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Advances in Brain-Inspired Cognitive Systems

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This special issue focuses on recent advancements in the field of brain-inspired cognitive systems. It comprises 18 articles which are carefully selected, significantly revised versions of papers presented at the seventh International Conference on Brain-Inspired Cognitive Systems (BICS 2015) held at Hefei, China, on December 11–13, 2015. The aim of BICS 2015 was to bring together leading scientists, engineers, and educators who use analytic, syntactic, and computational methods both to understand the prodigious processing properties of biological systems and, specifically, of the brain, and to exploit such knowledge to advance computational methods toward higher levels of cognitive competence. The conference featured plenary speeches given by renowned scholars and a range of technical sessions focusing on timely topics of interest to the scientific community.

Based on the recommendation of symposium organizers and reviewers, a number of authors were invited to submit revised versions of their contributions to this special issue. All articles went through a rigorous review procedure involving at least three independent experts before being accepted for publication.

Chen et al. propose an efficient algorithm for action-based pedestrian identification using hierarchical matching pursuit and order-preserving sparse coding to identify and classify features.

Gepperth et al. present a novel system for performing multi-sensor fusion with experience-based learning. The authors demonstrate that near-optimal fusion can be learned and is a resource-efficient alternative to empirical estimation of joint probability distributions and Bayesian inference. They also show that their generative learning approach outperforms Bayesian optimum as it is capable of rejecting outliers through detection of systematic changes in input statistics.

Mi et al. describe a novel system for occluded face recognition. They propose a new similarity matrix called 'averaged degree of aggregation of matched pixels' and show that their system is very robust against occlusion and competitive in terms of recognition accuracy and computation time.

Jiang et al. present a cognitively distributed simultaneous localization and tracking algorithm, with applications in Gaussian distributed wireless sensor networks, based on adaptive distributed filtering for target tracking and sensor localization. Their proposed system shows higher accuracy in parameter estimation, coupled with low computational complexity.

Zhao et al. propose a new method called 'elastic matching' for common visual pattern discovery, through inducing sparse solutions and conducting detection more robustly.

Zhang et al. describe a discriminative Lasso in which sparsity and correlation are jointly considered. The method

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can select features (or stimuli) that are correlated more strongly with the response but are less correlated with each other.

Wu et al. propose a semi-supervised technique for real-time robot localization using visual manifold learned by kernel Principal Component Analysis and simultaneous parameter selection by Genetic Algorithms. The self-contained simultaneous localization and mapping system combines dimension reduction methods, manifold regularization techniques and parameter selection.

Zhou et al. present a novel framework for content-based image retrieval. The method employs a hierarchical approach to performing discrete cubic partitioning of the image and hierarchical mapping of the image data. At the end, the integration of these data into a 2D compressive sensing model suppresses noise and provides refined features. The proposed method shows improved retrieval accuracy and reduced computational complexity making it suitable for real-time applications.

Yin et al. discuss an improved reversible image authentication scheme. This makes use of Hilbert curve mapping to map image data to a 1D vector and then divides them into non-overlapping subsets to embed authentication codes using a reversible data hiding approach. The scheme is shown to cause less image distortion, improve detection accuracy, and enhance image quality.

Hu and Gu propose an interesting method for face recognition using multi-manifolds discriminative canonical correlation analysis. A linearity-constrained hierarchical agglomerative clustering algorithm is used to cluster image sets for finding orthogonal projections of those images. Lastly, an iterative learning algorithm is used to find the discriminative features.

Li et al. describe an improved target tracking approach using combinations of sparse representation and particle filtering. Density histogram, local binary pattern feature fusion, trivial templates, and energy control parameters are utilized in this study to enhance tracking robustness for better adaption to illumination and occlusion. The method is shown to outperform existing state-of-the-art methods.

Gepperth and Karaoguz present an incremental learning architecture for applied perceptual problems. The authors show how their method allows the addition of a perceptual class to a trained architecture without retraining and avoiding severe forgetting effects. Finally, the authors demonstrate that by adding a short-term memory system, the system retains excellent classification accuracy including during incremental learning.

Mahmud et al. propose an automated characterization method for single-trial local field potentials (LFPs) recorded from rat barrel cortex. The characterization is performed in multiple passes involving removal of artifacts, detection of relevant events in the artifact removed signals, and finally calculating the required parameters from those signals. Single-trial LFPs recorded under two anesthetics (tiletamine/xylazine and urethane) were then analyzed to demonstrate the usability of the method.

Kaiser et al. describe a low-cost solar-powered automatic wheelchair controlled by surface electromyogram (sEMG) signals. Relevant features of sEMG signals are extracted and converted into control signals to command the wheelchair using an artificial-neural-network-based classifier. The control signals are fed into a neuro-fuzzy-based microcontroller system to drive the wheelchair in desired directions.

Gao et al. propose a progressive enhancement detection method for high-resolution synthetic aperture radar targets, by simulating the information processing chain of retina, primary and advanced visual cortex, respectively. The method is shown to deliver improved target detection accuracy in complex scenes.

Liu et al. discuss a parallel and distributed platform, termed the 'Parallel Brain Simulator,' for modeling the cognitive brain at multiple scales. The simulator, inspired by large-scale graph computation, can be considered a parallel execution engine with reduced complexity, enabling simulations of large-scale neural networks.

Wang et al. present a sequentially supervised long short-term memory architecture for gesture detection. The method uses posture information to guide the learning process for detection. The architecture is to shown to provide simultaneous gesture recognition and pose estimation from RGB videos without the need for manual intervention.

Ullah et al. propose a cloud elasticity framework using multiple feedback controllers, to appropriately scale actions with different intensities, which are intelligently selected using a fuzzy inference system. The authors propose use of a basal ganglia computational model as a soft-switching approach for action selection, which is shown to enhance the overall system performance in comparison with existing state-of-the-art approaches.

Finally, the guest editors would like to thank the anonymous reviewers for their valuable and timely reviews of the manuscripts, which have helped ensure the quality of this special issue.