Guest Editorial

Special issue on computer vision applying pattern recognition techniques

This Special Issue of the Elsevier Journal of Pattern Recognition entitled “Computer Vision applying Pattern Recognition Techniques” presents the ongoing and active research in the Pattern Recognition applied to Computer Vision area, with emphasis on topics around emerging paradigms on computer vision, robotics, and up-to-date applications to related fields (hardware implementations, parallelsolutions). The overall goal of this Special Issue is to summarize in a handbook manner, recent discoveries and groundbreaking studies that will account for new research fields and disciplines in the broad area of pattern recognition based approaches to tackle computer vision gaps in knowledge.

The call for papers resulted in 28 submissions. At least three reviewers assessed the quality of the papers, and those meeting the top standards were sent to a second round of reviews. Finally, 13 papers were selected for publication. The guest editors hope that the selected papers will provide the readers with interesting examples of current research on the most outstanding theoretical frameworks in the pattern recognition context applied to Computer Vision as well as in the challenging field of applications through practical and efficient algorithms.

Let us provide first a general view of this Special Issue (SI). This issue has been compiled to demonstrate the growing interest for robust and innovative pattern recognition techniques to be applied to classical image processing problems, such as image segmentation, image denoising, image classification, camera calibration, edge extraction/detection for image and video analysis. A special feature of this SI is an extended discussion on Bayesian probabilistic schemes and restricted Boltzmann machines subject and its applications to computer vision. A different view, considering the human “in the loop”, as part of complex systems is included in this Special Issue in the form of human–computer interfaces relying on pattern recognition techniques. Additionally, adaptive learning, data mining and new trends in graph theory and GPU processing, all applied to relevant Computer Vision problems, are also included in this Special Issue.

Kiran and Serra open this Special Issue with the work entitled, “Global–Local Optimizations by Hierarchical Cuts and Climbing Energies”. In this manuscript, authors propose a new theoretical scheme dealing with a very relevant matter in Computer Vision: to find optimal cuts in hierarchies of images to practical useful applications such as color image segmentation and texture enhancement. Other important applications are also noted along the paper: detail segmentation and image compression. Another remarkable contribution of this article is the introduction of some new concepts: h-increase, singular and scale increasing energies, which are shown to play a relevant role within the global combinatorial problem of partition selection which results in linear time dynamic programs. The mechanism to ensemble new energies function is also addressed in the article. Along the manuscript, several algorithms map the sound theoretical framework into practical tools. Results on several images show the benefits of the proposal and open new fields of research combining hierarchical cuts with wavelet decomposition.

Fischer and Igel, in the paper entitled, “Training Restricted Boltzmann Machines: An Introduction”, present a self-contained tutorial about the very challenging topic of Restricted Boltzmann Machines (RBM) from the probabilistic graphical model perspective, with emphasis on the learning algorithms and their theoretical justification through several theorems. There are not many tutorial papers in Deep Learning/RBMs, and thus the present paper explains recent algorithms, like parallel tempering and persistent contrastive divergence which are of the most interest for researchers on the pattern recognition community. In addition, the experiments section illustrates the behavior of RBMs in practice and shows some applications to notable computer vision problems.

Oommen and Thomas propose in the work entitled, “Anti-Bayesian Parametric Pattern Classification Using Order Statistics Criteria for Some Members of the Exponential Family” the use of order statistics (OS) for Pattern Recognition and apply the moments of order statistics to some probability density functions belonging to the exponential family of distributions. The new scheme, referred to as classification by moments of order statistics (CMOS), has an accuracy that attains Bayes’ bound for Symmetric distributions, and is, otherwise, very close to the optimal Bayes’ bound, as has been shown both theoretically and by rigorous experimental testing. The results shown in this article also give a theoretical foundation for the families of border identification (BI) algorithms reported in the related literature.

Negri et al. present the paper entitled, “Detecting Pedestrians on a Movement Feature Space” devoted to detecting pedestrians in surveillance video sequences taken from video surveillance-type fixed camera filming outdoors. As it is known, pedestrian detection is considered a key chapter of pattern recognition and computer vision. Given that images may suffer changes in the scene appearance or rapid changes in lighting, this is a challenging problem. The authors propose to divide the problem into two main sub-problems: first one consisting of detecting movement in the scene and then, checking whether the moving object (target) is a pedestrian. The movement detection part is solved through an innovative background model using level lines all embedded into a Color Texton Space. This allows for the retrieval of color transitions and generation Movement Feature Spaces (MFS). Then, several descriptors are assembled and processed by a cascade of boosted classifiers combining generative classification functions with discriminant functions in an efficiently manner to allow its use in real-time video surveillance applications.
In the next paper, “Finding Contrasted and Regular Edges by a Contrario Detection of Periodic Subsequences”, Tepper et al. address the dissection of meaningful boundaries, developing an algorithm to select salient pieces contained in them. Based on the fact that level sets provide a complete and contrast-invariant image description, each level line is considered as a periodic binary sequence where, following a partial saliency model, each point is labeled as salient or non-salient. Then, the goal is to extract meaningful subsequences of salient points. This is done through a new fully-automatic algorithm to extract such features. The method relies on subsequences of local low-level features, such as contrast and regularity extracted from the image.

In the paper “HEGM: A Hierarchical Elastic Graph Matching for Hand Gesture Recognition”, the main contribution that the authors propose is a method for using elastic graph matching for the classification of hand gestures. The gesture classes are discriminated by using the concept of nodes’ hierarchies. The higher the hierarchy a node has, it better represents its class. Each node is represented by HOG feature vectors, and the classification is performed through boosting. The second contribution of the paper is three methods for image annotation, namely (a) automatic, semi-automatic and automatic techniques. Annotation is necessary to determine the position and the links of the nodes that constitute the elastic graph. Metrics are suggested to objectively compare the strengths and flaws of these methods.

Alemán-Flores et al. propose in the article entitled, “Camera Calibration in Sport Event Scenarios” the design of a novel and robust methodology for calibrating cameras from a single image in sport scenarios. This can be regarded as a fundamental problem in the field of computer vision, with real applications emerging when broadcasting soccer, basketball or tennis matches. An important restriction to this challenging problem comes from the fact that the calibration must be performed from a single image of the field (e.g. soccer field). The camera is mounted on a tripod and a set of primitives (lines and circles within the scene), are first extracted. This is a complex problem due to shadows, which is solved through a novel approach. Radial distortion is also adequately modeled and corrected. Having the primitives extracted, the location of the sport court in the scene is automatically obtained by estimating the homography which matches the actual court with its projection onto the image. From that, the camera calibration parameters, including the focal length due to zooming operations, as well as the camera position and orientation in the 3D space are obtained. Authors present convincing results for scale soccer scenes and for real scenarios.

Astudillo and Oommen propose in the paper “Self-Organizing Maps Whose Topologies Can Be Learned With Adaptive Binary Search Trees Using Conditional Rotations” a novel integration between the areas of Adaptive Data Structures (ADSs) and the Self-Organizing Maps (SOM). A new method named Tree-based Topology Oriented SOM with Conditional Rotation (TTOCONROT) is proposed. TTOCONROT extends some properties of a previous algorithm named Tree-based Topology Oriented SOM (TTOSOM) by same authors. Several non-trivial modifications have been done to TTOSOM in order to obtain TTOCONROT. Among them we can highlight the rearrangement of neurons of the tree by the use of rotations. These rotations are thoroughly explained in this paper. Another remarkable contribution of this manuscript comes from the introduction of the pioneering concept referred to as Neural Promotion, where neurons gain prominence in the Neural Network (NN) as their significance increases. The advantage of such a scheme is that no previous knowledge is required to use the method presented regarding topological particularities of the stochastic data distribution. The proposed method was evaluated for skeletonization.

In the next paper, from authors Lopes and Ribeiro, entitled “Towards Adaptive Learning With Improved Convergence of Deep Belief Networks on Graphics Processing Units” we turn back again to Restricted Boltzmann Machines and present an interesting implementation of computer vision algorithms on Graphics Processing Unit (GPU). Authors focus on two complementary approaches which significantly reduce time performance for pre-training a Deep Belief Network (DBN). The first approach uses an adaptive step size technique to efficiently enhance the convergence of the Constrastive Divergence algorithm to reduce the number of epochs necessary to train the Restricted Boltzmann Machines (RBMs) that support the DBN infrastructure. The approach is mapped to a parallel implementation running on a highly-scalable GPU. As main conclusion, it is shown through convincing experiments that the results contradict the pre-conceived idea that all the layers within the DBN should be pre-trained and show that by incorporating Multiple Back-Propagation (MBP) layers with selective actuation neurons its generalization capability is remarkably enhanced.

The following article, from authors Parodi and Gómez, entitled “Legendre Polynomials Based Feature Extraction for Online Signature Verification. Consistency Analysis of Feature Combinations”, presents an approach for signature verification based on Legendre polynomials. The main contribution of this work is the introduction of a new consistency factor, that proved to be a good predictor of verification error and thereby a great help in selecting the optimal feature combination for online signature verification process. Two different signature styles (Western signatures and Chinese signatures) are considered to evaluate the performance of the verification system and two state-of-the-art classifiers, Support Vector Machines and Random Forests are used in the verification experiments. The authors remark in their conclusions that for both signature styles and the two classifiers considered, the pen pressure improves the consistency factor and the verification errors whenever incorporated to a feature combination.

Torres et al. in the article “Speckle Reduction in Polariometric SAR Imagery with Stochastic Distances and Nonlocal Means”, present a technique for reducing speckle in Polariometric Synthetic Aperture Radar (PolSAR) images. Authors discuss the new despeckling filter, the Stochastic Distances based Nonlocal Means (SDNLM) filter, which is a non-local means filter specifically suited to the peculiarities characterizing the PolSAR images. This is done by considering the Whistler model to account for PolSAR data. As opposed to the standard non-local means filter, in the computation of weights, a statistical test to verify the validity for a given pixel of fitting to a particular probability density function is included. This is a notable contribution. The test procedure applied to evaluate the performances of the proposed filter is also remarkable. Besides, this SDNLM filter requires only tuning parameters, which is of great value in terms of optimizing its design. To validate the performance of this interesting approach, image quality assessment methods on simulated and real data are presented. It is clearly shown that the proposed SDNLM filter also enhances the polarimetric entropy and preserves the scattering information of the targets.

In the following article, “Automatic Classification of Legumes Using Leaf Vein Image Features”, authors Larese et al. describe a procedure for classifying plant leaves based on the geometrical analysis of their veins, discarding any leaf shape, size, color and texture information, since the interest is just focused in detecting differences in the leaf vein morphology. The veins segmentation is performed using morphological operators. The proposed algorithm includes preprocessing, feature extraction and classification by means of support vector machines (linear and Gaussian kernels), penalized discriminant analysis and random forests. The analysis of the results includes comparison to human expert’s performance and to cleared leave images (as opposed to scanned leaves). The experiments presented show that the results obtained
with the scanned legume leaves (which are much cheaper and faster to obtain than the cleared ones) outperform the manual expert’s recognition. This research is of interest for the pattern recognition community, but mainly those interested in pattern recognition applications for agriculture.

This Special Issue closes with the article “A New Proposal for Graph-Based Image Classification using Frequent Approximate Subgraphs” dealing with graphs-data representation intended for image classification. Having in mind that graphs are powerful representational tools but certainly hard to work with, Acosta-Mendoza et al. explore the benefits of combining graph techniques with data mining paradigm introducing approximate patterns discovery in the mining process in order to allow certain distortions in the data being modeled. Out of a collection of images represented as graphs, rises the question of whether graph mining techniques can be used to discover beneficial information and to perform certain tasks like image classification. To make possible the combination of the two so at first analysis different fields of research, a new visual description of regions is employed, showing the relevance of making accurate choices in this direction, since the underlying representation is the basis for obtaining useful features in the mining process. This challenging proposal is tested in two well-known collections to show the improvement with respect to previous related works.

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