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Color Image and Video Enhancement

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Preface

Enhancement of digital images and video sequences is the process of increasing the quality of the visual information by improving its visibility and perceptibility. Enhancement is a necessary step in image/video processing applications when the conditions under which a scene is captured result in quality degradation, e.g., increased/decreased brightness and/or contrast, distortion of colors, and introduction of noise and other artifacts such as blotches and streaks. Unfortunately, most of the traditional enhancement methods are designed for monochromatic image/video data. The multivariate nature of color image/video data presents considerable challenges for researchers and practitioners as the numerous methods developed for single channel data are often not directly applicable to multichannel data.

The goal of this volume is to summarize the state-of-the-art in color image and video enhancement. The intended audience includes researchers and practitioners, who are increasingly using color images and videos.

The volume opens with two chapters related to image acquisition. In "Colorimetric Characterisation," Westland focuses on the problem of color reproduction in devices such as cameras, monitors, and printers. The author describes color spaces mainly used for representing colors by consumer technologies currently available, analyzes the device accuracy on the reproduction of real-world colors, and illustrates various color correction methods for matching the color gamuts of different devices. In "Image Demosaicing," Zhen and Stevenson present an overview of demosaicking methods. The authors introduce the fundamentals of interpolation and analyze the structure of various state-of-the-art approaches. In addition, they elaborate on the advantages and disadvantages of the examined techniques and evaluate their performance using popular image quality metrics. Finally, they discuss demosaicing combined with deblurring and super-resolution.

The volume continues with two chapters on noise removal. In "DCT-Based Color Image Denoising: Efficiency Analysis and Prediction," Lukin et al. discuss image denoising techniques based on the discrete cosine transform (DCT). The authors analyze noise models, discuss various image quality measures, describe various types of filters, and introduce the concept of image enhancement utilizing the DCT.

In “Impulsive Noise Filters for Colour Images,” Morillas et al. give an overview of the impulsive noise reduction methods for color images. They analyze various models of impulsive noise contamination, introduce quality metrics used for the evaluation of filtering effectiveness, discuss various methods of vector ordering, and analyze the main types of noise reduction algorithms. The authors not only describe various approaches to impulsive noise reduction, but also evaluate their effectiveness and summarize their main properties.

The volume continues with seven chapters on color/contrast enhancement. In “Spatial and Frequency-Based Variational Methods for Perceptually Inspired Color and Contrast Enhancement of Digital Images,” Provenzi considers perceptually inspired color correction algorithms that aim to reproduce the color sensation produced by the human vision system. These algorithms are based on the well-known Retinex model, introduced by Land and McCann about 45 years ago. The author shows that Retinex-like approaches can be embedded in a general variational framework, where these methods can be interpreted as a local, nonlinear modification of histogram equalization. In “The Color Logarithmic Image Processing (CoLIP) Antagonist Space,” Gavet et al. present a survey of Color Logarithmic Image Processing, a perceptually-oriented mathematical framework for representing and processing color images. The authors also present various applications of this framework ranging from contrast enhancement to segmentation. In “Color Management and Virtual Restoration of Artworks,” Maino and Monti present a survey of the use of color and contrast enhancement techniques in the virtual restoration of artworks such as paintings, mosaics, ancient archival documents, and manuscripts. Histogram equalization approaches, Retinex-like methods, and multi-spectral image processing algorithms are essential tools to analyse an artwork, to discover its history, to measure its conservation/degradation status, and to plan future physical restoration. The authors provide examples of applications of such digital techniques on several well-known Italian artworks. In “A GPU-Accelerated Adaptive Simultaneous Dynamic Range Compression and Local Contrast Enhancement Algorithm for Real-Time Color Image Enhancement,” Tsai and Huang propose an adaptive dynamic range compression algorithm for color image enhancement. The authors demonstrate that a CUDA implementation of the proposed algorithm achieves up to 700% speed up when executed on an NVIDIA NVS 5200M GPU compared to a LUT-accelerated implementation executed on an Intel Core i7-3520M CPU. In “Color Equalization and Retinex,” Wang et al. give an overview of several perceptually inspired color correction algorithms that attempt to simulate the human color constancy capability. The authors first describe two histogram equalization methods that modify the image colors by manipulating respectively the global and local color distributions. They then illustrate an automatic color equalization approach that enhances the color and contrast of an image by combining the Gray-World and White-Patch models. Finally, they describe the Retinex model and various implementations of it. In “Color Correction for Stereo and Multi-View Coding,” Fezza and Larabi first present a survey of color correction methods for multi-view video. They then compare the quantitative/qualitative performance of some of the popular

methods with respect to color consistency, coding performance, and rendering quality. Finally, in "Enhancement of Image Content for Observers with Colour Vision Deficiencies," Milić et al. present a survey of daltonization methods designed for enhancing the perceptual quality of color images for the benefit of observers with color vision deficiencies.

In "Computationally Efficient Data and Application Driven Color Transforms for the Compression and Enhancement of Images and Video," Minervini et al. deal with the problem of efficient coding and transmission of color images and videos. The RGB data recorded by camera sensors are typically redundant due to high correlation of the color channels. The authors describe two frameworks to obtain linear maps of the RGB data that minimize the loss of information due to compression. The first adapts to the image data and aims at reconstruction accuracy, representing an efficient approximation of the classic Karhunen-Loève transform. The second adapts to the application in which the images are used, for instance, an image classification task. A chapter entitled "Overview of Grayscale Image Colorization Techniques," by Popowicz and Smolka completes the volume. The authors first present a survey of semi-automatic grayscale image colorization methods. They then compare the performance of three semi-automatic and one fully-automatic method on a variety of images. Finally, they propose a methodology for evaluating colorization methods based on several well-known quality assessment measures.

As editors, we hope that this volume focused on color image and video enhancement will demonstrate the significant progress that has occurred in this field in recent years. We also hope that the developments reported in this volume will motivate further research in this exciting field.

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