RGB-YUV Conversion

The basic definition of the *color differences* U, V is as below:

$$\begin{aligned} U &= B - Y \\ V &= R - Y \end{aligned} \tag{1}$$

Therefore,

$$\begin{bmatrix} Y \\ U \\ V \end{bmatrix} = \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ -0.299 & -0.587 & 0.886 \\ 0.701 & -0.587 & -0.114 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} \tag{2}$$

One goes backwards, from (Y, U, V) to (R, G, B), by inverting the matrix in Eq. (2).

It real implementations, however, the following is used:

$$\begin{aligned} U &\approx 0.492(B - Y) \\ V &\approx 0.877(R - Y) \end{aligned} \tag{3}$$

As a result, the following matrices should be used in converting RGB to YUV, and in converting YUV back to RGB, e.g., in the JPEG codec steps.

$$\begin{bmatrix} Y \\ U \\ V \end{bmatrix} = \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ -0.14713 & -0.28886 & 0.436 \\ 0.615 & -0.51499 & -0.10001 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} \tag{4}$$

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 1 & 0 & 1.13983 \\ 1 & -0.39465 & -0.58060 \\ 1 & 2.03211 & 0 \end{bmatrix} \begin{bmatrix} Y \\ U \\ V \end{bmatrix} \tag{5}$$