.7517G+1.1301B$

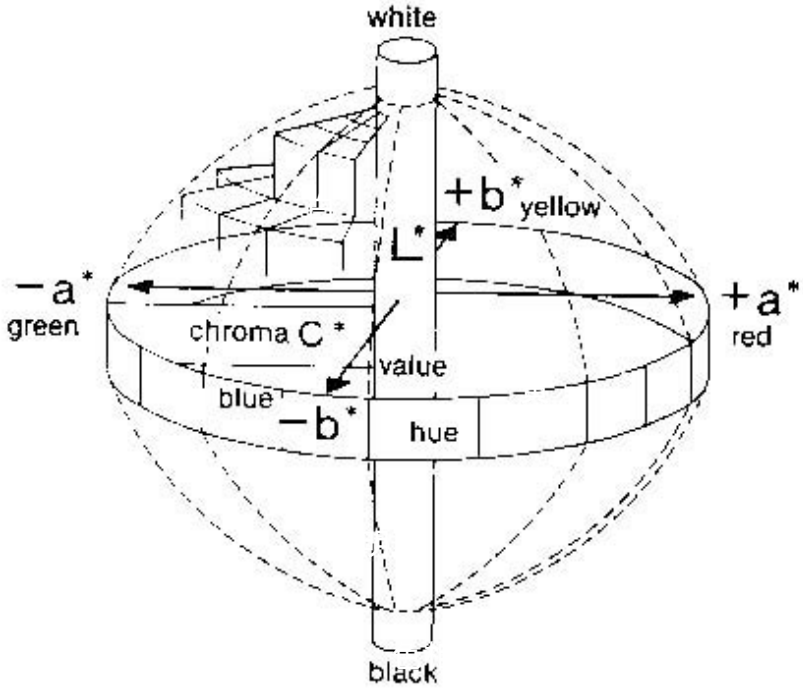
$Y = 1.0000R+4.5907G+0.0601B$

$Z = 0.0000R+0.0565G+5.5943B$

Y: Luminance

L*a*b* Color Coordinate System





L*a*b* Color solid

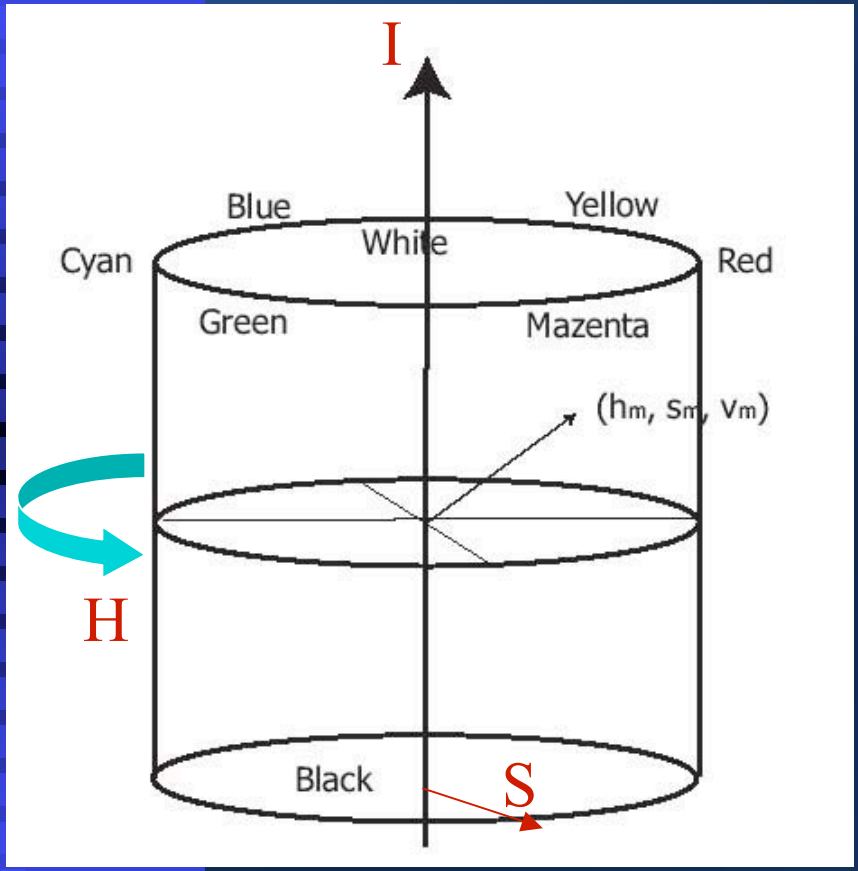
Transformation from XYZ to L*a*b*

$$L^* = 116(Y/Y_n)^{1/3} - 16$$
$$a^* = 500[(X/X_n)^{1/3} - (Y/Y_n)^{1/3}]$$
$$b^* = 200[(Y/Y_n)^{1/3} - (Z/Z_n)^{1/3}]$$

X, Y, Z: Tristimulous values on XYZ

$X_n = 0.95045$, $Y_n = 1.0$, $Z_n = 1.08892$

HSI (Cylindrical model)



$$[M_1\ M_2\ I_1] = [R_T\ G_T\ B_T] \begin{vmatrix} 2/\sqrt{6} & 0 & 1/\sqrt{3} \\ -1/\sqrt{6} & 1/\sqrt{2} & 1/\sqrt{3} \\ -1/\sqrt{6} & -1/\sqrt{2} & 1/\sqrt{3} \end{vmatrix}$$

$$M_1 = (2/\sqrt{6})R_T - (1/\sqrt{6})G_T - (1/\sqrt{6})B_T$$

$$M_2 = (1/\sqrt{2})G_T - (1/\sqrt{2})B_T$$

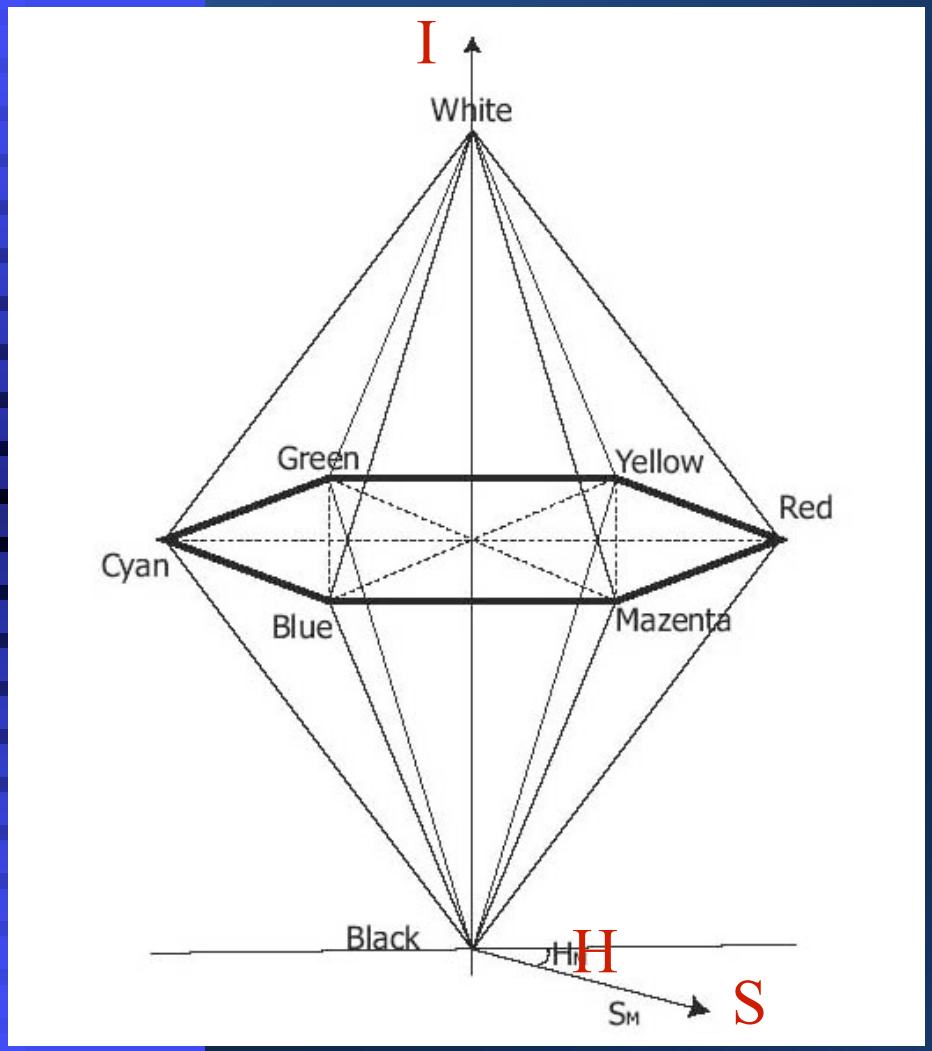
$$I_1 = (1/\sqrt{3})R_T + (1/\sqrt{3})G_T + (1/\sqrt{3})B_T$$

$$H = \arctan(M_1/M_2)$$

$$S = (M_1^2 + M_2^2)^{1/2}$$

$$I = \sqrt{3}\, I_1$$

HSI (Six-sided pyramid model)



Intensity

$I=(I_{max}+I_{min})/2$

$I_{max}=\max\{R_T,G_T,B_T\}$

$I_{min}=\min\{R_T,G_T,B_T\}$

Saturation

$S=(I_{max}-I_{min})/(I_{max}+I_{min})$ $(I<=0.5)$

$S=(I_{max}-I_{min})/(2-I_{max}-I_{min})$ $(I>0.5)$

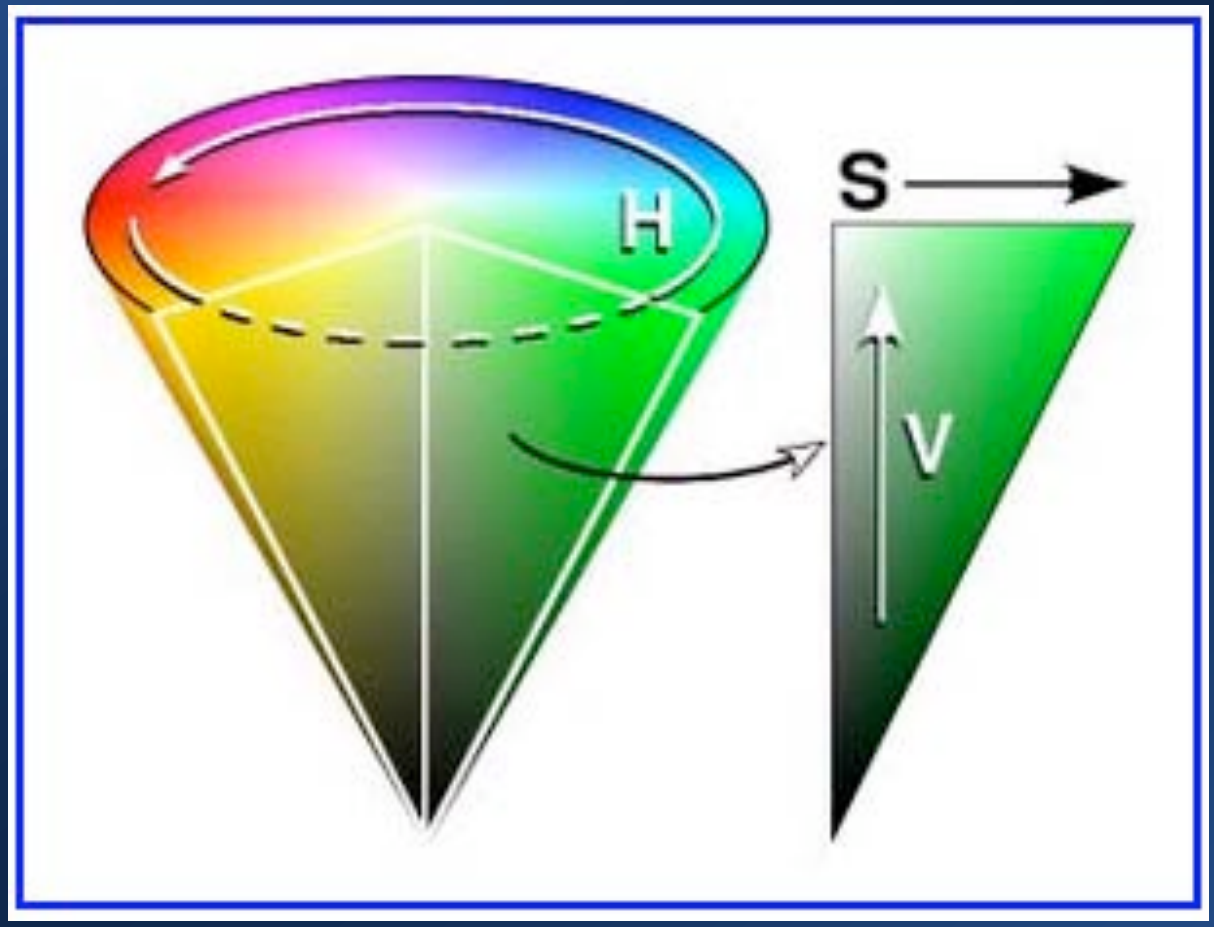
Hue

$H=\pi(b-g)/3$ $(I_{max}=R_T)$

$H=\pi(2+r-b)/3$ $(I_{max}=G_T)$

$H=\pi(4+g-r)/3$ $(I_{max}=B_T)$

HSV (Circular conic model)



HSL(Lightness), HSV(Value)

Second assignment

Describe the methods of color coordinate systems you learned.