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Editorial

Color in Image and Video Processing

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1. BACKGROUND AND MOTIVATION

Color perception is of paramount importance in applications, such as digital imaging, multimedia systems, visual communications, computer vision, entertainment, and consumer electronics. Color is essential in digital cinematography, modern consumer electronics solutions, and digital photography system such as digital cameras, video displays, video-enabled cellular phones, and printing solutions. In these applications, compression- and transmission-based as well as color management algorithms provide the foundation for cost effective, seamless processing of visual information through the processing pipeline. Color plays a significant role in many pattern recognition and multimedia systems, where color-based feature extraction and color segmentation are used to detect and classify objects in application areas such as biomedical image processing and geomatics.

During the last fifteen years, important contributions were made in the field of color image processing due to the utilization of color vision, colorimetry, and color appearance. A number of special issues, including survey papers that review the state-of-the-art in the area of color image processing, have been published in the last few years. This special issue on color image and video processing aims to fill the gap in the existing literature and to assist researchers and practitioners who work in the area.

Simple inspection of the pertinent scientific literature reveals a significant increase in the number of papers devoted to color image processing in the image processing community. The motivation behind this issue is the desire to provide both a comprehensive overview of the most recent trends and an outline of possible future research directions in color image and video processing. The special issue discusses problems currently under research by the color image processing community and outlines methodologies and approaches for their solution. It focuses on the most promising research areas in color imaging science and covers research topics which, in the opinion of the editors at least, will be the main focus of research attention in the years to come.

This issue is intended for graduate students, researchers, and practitioners who have a good knowledge in color science and digital imaging and who want to know and understand the most recent advances and research developments in digital color imaging.

2. SCANNING THE SPECIAL ISSUE

Accepted papers cover both the theoretical and practical aspects of the digital color imaging pipeline, including color image acquisition, representation, description, analysis, and processing.

The special issue opens with a survey of the most recent trends and future research directions: “Color in image and video processing (most recent trends and future research directions)” by A. Trémeau et al. It presents the most recent trends as well as the state-of-the-art, with a broad survey of the relevant literature, in the main active research areas in color imaging. This survey focuses on the most promising research areas in color imaging science. Lastly, it addresses the research areas which still need more elaboration and which are the next and future perspectives of color in image and video processing.

The special issue continues with three articles on color image analysis and description. In a paper titled “A colour topographic map based on the dichromatic model,” M. Gouiffès and B. Zavidovique introduce a novel representation of color topographic maps. The authors proposed to design color lines along each dominant color vector, from the body reflection. Topographic maps are an interesting alternative to edge-based techniques commonly used in computer vision applications. Indeed, unlike edges, level lines are closed and less sensitive to external parameters. Topographic maps provide a compact geometrical representation of images and they are, to some extent, robust to contrast changes. In a paper entitled "Demosaicking based on optimization and projection in different frequency bands," O. Omer and T. Tanaka introduce an iterative demosaicking algorithm capable of reconstructing a full-color image using single-color filter array data. The missing color values are interpolated using optimization and projection in different frequency bands. A filter bank is utilized in order to decompose the initially interpolated image into low-frequency and high-frequency bands. In the low-frequency band, a quadratic cost function is minimized using the fact that the low-frequency chrominance components vary slowly within an object region. Conversely, in the high-frequency bands, each initially interpolated channel is subsampled into subimages, and then the high-frequency components of the unknown values are projected onto the high-frequency components of the corresponding known values. In their work entitled "Color image coding by colorization approach," T. Horiuchi and S. Tominaga propose a new color image coding scheme called "colorization image coding." The scheme can colorize a gray scale (monochrome) image given only a small number of color pixels. In the proposed solution, the luminance component is firstly separated from the input color image. Then, a small number of color seeds are selected as chrominance information. The luminance image is coded using a lossy coding technique, while the chrominance information is stored as color seeds. Decoding is performed by simply colorizing the reconstructed luminance image using the color seeds.

The special issue continues with two articles on color image analysis and description, especially on image quality. In the paper entitled "Improving the quality of colour colonoscopy videos," R. Dahyot et al. present a method for aligning successively captured red, green, and blue channels of colonoscopy video. The paper proposes a solution to recurrent misalignment of color channels in colonoscopy videos. The color channels are first equalized based on cumulative histogram and processed using robust camera motion estimation and compensation for improving image quality. In another paper entitled "Robust color image super-resolution: an adaptive M-estimation framework," N. A. El-Yamany and P. E. Papamichalis introduce a new color image superresolution algorithm utilizing an adaptive, robust M-estimation framework. Using a robust error norm as the objective function, the estimation process is adapted to each of the low-resolution frames allowing for measurement outlier suppression. As a result, the method produces super-resoluted frames with crisp details and no color artefacts, without regularization.

The second part of the special issue is devoted to color image and video segmentation and color image description. This part opens with a sequence of three papers. O. Losson et al. in their paper "Fuzzy mode enhancement and detection for color image segmentation" present a new and flexible color image segmentation method based on pixel classification. Pixel classes are constructed by detecting the modes of a spatial-color compactness function, which takes into account both the distribution of colors in the color space as well as their spatial location in the image plane. Fuzzy morphological operators are utilized for reliable and cost effective mode detection. In a paper entitled "Colour appearance based approaches for segmentation of traffic signs," X. Gao et al. show that the CIECAMs color appearance model can be efficiently used to segment traffic sign images captured under variable weather conditions contributing towards a reliable, automated traffic system. In the last paper of this sequence entitled "A robust approach to segment desired object based on salient colors," J. Rugna and H. Konik combine existing techniques such as salient color extraction, peak-finding algorithm, and classical K-means clustering in order to devise a cost effective segmentation solution. The effectiveness of the proposed algorithm is demonstrated by observing its performance in tracking user-selected objects.

The special issue continues with three additional articles on color image and video segmentation and image description. K. Lee et al., in their paper entitled "Color-based image retrieval using perceptually modified Hausdorff distance" present a color image dissimilarity measure based on a perceptually modified Hausdorff distance. The new measure allows for the development of cluster-based representation that can deal efficiently with partial matching in image retrieval applications. In a paper entitled "Unsupervised video shot detection using clustering ensemble with a color global scale-invariant feature transform descriptor," Y. Chang et al. propose a color global scale-invariant feature transform. The method quantizes a color image, representing it with a small number of color indices, and it then transforms the image by determining scale, rotation, and view-point invariant local features. Clustering ensembles focusing on knowledge reuse are then applied to obtain better clustering results than using single-clustering methods for video shot description and detection. In the last paper of this segment, B. Ionescu et al. present a two-step method for detecting and analyzing the color content of animated movies in their paper entitled "A fuzzy color-based approach for understanding animated movies content in the indexing task." Several global statistical parameters are computed in order to effectively characterize and represent the color content of a motion picture. Subsequently, symbolic features are computed through the utilization of a fuzzy logic system.

The third part of the special issue is devoted to important problem of color vision description. In the following two papers, S. Yang et al. present a color compensation scheme which enhances the visual perception of people with color vision deficiency (CVD). Particular emphasis is given to the development of a solution capable to assist individuals suffering from anomalous trichromacy. Compensated color is realized by determining the spectral cone sensitivities of the human eye and the spectral emission functions of the display device. The fundamentals of the proposed color compensation solution are summarized in the paper entitled "Quantification and standardized description of color vision deficiency caused by anomalous trichromats—part I: simulation and measurement." The spectral sensitivity of anomalous cones is modelled according to the deficiency degree of the standardized CVD description in the paper entitled "Quantification and standardized description of color vision deficiency caused by anomalous trichromats—part II: modeling and color compensation." This is achieved by examining the error score of a computerized hue test (CHT), developed in part I. Shifts at each individual wavelength are modelled using the peak sensitivity and a shape model obtained using the Smith/Pokorny anomalous cone models.

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