Method for Inversion of CIECAM97s

(Provided to TC1-34 by R.W.G. Hunt, September, 1997)

Starting Data:

Q or J, M or C, H or h

A_w, n, z, F_L, N_{bb}, N_{cb} Obtained Using Forward Model

Surround Parameters: F, c, F_{LL}, N_c

Luminance Level Parameters: L_A, D

Unique Hue Data:

Red: h = 20.14, e = 0.8

Yellow: h = 90.00, e = 0.7

Green: h = 164.25, e = 1.0

Blue: h = 237.53, e = 1.2

(1) From Q Obtain J (if necessary)

$$J = 100(Qc/1.24)^{1/0.67} / (A_w + 3)^{0.9/0.67}$$

(2) From J Obtain A

$$A = (J/100)^{1/cz} A_w$$

(3) Using H, Determine h_1, h_2, e_1, e_2 (if h is not available)

e_1 and h_1 are the values of e and h for the unique hue having the nearest lower value of h and e_2 and h_2 are the values of e and h for the unique hue having the nearest higher value of h.

(4) Calculate h (if necessary)

$$h = \left[(H - H_1)(h_1/e_1 - h_2/e_2) - 100h_1/e_1\right] / \left[(H - H_1)(1/e_1 - 1/e_2) - 100/e_1\right]$$

H_1 is 0, 100, 200, or 300 according to whether red, yellow, green, or blue is the hue having the nearest lower value of h.

(5) Calculate e

$$e = e_1 + (e_2 - e_1)(h - h_1)/(h_2 - h_1)$$

e_1 and h_1 are the values of e and h for the unique hue having the nearest lower value of h and e_2 and h_2 are the values of e and h for the unique hue having the nearest higher value of h.

(6) Calculate C (if necessary)

$$C = M / F_L^{0.15}$$

(7) Calculate s

$$s = C^{1/0.69} / \left[2.44(J/100)^{0.67n}(1.64 - 0.29^n)\right]^{1/0.69}$$

(8) Calculate a and b

$$a = s(A / N_{bb} + 2.05) / \left\{ \left[1 + (\tan h)^2\right]^{1/2} \left[50000 e N_c N_{cb} / 13\right] + s\left[(11/23) + (108/23)(\tan h)\right] \right\}$$

In calculating $\left[1 + (\tan h)^2\right]^{1/2}$ the result is taken as:

positive for 0° ≤ h < 90°

negative for 90° ≤ h < 270°

positive for 270° ≤ h < 360°.

$$b = a(\tan h)$$

(9) Calculate R'_a, G'_a, and B'_a

$$R'_a = (20/61)(A / N_{bb} + 2.05) + (41/61)(11/23)a + (288/61)(1/23)b$$

$$G'_a = (20/61)(A / N_{bb} + 2.05) - (81/61)(11/23)a - (261/61)(1/23)b$$

$$R'_a = (20/61)(A / N_{bb} + 2.05) - (20/61)(11/23)a - (20/61)(315/23)b$$

(10) Calculate R', G', and B'

$$R' = 100\left[(2R'_a - 2) / (41 - R'_a)\right]^{1/0.73}$$

$$G' = 100\left[(2G'_a - 2) / (41 - G'_a)\right]^{1/0.73}$$

$$B' = 100\left[(2B'_a - 2) / (41 - B'_a)\right]^{1/0.73}$$

If R'_a-1 < 0 use:

$$R' = -100\left[(2 - 2R'_a) / (39 + R'_a)\right]^{1/0.73}$$

and similarly for the G' and B' equations.

(11) Calculate R_cY, G_cY, and B_cY

$$\begin{vmatrix} R_cY \\ G_cY \\ B_cY \end{vmatrix} = \mathbf{M}_B \mathbf{M}_H^{-1} \begin{vmatrix} R' / F_L \\ G' / F_L \\ B' / F_L \end{vmatrix}$$

(12) Calculate Y_c

$$Y_c = 0.43231 R_cY + 0.51836 G_cY + 0.04929 B_cY$$

(13) Calculate $(Y/Y_c)R$, $(Y/Y_c)G$, and $(Y/Y_c)^{1/p}B$

$$(Y/Y_c)R = (Y/Y_c)R_c / \left[D(1/R_w) + 1 - D\right]$$

$$(Y/Y_c)G = (Y/Y_c)G_c / \left[D(1/G_w) + 1 - D\right]$$

$$(Y/Y_c)^{1/p} B = \left[\left|(Y/Y_c)B_c\right|\right]^{1/p} / \left[D(1/B_w^p) + 1 - D\right]^{1/p}$$

If $(Y/Y_c)B_c < 0.0$ then $(Y/Y_c)^{1/p}B$ is also set to be negative.

(14) Calculate Y'

$$Y' = 0.43231 YR + 0.51836 YG + 0.04929 (Y/Y_c)^{1/p} BY_c$$

(15) Calculate X'', Y'' and Z''

$$\begin{vmatrix} X'' \\ Y'' \\ Z'' \end{vmatrix} = \mathbf{M}_B^{-1} \begin{vmatrix} Y_c(Y/Y_c)R \\ Y_c(Y/Y_c)G \\ Y_c(Y/Y_c)^{1/p} B/(Y'/Y_c)^{(1/p-1)} \end{vmatrix}$$

Note: X'', Y'', and Z'' are equal to the desired X, Y, and Z to a very close approximation. This is because Y' differs from Y since $(Y/Y_c)^{1/p}BY_c$ is used instead of YB. However this is multiplied by 0.04929 so the difference is small.