Spectral Analysis of Blacks

Razieh Jafari,[1] Seyed Hossein Amirshahi,[2*] Seyed Abdolkarim Hosseini Ravandi[1]

[1]Department of Textile Engineering, Isfahan University of Technology, Isfahan 84156, Iran

[2]Department of Textile Engineering, Amirkabir University of Technology (Tehran Polytechnic), Tehran 15914, Iran

Received 7 April 2010; revised 16 December 2010; accepted 21 December 2010

Abstract: The spectral behavior of different black surfaces including papers and fabrics are investigated in this study. Several colored pigments are mixed with the blacks in different concentrations to prepare black surfaces with different shades while a series of black dyestuffs are applied on textile materials to increase the ranges of black objects. The principal component analysis technique is applied to determine the actual spectral size of the reflectance dataset. The technique simply extracts the principal directions of spectral data and organizes them in restricted spectral spaces. Three different spectral spaces, i.e., the reflectance spectra, the Kubelka-Munk function of reflectance as well as the inverse of reflectance factor are selected to present the samples in the restricted spaces. Based on the results, it is found that, there are no significant differences between the employed spaces and far from the employed spectral domains, black surfaces could be adequately described in a three-dimensional space. The three extracted statistical colorants are used for reconstruction of reflectance spectra of samples while the root mean square error percentage and the color difference values under the standard observing condition confirm the suitability of such virtual primaries. The work is extended to reconstruction of spectral data from colorimetric information and the adequacy of such three-dimensional space is reconfirmed. © 2011 Wiley Periodicals, Inc. Col Res Appl, 37, 176–185, 2012; Published online 12 August 2011 in Wiley Online Library (wileyonlinelibrary.com). DOI 10.1002/col.20692

Key words: spectral data analysis; black surfaces; principal component analysis

INTRODUCTION

Ideally, black is an achromatic color with no hue and chroma i.e., it belongs to neutrals (perfect white, grays and black), and in reality, blacks are a group of samples which benefit from low chroma and lightness values and could be found in different hues. Opposed to whites, the psychophysical and spectral behaviors of blacks have not been deeply studied and/or reported,[1] while both are unique in the consumption, e.g., they are most important colors in different applications such as printing industry. In fact, black is the favorite color in printing of text and it seems that its position could not be replaced by any other colors. Besides, blacks are the color of a variety of formal objects like dresses in different cultures.[2]

Although the location and the border of whites have been roughly determined in some standard color spaces such as Munsell and CIEXYZ systems,[3,4] the loci of blacks are not clearly defined and still depends to the subjective evaluation of every individual observer. Despite this reality that whites and blacks form opposite poles of the most color ordering systems, it was assumed that the concept of whiteness could be employed in reverse direction for blacks. Due to the importance of white samples in many industries such as papers, textiles and detergent producers, a number of whiteness indices were suggested, used and examined in different applications.[1]

Recently,[5] the spectral properties of whites have been studied to prove the quasi one-two dimensional property of such samples. In fact, the principal component analysis (PCA) technique was employed to exploit the pattern of spectral data of white samples by extracting the main directions in which data are scattered. Amirshahi and Agahian showed that the spectral data of whites, including those which are treated with fluorescent whitening agents, could be adequately interpret in a two-dimensional space and vaguely referred to the such spectral property and the popular psychophysical terms named whiteness index and tinting of white samples. The relationship

*Correspondence to: Seyed Hossein Amirshahi (e-mail: hamirsha@aut.ac.ir).