Guest Editorial

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Special Issue on Computational Intelligence in Computer Vision and Image Processing

Vision in general and images in particular have always played an important and essential role in human life. Nowadays, the field of computer vision and image processing has been applied to a high number of real-world problems ranging from remote sensing to medical imaging, artificial vision, and computer-aided design. Specific applications range from low-level to high level, such as edge detection, segmentation, image understanding, automatic feature extraction and selection in complex images, object identification and scene analysis, object detection in medical images, face and fingerprint detection and recognition in security applications, texture image analysis, image registration, object tracking, and robot vision. The development of computer vision and image systems has attracted significant amount of attention recently from academia, industry, defence, and government as well.

However, despite the increasing power of the modern computer hardware, many traditional techniques still cannot meet our requirements in many aspects. Aspects such as the presence of noise in images, high clutter in image background, complex textures, large size in images and orders of magnitude, among others, cause difficulties for the success of the optimization process applied by traditional methods, which are prone to be trapped in local minima. In many of these aspects, automatic, efficient modeling and nonlinear optimization would be required. This is where computational intelligence such as evolutionary computation, fuzzy systems and neural networks has a great deal to offer in the field of computer vision and image processing. Approaches to edge detection, segmentation, feature extraction and selection, object recognition, object tracking, image registration, regression, classification and optimization all play important roles toward this objective.

The five articles that compose this special issue of *IEEE Computational Intelligence Magazine* highlight different aspects of this endeavor, from image segmentation, through object detection, motion detection, to video behavior analysis and mass classification in digital mammograms. The computational intelligence techniques involved include evolutionary computation, fuzzy systems and neural networks. They were selected from over 20 submissions through a rigorous, two-round peer-review process.

In the first article, "Image Segmentation Using Extended Topological Active Nets Optimized by Scatter Search," Bova, et al. apply Scatter Search to finding good extended topological active net models for image segmentation. They develop a new optimization approach by embedding the extended topological active nets (ETANs) into a global search memetic framework, Scatter Search, and consider multiple alternatives in the segmentation process using a very small solution population. They introduce a number of new developments including a global search-suitable internal energy term, a diversity function, a frequency memory population generator and two proper solution operators. This approach is examined and compared with two ETAN methods and a state-of-art-art memetic method based on differential evolution on a mixture of 20 synthetic and real medical images providing segmentation problems of varying difficulty. The results show that the new method significantly outperforms the three methods on these images.

In the second article, "Object Detection Using Color Entropies and a Fuzzy Classifier," Chen and Juang propose a novel approach to specific object detection in complex scenes using color-based entropy features and a fuzzy classifier (FC). The proposed detection approach consists of two filtering phases with two different color-based entropy features. The first phase filters a test pattern with the entropy of color component (ECC). A self-splitting clustering (SSC) algorithm is proposed to automatically generate clusters in the hue and saturation (HS) color space according to the composing pixels of an object. The second filtering phase uses the entropies of geometric color distributions (EGCD) to filter the object candidates obtained from the first phase. The EGCD values are fed to an FC to enable advanced filtering. A new FC using the SSC algorithm and support vector machine (FC-SSCSVM) for antecedent and consequent parameter learning, respectively, is proposed to improve detection performance. The results on the detection of different

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objects and comparisons with various detection approaches and classifiers verify the advantage of the proposed detection approach.

In the third article, "Understanding of GP-Evolved Motion Detectors," Song, et al. describe an approach to the use of genetic programming for motion detection, which is a fundamental functionality in many vision systems. This paper not only shows that good performance can be achieved using genetic programming for detecting moving objects of interest, but also that the evolved/learned programs (motion detectors) can be interpreted by humans. The analyses also show the capability of genetic programming to ignore uninteresting motions, differentiating fast motions from slow motions, identifying genuine motions from moving background and handling noise in the images.

In the fourth article, "Video Behavior Analysis Using Topic Models and Rough Sets," Zhao et al. propose an approach to the use of topic models and rough sets for analyzing video behaviors. In the new method, atomic activities are detected to construct the behaviors, optical flow is used for feature detection, and rough sets are used for behavior classification. This approach is compared with a Support Vector Machine (SVM) with a Gaussian kernel function for classification and the results suggest that the proposed approach outperformed the SVM method on the video image data sequences tested in the paper.

In the fifth article, "Variable Hidden Neuron Ensemble for Mass Classification in Digital Mammograms," Leod and Verma propose a variable hidden neuron based ensemble technique for classification of masses in digital mammograms. A novel ensemble technique using variable hidden neurons, hierarchical fusion and ten-fold cross validation is evaluated on the DDSM benchmark dataset. The results show a significant improvement in classification accuracy (98%) over single neural network and Adaboost, which obtained highest classification accuracy of 86% and 90% respectively. A comparative analysis conducted in this research indicates that the proposed ensemble technique produces potentially better results than some of the existing techniques for the classification of masses in digital mammograms.

In summary, the five selected papers for this special issue highlight challenging and novel applications of computational intelligence to computer vision and image processing. We would like to express our thanks to the reviewers who volunteered their time, experience, and professionalism to this special issue. We are very grateful to Dr. Kay Chen Tan, Editor-in-Chief of *IEEE Computational Intelligence Magazine* for his initial suggestion to develop this special issue, and for his suggestions and advice throughout the entire process of this special issue. We would also like to thank the authors for their time, effort and great work, and hope that this issue inspires others to assist with the growing need for rapid analysis in computer vision and image processing.