1 Converting RGB to HSV

We start out by retrieving the red (R), green (G), blue (B) values, in a scale from 0 to 1, inclusively, as well as the largest and smallest of the R, G, B, values, and the difference between the two.

The "scale_x" variable, below, represents the channel scale, e.g. 255.

$$R = \frac{R'}{\text{scale}_r}, G = \frac{G'}{\text{scale}_g}, B = \frac{B'}{\text{scale}_b} \tag{1}$$
$$m_{\text{max}} = \max(R, G, B) \tag{2}$$
$$m_{\text{min}} = \min(R, G, B) \tag{3}$$
$$\Delta = m_{\text{max}} - m_{\text{min}} \tag{4}$$
$$\tag{5}$$

Now, we get the hue, H, value. To do that, we look at the largest of the R, G, B, values. The smallest two are subtracted off, and divided by the difference between the largest and the smallest. We then normalize the hue by adding either 0, 2, or 4. The resulting H is any real number. However, any arbitrary number below 0, and above 6 is considered redundant, and you may as well derive a value $H \bmod 6$, or if H is negative, then $(H \bmod 6) + 6$, but it's not necessary, since a relatively decent HSV to RGB conversion algorithm should be able to work with any values of H.

$$H = \begin{cases} \text{undefined}, & \text{if } \Delta = 0 \\ \frac{G-B}{\Delta} & \text{if } m_{\text{max}} = R \\ \frac{B-R}{\Delta} + 2 & \text{if } m_{\text{max}} = G \\ \frac{R-G}{\Delta} + 4 & \text{if } m_{\text{max}} = B \end{cases} \tag{6}$$
$$H' = H \times \text{scale}_h \tag{7}$$

The brightness, V, is based on the brightest colour channel.

$$V = m_{\text{max}} \tag{8}$$
$$V' = V \times \text{scale}_v \tag{9}$$
$$\tag{10}$$

The saturation, S, is the difference between the largest and smallest colour channel values, divided by the brightness, V. If V is 0, then the resulting saturation is 0.

$$S = \begin{cases} 0, & \text{if } V = 0 \\ \frac{\Delta}{V} & \text{otherwise} \end{cases} \tag{11}$$
$$S' = S \times \text{scale}_s \tag{12}$$

2 Converting HSV to RGB

First, we get the hue (H), saturation (S), brightness (V), where H is in a scale between 0 to 6 inclusively, and S and V in a scale between 0 to 1.

Incidentally, the brightness, V, also happens to represent the brightest channel in our resulting RGB colour.

$$H = \begin{cases} \text{undefined} & \text{if } H' \text{ is undefined} \\ (\frac{H'}{\text{scale}_h} \bmod 6) + 6 & \text{if } H' < 0 \\ \frac{H'}{\text{scale}_h} \bmod 6 & \text{otherwise} \end{cases} \tag{13}$$

$$S = \frac{S'}{\text{scale}_s}, V = \frac{V'}{\text{scale}_v} \tag{14}$$

Next, get some channel values in decreasing brightness. Whether any of the below α, β, γ values represent either red, green, or blue, will be decided shortly afterwards.

$$\alpha = V \times (1 - S) \tag{15}$$

$$\beta = \begin{cases} \text{undefined} & \text{if } H \text{is undefined} \\ V \times (1 - (H - \lfloor H \rfloor) \times S) & \text{otherwise} \end{cases} \tag{16}$$

$$\gamma = \begin{cases} \text{undefined} & \text{if } H \text{is undefined} \\ V \times (1 - (1 - (H - \lfloor H \rfloor)) \times S) & \text{otherwise} \end{cases} \tag{17}$$

Now, you can imagine a colour wheel—represented by figure 1 (on the next page)—and H, being a magnitude from 0 to 6 of the rotation within the wheel. When H is less than 1, then the colour is more red leaning. Hence, below, you see that the brightest value in the resulting (R, G, B) triple will be $R = V$. When it is greater than 1 and less than 2, then $G = V$ will be the largest, and so on, and so fourth.

$$(R, G, B) = \begin{cases} (V, V, V) & \text{if } H \text{ is undefined} \\ (V, \gamma, \alpha) & \text{if } 0 \leq H < 1 \\ (\beta, V, \alpha) & \text{if } 1 \leq H < 2 \\ (\alpha, V, \gamma) & \text{if } 2 \leq H < 3 \\ (\alpha, \beta, V) & \text{if } 3 \leq H < 4 \\ (\gamma, \alpha, V) & \text{if } 4 \leq H < 5 \\ (V, \alpha, \beta) & \text{if } 5 \leq H < 6 \end{cases} \tag{18}$$

$$(R', G', B') = (R \times scale_r, G \times \text{scale}_g, B \times \text{scale}_b) \tag{19}$$

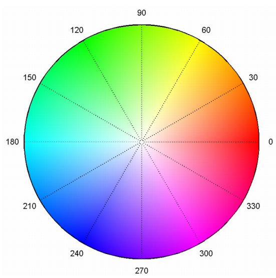

Figure 1: The colour represented by 0 degrees is red. By 60, yellow; 120, green; 180, cyan; 240, blue; 300, magenta. [1]

[1] http://www.hobbitsandhobos.com/wp-content/uploads/2011/06/colorWheel.png