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IEEE Access special section editorial: Biologically inspired image processing challenges and future directions

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EDITORIAL

IEEE ACCESS SPECIAL SECTION EDITORIAL: BIOLOGICALLY INSPIRED IMAGE PROCESSING CHALLENGES AND FUTURE DIRECTIONS

Human kind is exposed to large amounts of data. According to statistics, more than 80% of information received by humans comes from the visual system. Therefore, image information processing is not only an important research topic but also a challenging task. The unique information processing mechanism of the human visual system provides it with fast, accurate, and efficient image processing capabilities. At present, many advanced image analysis and processing techniques have been widely used in image communication, geographic information systems, medical image analysis, and virtual reality. However, there is still a large gap between these technologies and the human visual system. Therefore, building an image system research mechanism based on the biological vision system is an attractive but difficult target. Although it is a challenge, it can also be considered as an opportunity which utilizes biologically inspired ideas. Meanwhile, through the integration of neural biology, biological perception mechanisms, and computer science and mathematical science, related research can bridge biological vision and computer vision. Finally, the biologically inspired image analysis and processing system is expected to be built on the basis of further consideration of the learning mechanism of the human brain.

The goal of this IEEE ACCESS Special Section on ''Biologically Inspired Image Processing Challenges and Future Directions'' is to explore biological vision mechanisms and characteristics to establish an objective image-processing model and algorithm that is closer to the human visual information-processing model.

The Call for Papers drew wide attention from the academic community and attracted more than 30 submissions. Eighteen high-quality articles were accepted as final publications in the Special Section after a rigorous review by at least two peer reviewers.

In the article, ''Deep multi-level semantic hashing for cross-modal retrieval,'' by Ji *et al.*, the authors propose a novel deep hashing framework based on multi-level semantic supervision for multi-label image-text cross retrieval. The binary similarity and complex semantic structure of data in different forms can be simultaneously captured by the proposed framework to improve the accuracy of searching results.

In the article, ''Knowledge graph-based image classification refinement,'' by Zhang *et al.*, the authors propose an image classification scheme with the novel concept of the image knowledge graph (IKG) to incorporate semantic association and scene association to fully consider the relations between objects (external and internal). The scheme overcomes the problems of background complexity and visual inconsistency and verifies its effectiveness on the ImageNet dataset.

In the article, ''Learning identity-aware face features across poses based on deep Siamese networks,'' by Gao *et al.*, the authors introduce deep Siamese networks to learn identity-aware and pose-invariant features by adding contrastive loss into face synthesis models, which preserves the face identity while synthesizing the face. Face synthesis models are trained with different target poses as supervisory signals, and the learned pose-invariant features are incorporated by another Siamese network to generate deeper pose-invariant and identity-aware features.

In the article, ''Moving target detection and tracking algorithm based on context information,'' by Li *et al.*, the authors propose a moving target detection and tracking algorithm based on context information and closed-loop learning to improve the robustness of the algorithm in complex environments in the long-term tracking task.

In the article, ''ESFNet: Efficient network for building extraction from high-resolution aerial images,'' by Lin *et al.*, the authors introduce a network named ESFNet, based on separable factorized residual block and the dilated convolutions for extracting building footprint from high-resolution aerial images. The network preserves slight accuracy loss, with low computational cost and memory consumption, and the idea can be further extended to other areas.

In the article, ''Parallel K nearest neighbor matching for 3D reconstruction,'' by Cao *et al.*, the authors propose a new feature tacking method for 3D reconstruction that works in a parallel manner, involving keypoint detection, descriptor computing, descriptor matching by parallel k-nearest neighbor (Parallel-KNN) search, and outlier rejecting. This method can rapidly match a large volume of keypoints, avoids consuming high computation time, and then yields correct correspondences.

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In the article, ''A human-inspired recognition system for pre-modern Japanese historical documents,'' by Le *et al*., the authors present a human-inspired document reading system to recognize multiple lines of pre-modern Japanese historical documents. The system, based on an attention-based encoder-decoder, is successful in recognizing multiple lines and connected and cursive characters without performing character/lines segmentation. The coverage model, which stores the history of eye movement, improves the precision of predicting the next movement.

In the article, ''Hide-CAM: Finding multiple discriminative regions in weakly supervised location,'' by Xu *et al*., the authors propose a weakly supervised localization scheme by hide strategy with the most discriminative and complementary object regions of the object to complete the location task.

In the article, ''Finger-vein image enhancement based on pulse coupled neural network,'' by Lei *et al*., the authors describe a new finger-vein image enhancement model based on the pulse coupled neural network (PCNN). A new parameter setting scheme is developed to automatically adjust the parameters of PCNN without empirical correlation or training. The enhanced finger-vein images produced by the present model improve recognition accuracy significantly.

In the article, ''Extracting palmprint ROI from whole hand image using straight line clusters,'' by Xiao *et al*., the authors describe a novel method to extract a palmprint region of interest (ROI) from whole hand images using a straight line cluster without knowing approximate positions of finger joint areas in advance, setting a reference point in advance, and extracting contours of the hand.

In the article, ''Real-time video saliency prediction via 3D residual convolutional neural network,'' by Sun *et al*., the authors introduce a novel end-to-end video saliency prediction model based on 3D-ResNet for data-driven spatio-temporal feature representation combining a multi-scale feature representation scheme and a frame skipping strategy. Moreover, a new challenging eye-tracking database with 220 video clips is established to facilitate the research of video saliency prediction.

The article, ''Toward a quality predictor for stereoscopic images via analysis of human binocular visual perception,'' by Liu *et al*., investigates a full-reference objective quality evaluator for stereoscopic images by simulating binocular interaction and depth perception based on a cyclopean image from a novel binocular combination model, and a depth binocular combination model from a depth synthesized procedure. The predicted results of the evaluator achieve high-consistent alignment with subjective observations.

In the article, ''An approach to extraction midsagittal plane of skull from brain CT images for oral and maxillofacial surgery,'' by Tan *et al*., the authors propose a semi-automatic extracting method based on the region growing method, oriented bounding box (OBB) bounding box, and mutual information algorithm for the midsagittal plane of skull in brain computed tomography (CT) images to ensure the accuracy and stability of extracting midsagittal plane while shortening the operation time.

In the article, ''Automatic kidney lesion detection for CT images using morphological cascade convolutional neural networks,'' by Zhang *et al*., the authors exploit a lesion detection tool using multi intersection over union (IOU) threshold based on morphological cascade convolutional neural networks (CNNs) to detect the location and size of lesions in CT scan images.

The article, ''Multivariate pattern analysis of EEG-based functional connectivity: A study on the identification of depression,'' by Peng *et al*., identifies the altered electroencephalography (EEG) resting-state functional connectivity patterns of depressed patients based on the phase lag index for constructing function connectivity matrices and the altered Kendall rank correlation coefficient for identifying highly discriminative features. The study sheds new light on the pathological mechanism of depression and suggests that EEG resting state functional connectivity analysis may identify potentially effective biomarkers for clinical diagnosis.

In the article, ''Multiple image features-based retinal image registration using global and local geometric structure constraints,'' by Bi *et al*., the authors propose a robust non-rigid retinal image registration based on multi-image features and dual constraints (i.e., the global and local geometric structure constraints) to overcome the problems of unreliable features, inaccurate matching, and geometric distortion.

In the article, ''Bio-inspired stereo vision calibration for dynamic vision sensors,'' by Domínguez-Morales *et al*., the authors present a bio-inspired stereo system connecting with a spike-based calibration mechanism. The novel calibration reduces the number and complexity of operations, allowing its integration into autonomous robots (provided with FPGA) without the need for computers with high power consumption and computational resources.

Finally, the invited article, ''MFNN: Position and attitude measurement neural network based on multi-feature fusion,'' by Man *et al*., describes a multi-feature fusion position and attitude measurement neural network (MFNN) combining with the HOG features to measure the position and attitude information of application engineering

In conclusion, we express our gratitude to the authors who submitted their research articles to this Special Section and the reviewers for their constructive comments. We are also grateful to the Editor-in-Chief and staff members for their guidance and support.

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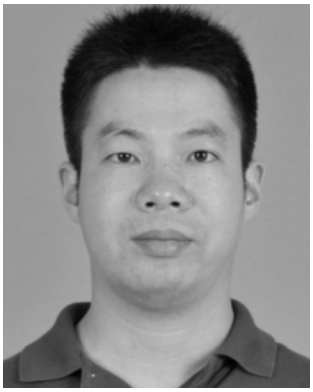
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