

Image sensor 测试测量及相关标准

课程介绍

Sensor Physics 相关指标与测量——Color Accuracy

Wang Pengfei

2019 April

本课主题：

- 1.Color basics
 - CIELAB色空间
 - RGB色空间
- 2. Color Accuracy计算
 - SMIA Color Accuracy 计算过程
- 3.Demo: Color Accuracy

1. Color Basics-1

*预备知识

色彩学基础，CIE标准色度体系：CIEXYZ，CIELAB，色差公式等

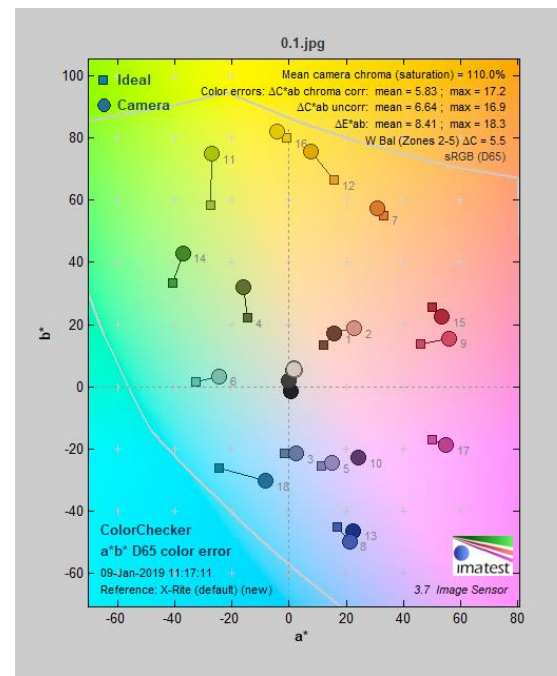
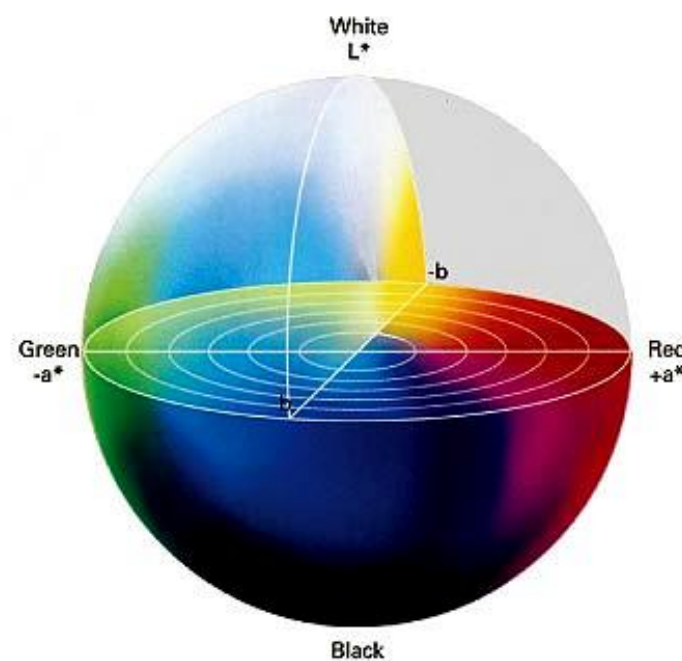
- CIE1976L*a*b*色空间

- L*, a*, b*三个量定义一个颜色

$$L^* = 116(Y/Y_n)^{1/3} - 16$$

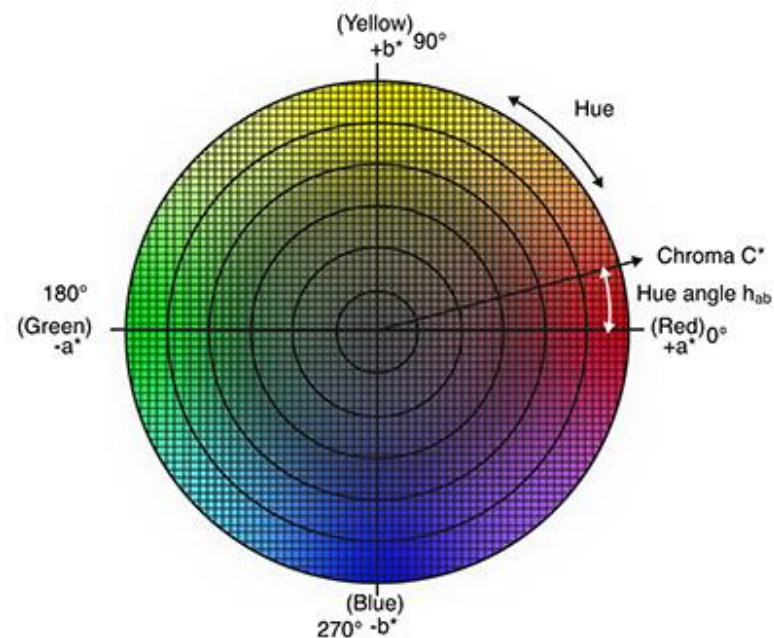
$$a^* = 500 \left[(X/X_n)^{1/3} - (Y/Y_n)^{1/3} \right]$$

$$b^* = 200 \left[(Y/Y_n)^{1/3} - (Z/Z_n)^{1/3} \right]$$



1. Color Basics-2

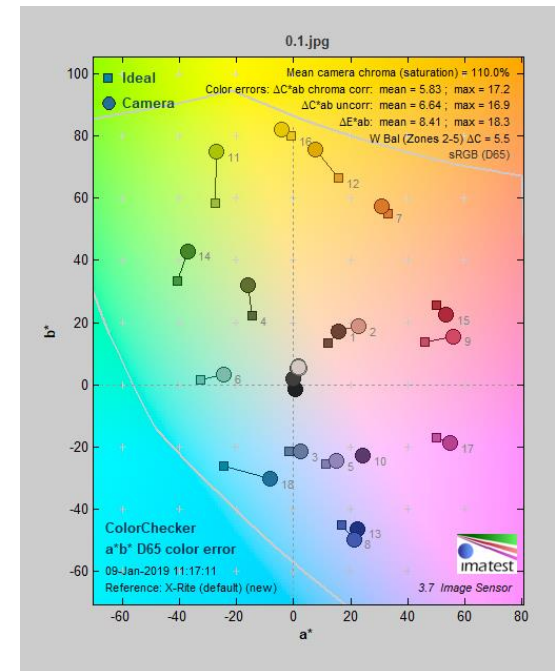
- 颜色三属性：明度、色调角、彩度
 - 明度, illuminant
 - 色调角, Hue angle, 0~360°
 - 彩度, Saturation



$$L^* = 116(Y/Y_n)^{1/3} - 16$$

$$h = \frac{180}{\pi} \operatorname{tg}^{-1} \frac{b^*}{a^*}$$

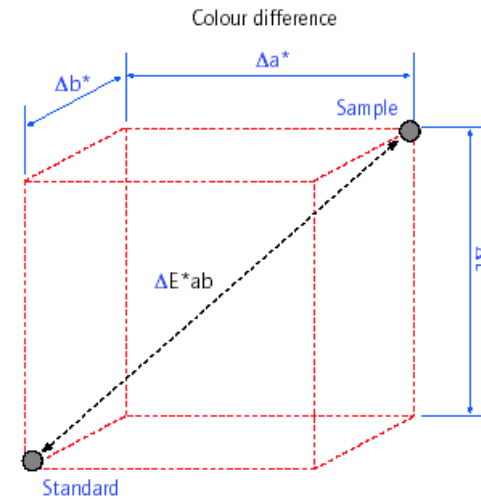
$$C^* = \sqrt{(a^*)^2 + (b^*)^2}$$



1. Color Basics-3

- 色差
 - 两个颜色样本的在CIELAB色空间的欧式距离

$$\begin{aligned}\Delta E_{ab}^* &= \sqrt{(L_1^* - L_2^*)^2 + (a_1^* - a_2^*)^2 + (b_1^* - b_2^*)^2} \\ &= \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2}\end{aligned}$$



1. Color Basics-4

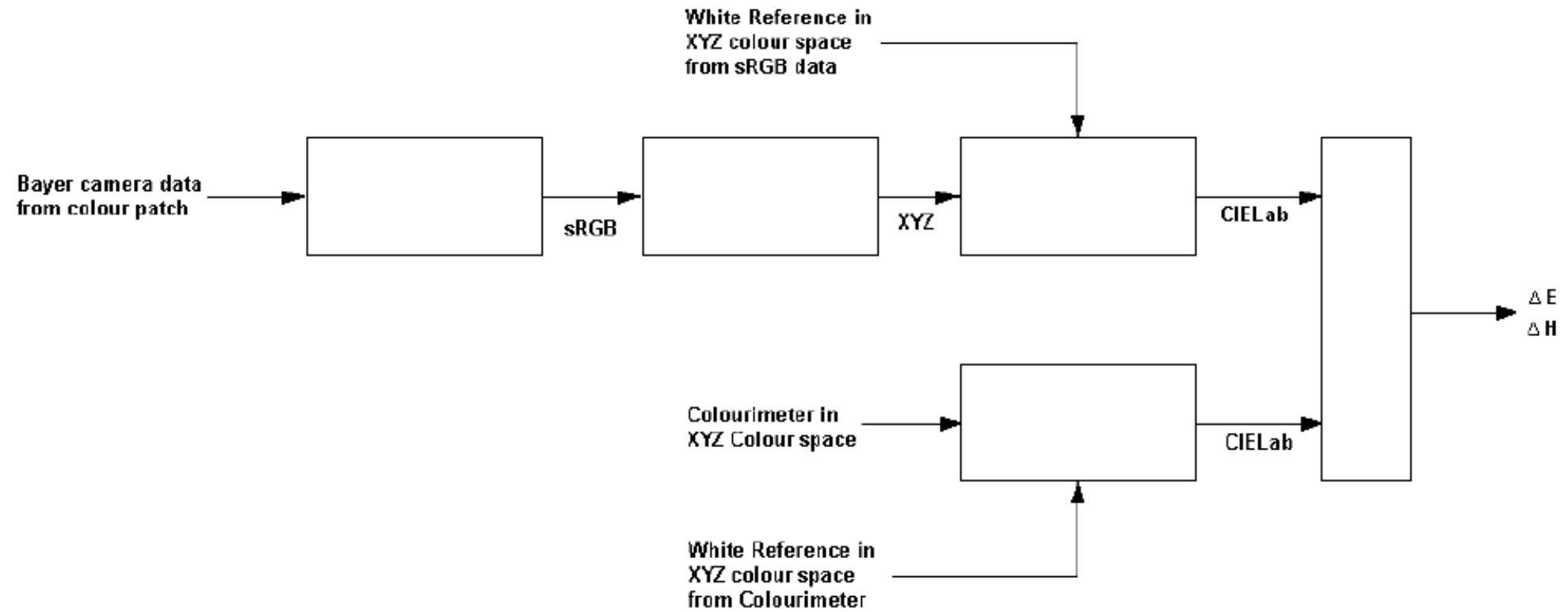
- RGB色空间

- 常见RGB色空间: sRGB, Adobe RGB, Apple RGB, DCI-P3, Display-P3
- RGB色空间重要参数: 参考白点, Gamma, 三原色坐标, 到色度空间变换关系

Name	Gamma	Reference White	Red Primary			Green Primary			Blue Primary		
			x	y	Y	x	y	Y	x	y	Y
Lab Gamut	-	D50	-	-	-	-	-	-	-	-	-
Adobe RGB (1998)	2.2	D65	0.6400	0.3300	0.297361	0.2100	0.7100	0.627355	0.1500	0.0600	0.075285
Apple RGB	1.8	D65	0.6250	0.3400	0.244634	0.2800	0.5950	0.672034	0.1550	0.0700	0.083332
Best RGB	2.2	D50	0.7347	0.2653	0.228457	0.2150	0.7750	0.737352	0.1300	0.0350	0.034191
Beta RGB	2.2	D50	0.6888	0.3112	0.303273	0.1986	0.7551	0.663786	0.1265	0.0352	0.032941
Bruce RGB	2.2	D65	0.6400	0.3300	0.240995	0.2800	0.6500	0.683554	0.1500	0.0600	0.075452
CIE RGB	2.2	E	0.7350	0.2650	0.176204	0.2740	0.7170	0.812985	0.1670	0.0090	0.010811
ColorMatch RGB	1.8	D50	0.6300	0.3400	0.274884	0.2950	0.6050	0.658132	0.1500	0.0750	0.066985
Don RGB 4	2.2	D50	0.6960	0.3000	0.278350	0.2150	0.7650	0.687970	0.1300	0.0350	0.033680
ECI RGB v2	L*	D50	0.6700	0.3300	0.320250	0.2100	0.7100	0.602071	0.1400	0.0800	0.077679
Ekta Space PS5	2.2	D50	0.6950	0.3050	0.260629	0.2600	0.7000	0.734946	0.1100	0.0050	0.004425
NTSC RGB	2.2	C	0.6700	0.3300	0.298839	0.2100	0.7100	0.586811	0.1400	0.0800	0.114350
PAL/SECAM RGB	2.2	D65	0.6400	0.3300	0.222021	0.2900	0.6000	0.706645	0.1500	0.0600	0.071334
ProPhoto RGB	1.8	D50	0.7347	0.2653	0.288040	0.1596	0.8404	0.711874	0.0366	0.0001	0.000086
SMPTE-C RGB	2.2	D65	0.6300	0.3400	0.212395	0.3100	0.5950	0.701049	0.1550	0.0700	0.086556
sRGB	≈2.2	D65	0.6400	0.3300	0.212656	0.3000	0.6000	0.715158	0.1500	0.0600	0.072186
Wide Gamut RGB	2.2	D50	0.7350	0.2650	0.258187	0.1150	0.8260	0.724938	0.1570	0.0180	0.016875

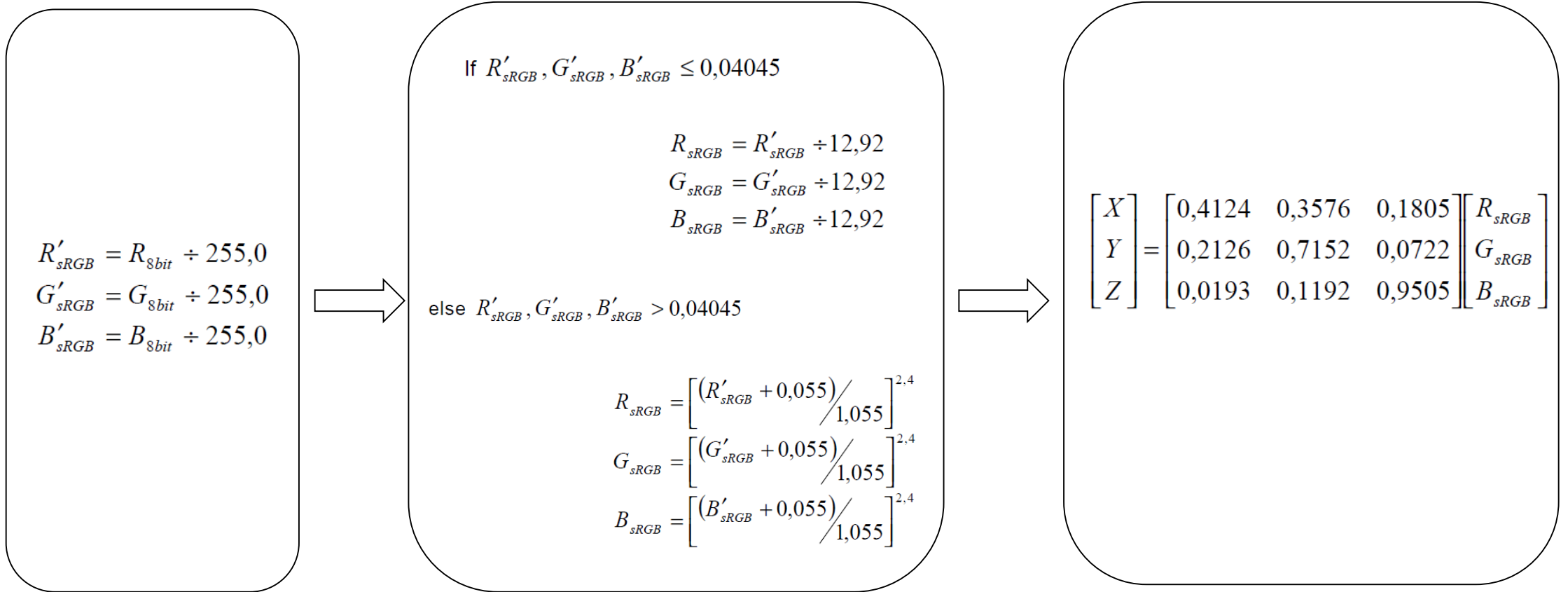
2. Color Accuracy-1

- SMIA Color Accuracy Process



2.Color Accuracy-2

RGB to CIEXYZ conversion



3.Demo: Color Accuracy

RAW Settings:

width	<input type="text" value="1920"/>	height	<input type="text" value="1080"/>
bit depth	<input type="text" value="16"/>	black level(16 bit)	<input type="text" value="240"/>
byte order	<input type="text" value="ieee-le"/>	bayern pattern	<input type="text" value="RGGB"/>

Color Settings:

ref data	<input type="text" value="Xrite published (default)"/>	color space	<input type="text" value="sRGB"/>
color difference option	<input type="text" value="CIE 1976"/>		

谢谢