Improving the efficiency of an iterative method for accurate color reproduction in color displays

M. J. Pérez-Peñalver[♢], S. W. Lee [△], C. Jordán [♮], E. Sanabria-Codesal[♢] and S. Morillas [♭],[1]

(♢) Departamento de Matemática Aplicada, Universitat Politècnica de València

(△) Department of Information Display and Advanced Display Research Center, Kyung Hee University.

(♮) Intituto de Matemática Multidisciplinar, Universitat Politècnica de València.

(♭) Intituto de Matemática Pura y Aplicada, Universitat Politècnica de València.

Abstract

Accurate color reproduction is of paramount importance in both industry and domestic applications, and has recently gained more attention due to the availability of various display technologies. In general, display characterization means to create a model able to relate device dependent DACRGB inputs with display outputs expressed in an appropriate device independent color space (usually tristimulus values XY Z or xyY color coordinates). We have proposed in [2] a new inverse model for a display based on the direct model developed in [1]. But it involves the use of an iterative method that can be quite costly in some situations.

In this paper, we start from the same idea: The method starts by calculating the values of (X, Y, Z) corresponding to the RGB values of pure red, green, and blue, obtained using a colorimeter and the adjustment made from the direct method of [1]. By using these values, a triangle is considered whose vertices are the chromatic coordinates of the pure colors red, green, and blue. Given a color in device-independent coordinates (X, Y, Z), whose RGB coordinates are desired, the coordinates xyY are calculated. But in the current process, we not only take into account the proportions given by the orthogonal projections of the chromatic coordinates on the sides of the Gamut triangle but also incorporate in the same iteration adjustments according to which color contributes the most to the luminance. We have also changed the stopping criterion: either when the maximum number of iterations is reached or when the current RGB approximation appears in a previous iteration.

In this work, an extensive experimental evaluation is carried out, having calculated parameters both when analyzing chromaticity and luminance, followed by an analysis of the method's performance in terms of the iterations needed. As a consequence, a way to improve efficiency that can save a significant number of operations for a wide range of colors and is very good in terms of $\Delta E00$ color difference is proposed. We have also analyzed the performance of this method with other well-known state-of-the-art methods.

References

[1] Kim, J. M ., Lee, S. W., Universal color characterization model for all types of displays. *Optical Engineering*, 54 (10): 103103, 2015. https://doi.org/10.1117/1.oe.54.10.103103.

[2] Perez-Peñalver, M. J., Lee, S. W., Jordan, C., Sanabria-Codesal E. and Morillas S. *A new iterative inverse display model*, Mathematical Modelling in Engineering & Human Behaviour 2022 (MME&HB 2022), 202-207, 2022.

[1] smorillas@mat.upv.es