Color conversions

See **cv::cvtColor** and **cv::ColorConversionCodes**

Todo:
document other conversion modes

RGB ↔ GRAY

Transformations within RGB space like adding/removing the alpha channel, reversing the channel order, conversion to/from 16-bit RGB color (R5:G6:B5 or R5:G5:B5), as well as conversion to/from grayscale using:

$$\text{RGB[A] to Gray:} \quad Y \leftarrow 0.299 \cdot R + 0.587 \cdot G + 0.114 \cdot B$$

and

$$\text{Gray to RGB[A]:} \quad R \leftarrow Y, G \leftarrow Y, B \leftarrow Y, A \leftarrow \max(ChannelRange)$$

The conversion from a RGB image to gray is done with:

```
cvtColor(src, bwsrc, cv::COLOR_RGB2GRAY);
```

More advanced channel reordering can also be done with **cv::mixChannels**.

See also
cv::COLOR_BGR2GRAY, **cv::COLOR_RGB2GRAY**, **cv::COLOR_GRAY2BGR**, **cv::COLOR_GRAY2RGB**

RGB ↔ CIE XYZ.Rec 709 with D65 white point

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} \leftarrow \begin{bmatrix} 0.412453 & 0.357580 & 0.180423 \\ 0.212671 & 0.715160 & 0.072169 \\ 0.019334 & 0.119193 & 0.950227 \end{bmatrix} \cdot \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} \leftarrow \begin{bmatrix} 3.240479 & -1.53715 & -0.498535 \\ -0.969256 & 1.875991 & 0.041556 \\ 0.055648 & -0.204043 & 1.057311 \end{bmatrix} \cdot \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}$$

X, Y and Z cover the whole value range (in case of floating-point images, Z may exceed 1).

See also
cv::COLOR_BGR2XYZ, **cv::COLOR_RGB2XYZ**, **cv::COLOR_XYZ2BGR**, **cv::COLOR_XYZ2RGB**

RGB ↔ YCrCb JPEG (or YCC)

$$Y \leftarrow 0.299 \cdot R + 0.587 \cdot G + 0.114 \cdot B$$

$$Cr \leftarrow (R - Y) \cdot 0.713 + delta$$

$$Cb \leftarrow (B - Y) \cdot 0.564 + delta$$

$$R \leftarrow Y + 1.403 \cdot (Cr - delta)$$

$$G \leftarrow Y - 0.714 \cdot (Cr - delta) - 0.344 \cdot (Cb - delta)$$

$$B \leftarrow Y + 1.773 \cdot (Cb - delta)$$

where

$$delta = \begin{cases} 128 & \text{for 8-bit images} \\ 32768 & \text{for 16-bit images} \\ 0.5 & \text{for floating-point images} \end{cases}$$

Y, Cr, and Cb cover the whole value range.

See also
cv::COLOR_BGR2YCrCb, **cv::COLOR_RGB2YCrCb**, **cv::COLOR_YCrCb2BGR**, **cv::COLOR_YCrCb2RGB**

RGB ↔ HSV

In case of 8-bit and 16-bit images, R, G, and B are converted to the floating-point format and scaled to fit the 0 to 1 range.

$$V \leftarrow max(R,G,B)$$

$$S \leftarrow \begin{cases} \frac{V - min(R,G,B)}{V} & \text{if } V \neq 0 \\ 0 & \text{otherwise} \end{cases}$$

$$H \leftarrow \begin{cases} 60(G-B)/(V-min(R,G,B)) & \text{if } V = R \\ 120 + 60(B-R)/(V-min(R,G,B)) & \text{if } V = G \\ 240 + 60(R-G)/(V-min(R,G,B)) & \text{if } V = B \end{cases}$$

If $H < 0$ then $H \leftarrow H + 360$. On output $0 \leq V \leq 1, 0 \leq S \leq 1, 0 \leq H \leq 360$.

The values are then converted to the destination data type:

- 8-bit images: $V \leftarrow 255V, S \leftarrow 255S, H \leftarrow H/2 (\text{to fit to 0 to 255})$
- 16-bit images: (currently not supported) $V < -65535V, S < -65535S, H < -H$
- 32-bit images: H, S, and V are left as is

See also

cv::COLOR_BGR2HSV, **cv::COLOR_RGB2HSV**, **cv::COLOR_HSV2BGR**, **cv::COLOR_HSV2RGB**

RGB ↔ HLS

In case of 8-bit and 16-bit images, R, G, and B are converted to the floating-point format and scaled to fit the 0 to 1 range.

$$V_{max} \leftarrow max(R,G,B)$$

$$V_{min} \leftarrow min(R,G,B)$$

$$L \leftarrow \frac{V_{max} + V_{min}}{2}$$

$$S \leftarrow \begin{cases} \frac{V_{max} - V_{min}}{V_{max} + V_{min}} & \text{if } L < 0.5 \\ \frac{V_{max} - V_{min}}{2 - (V_{max} + V_{min})} & \text{if } L \geq 0.5 \end{cases}$$

$$H \leftarrow \begin{cases} 60(G-B)/(V_{max} - V_{min}) & \text{if } V_{max} = R \\ 120 + 60(B-R)/(V_{max} - V_{min}) & \text{if } V_{max} = G \\ 240 + 60(R-G)/(V_{max} - V_{min}) & \text{if } V_{max} = B \end{cases}$$

If $H < 0$ then $H \leftarrow H + 360$. On output $0 \leq L \leq 1, 0 \leq S \leq 1, 0 \leq H \leq 360$.

The values are then converted to the destination data type:

- 8-bit images: $V \leftarrow 255 \cdot V, S \leftarrow 255 \cdot S, H \leftarrow H/2 \text{ (to fit to 0 to 255)}$
- 16-bit images: (currently not supported) $V < -65535 \cdot V, S < -65535 \cdot S, H < -H$
- 32-bit images: H, S, V are left as is

See also

cv::COLOR_BGR2HLS, **cv::COLOR_RGB2HLS**, **cv::COLOR_HLS2BGR**, **cv::COLOR_HLS2RGB**

RGB ↔ CIE L*a*b*

In case of 8-bit and 16-bit images, R, G, and B are converted to the floating-point format and scaled to fit the 0 to 1 range.

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} \leftarrow \begin{bmatrix} 0.412453 & 0.357580 & 0.180423 \\ 0.212671 & 0.715160 & 0.072169 \\ 0.019334 & 0.119193 & 0.950227 \end{bmatrix} \cdot \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

$$X \leftarrow X/X_n, \text{where} X_n = 0.950456$$

$$Z \leftarrow Z/Z_n, \text{where} Z_n = 1.088754$$

$$L \leftarrow \begin{cases} 116 * Y^{1/3} - 16 & \text{for } Y > 0.008856 \\ 903.3 * Y & \text{for } Y \leq 0.008856 \end{cases}$$

$$a \leftarrow 500(f(X) - f(Y)) + delta$$

$$b \leftarrow 200(f(Y) - f(Z)) + delta$$

where

$$f(t) = \begin{cases} t^{1/3} & \text{for } t > 0.008856 \\ 7.787t + 16/116 & \text{for } t \leq 0.008856 \end{cases}$$

and

$$delta = \begin{cases} 128 & \text{for 8-bit images} \\ 0 & \text{for floating-point images} \end{cases}$$

This outputs $0 \leq L \leq 100, -127 \leq a \leq 127, -127 \leq b \leq 127$. The values are then converted to the destination data type:

- 8-bit images: $L \leftarrow L * 255/100, \; a \leftarrow a + 128, \; b \leftarrow b + 128$
- 16-bit images: (currently not supported)
- 32-bit images: L, a, and b are left as is

See also

cv::COLOR_BGR2Lab, **cv::COLOR_RGB2Lab**, **cv::COLOR_Lab2BGR**, **cv::COLOR_Lab2RGB**

RGB ↔ CIE L*u*v*

In case of 8-bit and 16-bit images, R, G, and B are converted to the floating-point format and scaled to fit 0 to 1 range.

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} \leftarrow \begin{bmatrix} 0.412453 & 0.357580 & 0.180423 \\ 0.212671 & 0.715160 & 0.072169 \\ 0.019334 & 0.119193 & 0.950227 \end{bmatrix} \cdot \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

$$L \leftarrow \begin{cases} 116 * Y^{1/3} - 16 & \text{for } Y > 0.008856 \\ 903.3Y & \text{for } Y \leq 0.008856 \end{cases}$$

$$u' \leftarrow 4 * X/(X + 15 * Y + 3Z)$$

$$v' \leftarrow 9 * Y/(X + 15 * Y + 3Z)$$

$$u \leftarrow 13 * L * (u' - u_n) \quad \text{where} \quad u_n = 0.19793943$$

$$v \leftarrow 13 * L * (v' - v_n) \quad \text{where} \quad v_n = 0.46831096$$

This outputs $0 \leq L \leq 100, -134 \leq u \leq 220, -140 \leq v \leq 122$.

The values are then converted to the destination data type:

- 8-bit images: $L \leftarrow 255/100L, \; u \leftarrow 255/354(u + 134), \; v \leftarrow 255/262(v + 140)$
- 16-bit images: (currently not supported)
- 32-bit images: L, u, and v are left as is

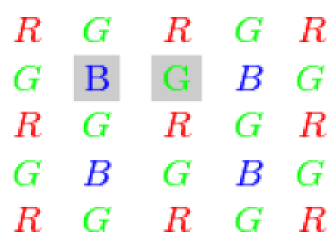
The above formulae for converting RGB to/from various color spaces have been taken from multiple sources on the web, primarily from the Charles Poynton site http://www.poynton.com/ColorFAQ.html

See also

cv::COLOR_BGR2Luv, **cv::COLOR_RGB2Luv**, **cv::COLOR_Luv2BGR**, **cv::COLOR_Luv2RGB**

Bayer → RGB

The Bayer pattern is widely used in CCD and CMOS cameras. It enables you to get color pictures from a single plane where R,G, and B pixels (sensors of a particular component) are interleaved as follows:



Bayer pattern

The output RGB components of a pixel are interpolated from 1, 2, or 4 neighbors of the pixel having the same color. There are several modifications of the above pattern that can be achieved by shifting the pattern one pixel left and/or one pixel up. The two letters C_1 and C_2 in the conversion constants CV_Bayer

$C_1 C_2$ 2BGR and CV_Bayer $C_1 C_2$ 2RGB indicate the particular pattern type. These are components from the second row, second and third columns, respectively. For example, the above pattern has a very popular "BG" type.

See also

cv::COLOR_BayerBG2BGR, **cv::COLOR_BayerGB2BGR**, **cv::COLOR_BayerRG2BGR**, **cv::COLOR_BayerGR2BGR**, **cv::COLOR_BayerBG2RGB**, **cv::COLOR_BayerGB2RGB**, **cv::COLOR_BayerRG2RGB**, **cv::COLOR_BayerGR2RGB**

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