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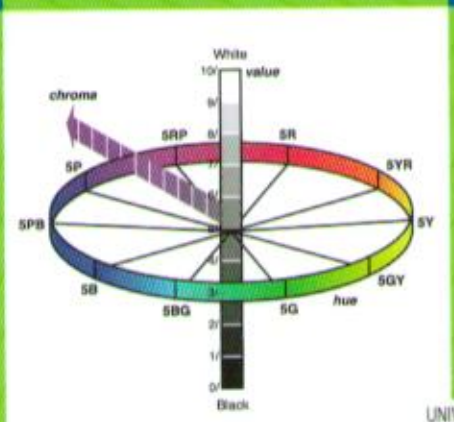

Colour measurement

Principles, advances and industrial applications

Edited by M. L. Gulrajani

The Textile Institute

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Camera-based colour measurement

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Abstract: For several decades, imaging sensors (CCD and CMOS) have been extensively used in many types of imaging capture devices (cameras and scanners). This first stage in any digital imaging workflow is very important in order to control the exact colour reproduction of images in subsequent applications (astronomy, television, cinema, printing, machine vision, mobiles, etc). However, there are many parameters (spectral sensitivities, white balance, dynamic range, etc) which can negatively influence accurate control of the colour reproduction of digital imaging devices. Nevertheless, if all these parameters are controlled, it is possible to transform a conventional digital imaging capture device into a versatile tele-colorimeter or even tele-spectrocolorimeter. In this chapter, the fundamentals and challenges of camera-based colour measurement will be explained, including several aspects of special interest, such as the control of raw RGB colour space, and the similarities and differences between spectral and colorimetric characterization and calibration. Finally, future trends with clear industrial applications will be described, including case studies focused on the spatial-chromatic dithering of texture images (textiles, ceramic tiles, natural stones, etc), and the pseudo-visualization of non-visible images from multi-spectral imaging capture.

Key words: imaging sensor, digital imaging workflow, spectral sensitivity, white balance, exposure level, dynamic range, raw RGB colour space, colour gamut, calibration vs. characterization, luminance adaptation, multi-spectral imaging, spatial-chromatic dithering in texture images, pseudo-visualization of non-visible images

6.1 Introduction

With the invention in 1969 of the charge-coupled device (CCD) (Holst 1998) by Willard S. Boyle and George E. Smith – both awarded the Nobel Prize in Physics in 2009 – and its combination with photo-detection sensors, it was possible to expand many industrial applications, and even introduce new ones. In digital colour imaging, this invention was considered a significant milestone, together with the invention in 1993 of the CMOS or active pixel sensor by E. Fossum (Lee 2005; Nakamura 2006; Ohta 2008). Although both imaging sensors present similarities and differences, it is probable that the specific advantages and drawbacks of each in respect to each particular application will condition future trends in their application fields (see Fig. 6.1).

In digital colour imaging these imaging sensors are essential elements for any digital imaging workflow (Jacobson et al. 2000; Saxby 2002; Sharma 2003; Peres

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The measurement of colour is important in many commercial operations and professions, such as bleaching and coloration of textiles, applications of paints, dentistry and coloration of food products. This book will discuss colour measurement theories, the latest technological and scientific developments in measuring colour and the applications of colour measurement.

Part I reviews the underlying theories, principles and methods of how to measure colour. It includes topics such as expressing colours numerically, camera-based colour measurement, colour shade sorting and determining and improving the accuracy of colour measurement. Part II presents a selection of industrial applications illustrating the use of colour measurement in textiles, paint, teeth, hair and food.

With its international range of contributors, *Colour measurement: principles, advances and industrial applications* is aimed at a variety of readers including colour technologists, colour quality inspectors, product developers, dentists, cosmetologists and anyone who uses colour in their work. It will also be beneficial for academics and students studying design, fashion or colour-related subjects.

Dr M. L. Gulrajani is a Professor at the Indian Institute of Technology in Delhi. He has undertaken more than 50 consultancy projects from various textile industries, published over 150 research papers, edited 24 books, including conference proceedings and has five Indian patents. He is a Fellow of the Society of Dyers and Colourists (UK), the Textile Association (India) and is an Honorary Member of the Association of Chemical Technologists (India).

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