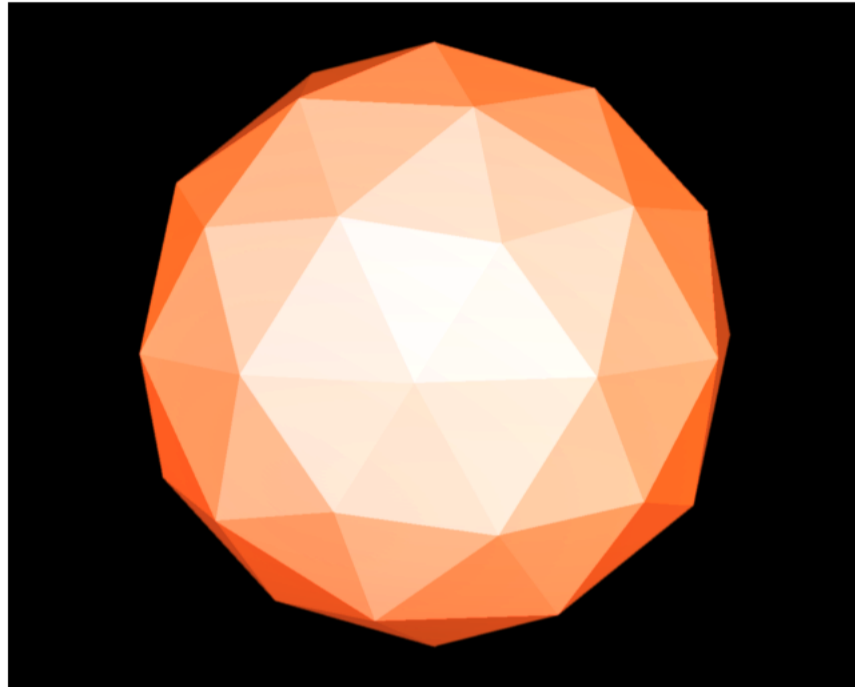


Gernot Hoffmann

Correlated Color Temperature



Contents

| | |
|-----------------|---|
| 1. Introduction | 2 |
| 2. Algorithm | 3 |
| 3. Table | 4 |
| 4. References | 5 |

1. Introduction

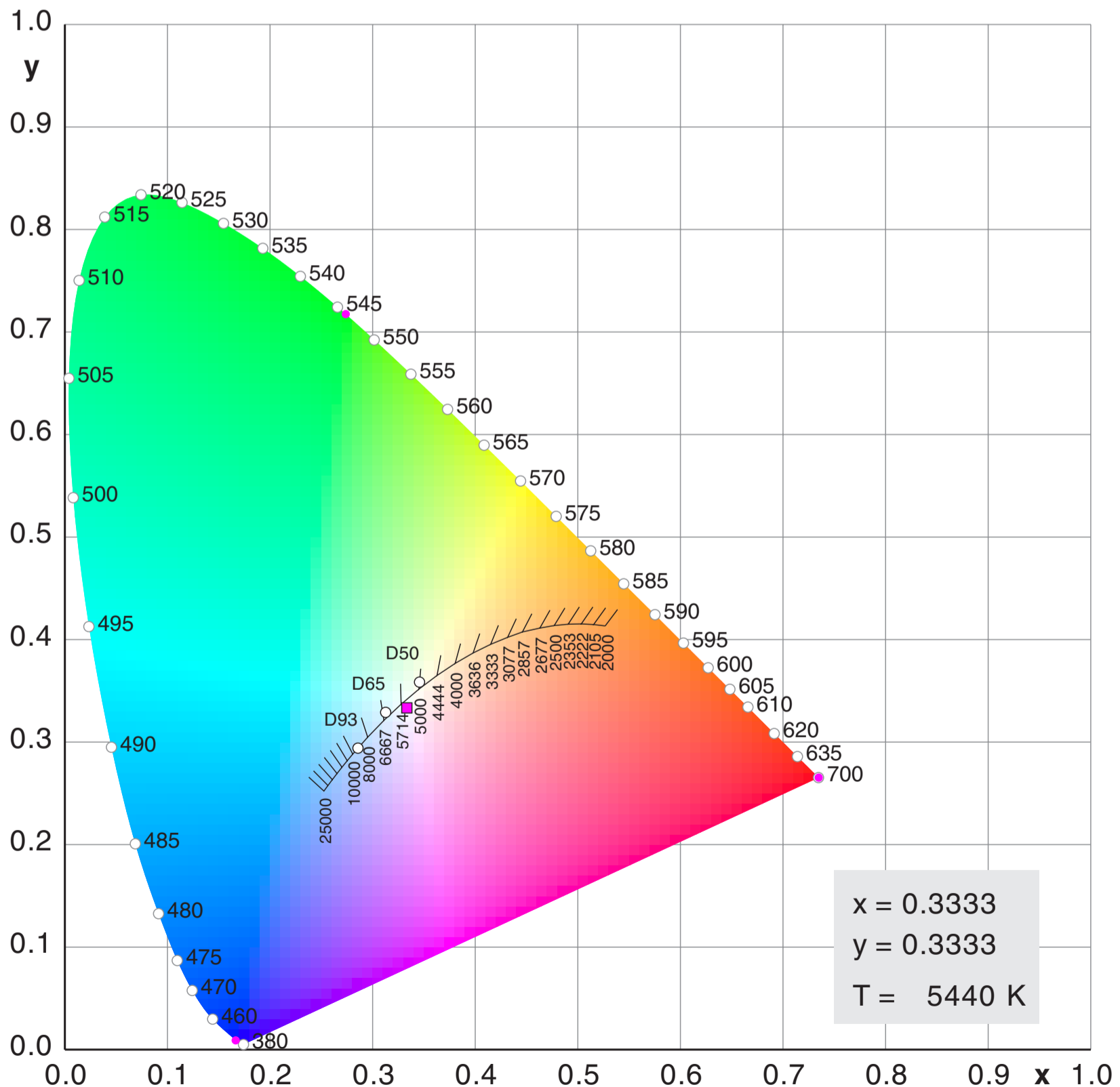
Color temperature is the physical temperature of a heated *Planckian* radiator. The color coordinates for the emitted light are shown below in the CIE chromaticity diagram for temperatures 2000K to 25000K.

Correlated color temperature (CCT) is calculated by projecting the actual color coordinates x,y along a line of constant CCT onto the curve for the *Planckian* radiator.

Coordinates and the slope of the Iso-CCT lines are given on page 4 according to [1]. The algorithm is described there as well, it is the method by *Robertson*.

Here we use a modern nomenclature for vector geometry. The final step is done by inverse linear interpolation because the inverse temperatures are approximately equally spaced on the curve.

A correlated color temperature does not make any sense if the actual color is too far away from the *Planckian* curve.



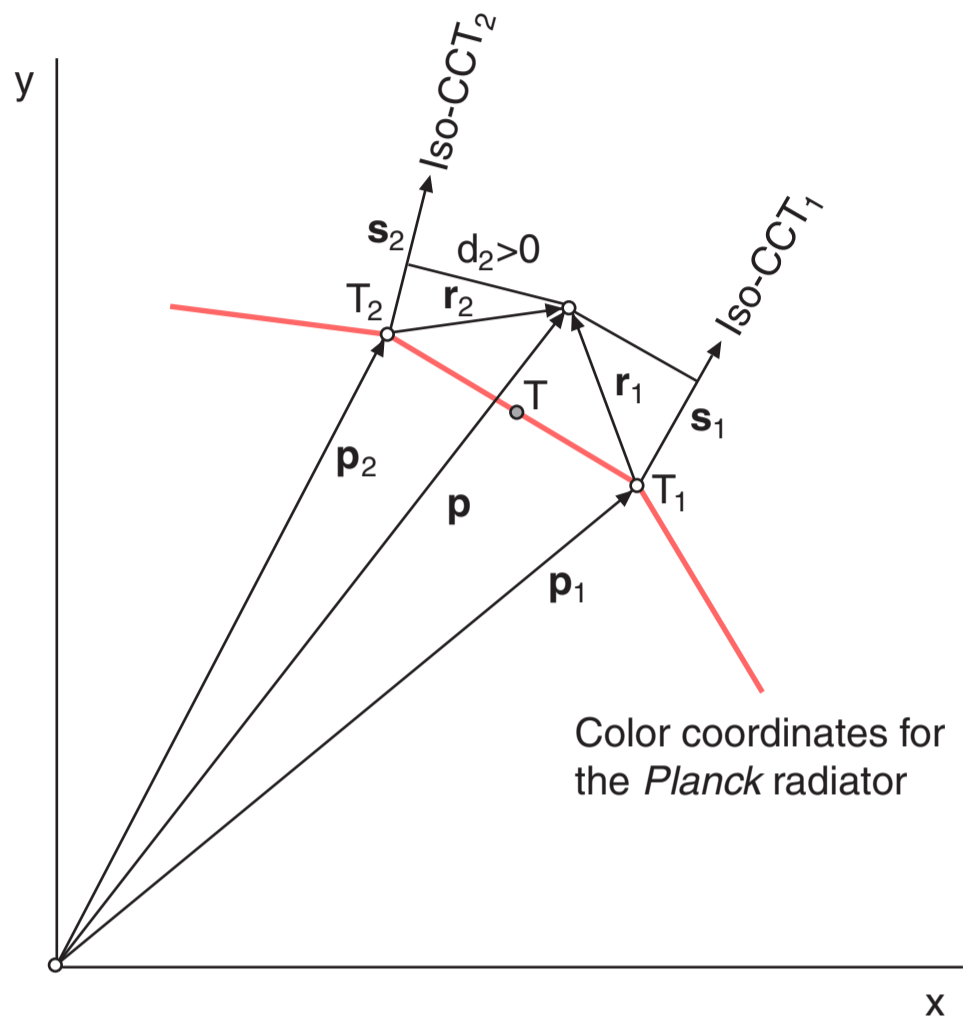
2. Algorithm

Given are $i = 0 \dots n$ points x, y in the CIE chromaticity diagram for n line segments on the curve for the *Planckian* radiator by a table (p. 4). Calculate the CCT for a color x, y . The algorithm is described in pseudo-code. PostScript code is available.

```

i=0
found=False
Calculate values(2) at i
For i=1 to n Do
  Begin
    values(1)=values(2)
    Calculate values(2) at i
    If  $d_1 \cdot d_2 \leq 0$  Then
      Begin
        found=True
        Exit Loop
      End
    End
  End
If found Then
  Begin
    Calculate k and T
    Print 'T=', T
  End
Else
  Print 'Not found'

```



Equations for values (1). Use the same formulas for values (2):

$$p = \begin{bmatrix} x \\ y \end{bmatrix} \quad \text{coordinates in chromaticity diagram}$$

$$p_1 = \begin{bmatrix} x_1 \\ y_1 \end{bmatrix} \quad \text{coordinates at } T_1 \text{ according to table}$$

$$t_1 = dy/dx \quad \text{slope at } T_1 \text{ according to table}$$

$$s_1 = \begin{bmatrix} 1 \\ t_1 \end{bmatrix} \frac{1}{\sqrt{1+t_1^2}} \quad \text{Iso - CCT direction vector at } T_1$$

$$s_1 = -s_1 \quad \text{if } t_1 < 0$$

$$r_1 = p - p_1 \quad \text{difference vector}$$

$$d_1 = (r_1 \times s_1)_z \quad \text{signed distance}$$

$$d_1 = r_{1x}s_{1y} - r_{1y}s_{1x}$$

$$d_1 d_2 \leq 0 \quad \text{correct line segment}$$

$$k = \frac{|d_1|}{|d_1| + |d_2|} \quad \text{linearized inverse interpolation}$$

$$T = \frac{1}{1/T_1 + k(1/T_2 - 1/T_1)}$$

3. Table

Table for the color temperature of the *Planckian* radiator and the Iso-CCT slope [1].

| T/K | x | y | t | |
|-------|---------|---------|-----------|----------------|
| 2000 | 0.52669 | 0.41331 | 1.33101 | |
| 2105 | 0.51541 | 0.41465 | 1.39021 | |
| 2222 | 0.50338 | 0.41525 | 1.45962 | |
| 2353 | 0.49059 | 0.41498 | 1.54240 | |
| 2500 | 0.47701 | 0.41368 | 1.64291 | |
| 2677 | 0.463** | 0.41121 | 1.76811 | Error in table |
| 2857 | 0.446** | 0.40742 | 1.92863 | Error in table |
| 3077 | 0.43156 | 0.40216 | 2.14300 | |
| 3333 | 0.41502 | 0.39535 | 2.44455 | |
| 3636 | 0.39792 | 0.38690 | 2.90309 | |
| 4000 | 0.38045 | 0.37676 | 3.68730 | |
| 4444 | 0.36276 | 0.36496 | 5.34398 | |
| 5000 | 0.34510 | 0.35162 | 11.17883 | |
| 5714 | 0.32775 | 0.33690 | -39.34888 | |
| 6667 | 0.31101 | 0.32116 | -6.18336 | |
| 8000 | 0.29518 | 0.30477 | -3.08425 | |
| 10000 | 0.28063 | 0.28828 | -1.93507 | |
| 11111 | 0.27524 | 0.28182 | -1.65981 | |
| 12500 | 0.27011 | 0.27547 | -1.44313 | |
| 14286 | 0.26526 | 0.26930 | -1.26959 | |
| 16667 | 0.26070 | 0.26333 | -1.12891 | |
| 20000 | 0.25645 | 0.25763 | -1.01403 | |
| 25000 | 0.25251 | 0.25222 | -0.91976 | |

4. References

- [1] G.Wyszecki + W.S.Stiles
Color Science
John Wiley & Sons, New York ,..., 1982
- [2] M.Stokes + M.Anderson + S.Chandrasekar + R.Motta
A Standard Default Color Space for the Internet - sRGB
<http://www.w3.org/graphics/color/srgb.html>
1996
- [3] M.Nielsen + M.Stokes
The Creation of the sRGB ICC Profile
<http://www.srgb.com/c55.pdf>
Year unknown, after 1998
- [4] International Color Consortium
<http://www.color.org>
- [5] Specification ICC.1:21001-12
File Format for Color Profiles (Version 4.0.0)
<http://www.color.org/newiccspec.pdf>
- [6] G.Hoffmann
CIE (1931) Color Space
<http://docs-hoffmann.de/ciexyz29082000.pdf>
- [7] G.Hoffmann
CIELab Color Space
<http://docs-hoffmann.de/cielab03022003.pdf>
- [8] Everything about Color and Computers
<http://www.efg2.com>

This doc:
<http://docs-hoffmann.de/coltemp18102003.pdf>