1. Introduction and Background

Texture and color are two types of visual stimuli that determine, to a great extent, the appearance of objects, materials, and scenes. The ability to process these stimuli enables humans and animals to interact with the environment they live in. As a consequence, texture and color have attracted a lot of research interest since early on. Color and texture analyses are also central to a wide range of applications including materials classification, surface inspection and grading, object recognition, biometric identification, content-based multimedia retrieval, remote sensing, and medical image analysis. In recent years, the appearance of new methodologies (notably deep learning) has elicited renewed interest toward the field. In this context, the objective of this Special Issue is to provide a forum for scientists and practitioners to discuss strategies, challenges, and perspectives in the discipline. The response of the community was substantial, which again confirms the interest in the topics; altogether, we received 26 contributions, of which 16 were deemed suitable for publication after peer review.

2. Theory

Four papers treated theoretical aspects of image processing, and two of them [1,2] were focused on color texture analysis. Navarro and Perez [1] introduced a method for pattern classification through color and texture features based on image partition. Their approach computes global and local features from different areas of the input image. Each pixel is represented as a quaternion and the color features are collected in a histogram obtained using Binary Quaternion Moment Preserving (BQMP). Textural information is extracted via Haralick's features from each partition to conform a feature vector, and a joint color–texture representation is obtained by merging the color code and a normalized texture descriptor. Smeraldi et al. [2] proposed a novel framework for color texture analysis based on partial orderings. Partial orders (PO) make it possible to compare multivariate data that, like colors, lack a natural order. In their work, the authors defined a general approach to extract rank features in color spaces via PO. They also extended a classical descriptor (the Texture Spectrum) to work with partial orders and showed that the partial-order version in color space outperformed the original grayscale descriptor.

Zhang et al. [3] presented a method for the identification of tampered images. In their solution, the input image is first filtered with Local Tchebichef Moments (LTM); then, the result is subtracted from the original image to obtain the 'residuals'. An error-correcting output code based on ensemble learning eventually classifies the images as tampered or not tampered.

In [4] Tang et al. addressed the problem of training Convolutional Neural Networks (CNN) and introduced a novel bounded scheduling procedure called Bsadam. The method first searches the upper and lower bound for Adam, then splits the training process into three steps: (1) the minimization step, (2) the convergence step, and (3) the uniform
The proposed solution was effectively tested with simple neural networks, deep convolution networks, and recurrent networks for image classification and language modeling tasks.

3. Applications

Biomedical image analysis received much attention in this Special Issue with a total of four papers accepted. In [5], González-Patiño et al. addressed segmentation of mammograms as an optimization problem and considered three metaheuristic approaches: simulated annealing, genetic algorithms, and a bat algorithm. They used Dunn index as the fitness function to evaluate segmented regions, which were characterized by clinical data, intensity, texture, and shape descriptors. Then, for the diagnosis of breast cancer lesions, they proposed a new artificial immune system (AIS). The performance of the metaheuristic algorithms was compared to intensity-based segmentations obtained using the Otsu method, and the outcomes of the AIS were evaluated on six datasets. Bhattacharjee et al. [6] investigated automated grading of prostate cancer from histology images. Their method is based on four steps: (1) segmentation of the input images via $k$-means; (2) separation of the touching cells through watershed transform; (3) extraction of morphological features; (4) SVM-based classification into four Gleason grade groups—grade 3, grade 4, grade 5, and benign.

Bontozoglou and Xiao [7] explored assessing a person’s condition from capacitive images of their hair and skin. Concretely, they attempted to determine whether a capacitive imaging sensor in combination with image processing algorithms such as gradient-based segmentation, gray level co-occurrence matrix, and normalized cross-correlation could be used in different hair and skin analysis tasks that are of great interest to the cosmetic and pharmaceutic industries, namely, the detection of skin polygons, the estimation of the bounding wrinkles length, and the observation of hair water sorption capabilities. The experimental results indicate that the proposed approach can be successful for detecting and tracking skin artifacts (e.g., wrinkles, moles, or scars) as well as skin age classification. Evidence indicates that capacitive imaging can also be applied to hair water loss studies.

In [8], Obuchowicz et al. examined whether additional digital intraoral radiography (DIR) image preprocessing based on texture analysis improves the recognition and differentiation of periapical lesions. They applied several texture models such as co-occurrences, first-order features, run-length matrices, gray-tone difference matrices, and local binary patterns to transform DIR images into feature maps. To improve the recognition of osteolytic and sclerotic lesions, the feature maps were further processed through $k$-means clustering. The ability of the proposed approach to yield information about the shape of a structure, its pattern, and adequate contrast was validated by two radiologists independently. The experimental results showed that the application of feature mapping to radiographic dental images constitutes a promising tool for the refinement and possible differentiation of periapical lesions.

Three papers investigated industrial applications. Furferi et al. [9] presented a computer vision system for counting small metal parts produced by electrodeposition. This manufacturing procedure is common in the fashion field and, since the raw materials are usually gold and silver, it is of paramount importance to reduce the amount of waste. The devised method employs a combination of image thresholding and morphological operations. Liu et al. [10] investigated online defect detection in the production of steel plates. This is a fairly common problem in the industry, and requires both speed and high recognition accuracy. The proposed solution relies on Multiblock Local Binary Patterns (MB-LBP), which the authors found to be superior to other methods such as the Gray-Level Co-occurrence Matrix (GLCM), the Scale-Invariant Feature Transform (SIFT), and the speeded up robust feature (SURF). Geng et al.’s work [11] is concerned with the problem of measuring the period length and the skew angle patterns of textile cutting pieces. This kind of semifinished product has been widely used in car seat and garment production.
Experimenting on a dataset of 5000 images, the authors demonstrated the suitability of a regional convolutional neural network (R-CNN) for the task.

Two papers addressed remote sensing problems. Wang et al. [12] described a technique to accurately identify maceral components in the fields of mining and geology. The correct identification of such components is central to a number of industrial processes such as hydrogenation, combustion, carbonization, and gasification. The proposed method employs a two-level coarse-to-fine clustering procedure to divide microscopic images into a sequence of regions with similar attributes (i.e., binder, vitrinite, liptinite, and inertinite). Yu et al. [13] addressed the problem of image segmentation of river scenes. To this end, they proposed a novel approach based on a reflection mechanism of the water surface. Their method employs a Multiblock Local Binary Patterns texture and hue variance in the HSI color space to detect the shadow area of the water’s surface. A morphological operation with multiple dilation was employed to reduce false positives due to pseudo-water-patches.

The work by Nanni et al. [14] considered quite an original case study, that is, the automated classification of animal audio. For this task, the authors proposed the use a combination of Siamese neural network and different clustering techniques to train a support vector classifier.

4. Benchmarks and Comparative Evaluations

Using handcrafted features as visual descriptors has been the dominant paradigm in computer vision for many years. In the last decade however, consequently with the extraordinary advances in the field of deep learning, focus has been shifting from the model-based (‘a priori’) approach to ‘a posteriori’ strategies, where the features are learned from the data. Both methods have pros and cons; which one should be used in any specific application however, is far from clear. In this context, Karabağ et al. [15] comparatively evaluated traditional and deep learning methods for texture segmentation. In their work, they considered five well-known hand-designed methods (co-occurrence, filtering, local binary patterns, watershed, and multiresolution sub-band filtering) and a deep learning approach based on the U-Net architecture. The methods were evaluated on six classic mosaics of textured images. The main conclusion is that U-Net is effective for texture segmentation and provides equal or better than achieved with traditional texture algorithms. The authors also concluded that determining the correct configuration of the network is not a trivial task, and that variations of some parameters can easily lead to suboptimal results.

5. Reviews

Buzzelli [16] presented a valuable review of different approaches for automatic estimation of visual saliency—i.e., the perceptual property that makes specific elements in a scene stand out and attract the attention of the viewer. The work mainly investigates those domains where research attention is currently high, such as omnidirectional images, image groups for cosaliency, and video sequences. The paper also introduces domain-specific evaluation measures and provides quantitative comparisons among the different methods.

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