Delta E (CMC)

The color difference method of the Color Measurement Committee (the CMC) is a model using two parameters *l* and *c*, typically expressed as CMC(*l*:*c*). Commonly used values for acceptability are CMC(2:1) and for perceptibility are CMC(1:1).

The color difference, or ΔE, between a sample color $L_2a_2b_2$ and a reference color $L_1a_1b_1$ is:

$$\Delta E = \sqrt{\left(\Delta L / l\, S_L\right)^2 + \left(\Delta C / c\, S_C\right)^2 + \left(\Delta H / S_H\right)^2}$$

where

$$\Delta C = C_1 - C_2$$

$$C_1 = \sqrt{a_1^2 + b_1^2}$$

$$C_2 = \sqrt{a_2^2 + b_2^2}$$

$$\Delta H = \sqrt{\Delta a^2 + \Delta b^2 - \Delta C^2}$$

$$\Delta L = L_1 - L_2$$

$$\Delta a = a_1 - a_2$$

$$\Delta b = b_1 - b_2$$

$$S_L = \begin{cases} 0.511 & L_1 < 16 \\ \dfrac{0.040975\, L_1}{1 + 0.01765\, L_1} & L_1 \geq 16 \end{cases}$$

$$S_C = \frac{0.0638\, C_1}{1 + 0.0131\, C_1} + 0.638$$

$$S_H = S_C\left(FT + 1 - F\right)$$

$$T = \begin{cases} 0.56 + \left|0.2\cos\left(H_1 + 168\right)\right| & 164 \leq H_1 \leq 345 \\ 0.36 + \left|0.4\cos\left(H_1 + 35\right)\right| & otherwise \end{cases}$$

$$F = \sqrt{C_1^4 / \left(C_1^4 + 1900\right)}$$

$$H_1 = \tan^{-1}\left(b_1 / a_1\right)$$

Implementation Notes:

1. H_1 is in degrees, not radians.
2. If $H_1 < 0°$, add 360° to it.
3. If $H_1 \geq 360°$, subtract 360° from it.
4. In computing H_1, be careful with the inverse tangent since *a* could be zero. Instead, use special math functions to do this. In both the Standard C library and Java, this function is called **atan2**. In Microsoft Excel, it is called **ATAN2**. These special functions will compute the proper inverse tangents without needing to worry about "divide by zero" conditions.

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