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IEEE Access Special Section Editorial: Trends and Advances in Bio-Inspired Image-Based Deep Learning Methodologies and Applications

Peter Peer

Carlos M. Travieso-Gonzalez

Vijayan K. Asari

Malay Kishore Dutta

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EDITORIAL

IEEE ACCESS SPECIAL SECTION EDITORIAL: TRENDS AND ADVANCES IN BIO-INSPIRED IMAGE-BASED DEEP LEARNING METHODOLOGIES AND APPLICATIONS

Many of the technological advances we enjoy today have been inspired by biological systems due to their ease of operation and outstanding efficiency. Designing technological solutions based on biological inspiration has become a cornerstone of research in a variety of areas ranging from control theory and optimization to computer vision, machine learning, and artificial intelligence. Especially in the latter few areas, biologically relevant solutions are becoming increasingly important as we look for new ways to make artificial systems more efficient, intelligent, and overall effective.

It is generally acknowledged that the human brain is a multitude of times more efficient than the best artificial intelligence algorithms and machine learning models available today. This suggests that there is still something fundamental to learn from the way the brain processes information and new biologically inspired ideas are needed to devise a more effective form of computation capable of competing with the efficiency of biological systems.

One of the hottest and most active research topics in the field of machine learning and artificial intelligence right now is deep learning. Deep learning models exhibit a certain kind of biological relevance, but differ significantly from what we see in the human brain in their structure and efficiency, and the way they process information. Deep learning models, such as convolutional neural networks, consist of several processing layers that represent data at multiple levels of abstraction. Such models can implicitly capture the intricate structures of large-scale data and are closer in terms of information processing mechanisms to biological systems than earlier so-called shallow machine learning models.

However, despite the recent progress in deep learning methodologies and their success in various fields, such as computer vision, speech technologies, natural language processing, medicine, and the like, it is obvious that current models are still unable to compete with biological intelligence. It is, therefore, natural to believe that the state of the art in this area can be further improved if bio-inspired concepts are integrated into deep learning models.

The purpose of this Special Section is to present and discuss novel ideas, research, applications, and results related to techniques of image processing and computer vision approaches based on bio-inspired intelligence and deep learning methodologies. It aims to bring together researchers from various fields to report the latest findings and developments in bio-inspired image-based intelligence, with a focus on deep learning methodologies and applications, and to explore future research directions.

The submissions were expected to include a discussion about the bio-inspired background of the presented method. The authors had to explain how their method and its novelty correlate with what we find in nature and/or organisms, brain, psychology, and similar.

The Call for Papers aroused great enthusiasm in the scientific community and received 47 submissions. Out of these, six articles were accepted for inclusion in the Special Section after a thorough review process by at least three independent referees.

In the article by J. Li *et al.*, "An end-to-end task-simplified and anchor-guided deep learning framework for image-based head pose estimation," the authors present a method that integrates the deep task-simplification oriented image regularization module into the anchor-guided pose estimation module, and formulate the head pose estimation problem into a unified end-to-end learning framework. The anchors are defined as images that strictly follow the gravity rule in camera and are employed in the proposed anchor-guided pairwise loss that describes the interdependent relevance of poses between pairs of images.

In the article by Z. Li *et al.*, "Towards adversarial robustness via feature matching," the authors introduce an enhanced adversarial training approach that begins with an empirical analysis of how the attention map of a deep neural network on an image will change as the model undergoes attacks. Motivated by the observation that the class-specific attention gets diverted, they propose a regularizer encouraging the consistency in attention maps of the clean image and its adversarial counterpart.

In the article by S. Kim *et al.*, "Bat-G2 net: Bat-inspired graphical visualization network guided by radiated ultrasonic call," the authors present a noise-immune bat-inspired graphical visualization network guided by the radiated ultrasonic call that can reconstruct 3-D shapes of a target from ultrasonic echoes. The Bat-G2 net achieves noise-resiliency by emulating bat's auditory system that processes echoes along with the highly correlated radiated ultrasonic call. In order to extract the information contained in the echoes robustly and effectively, two implementation ideas have been applied to the Bat-G2 net: radiated-ultrasonic-call-guided attention and nonlocal attention.

In the article by Yang *et al*., "DDaNet: Dual-path depth-aware attention network for fingerspelling recognition using RGB-D images," the authors propose a network that learns discriminative features related to fine-grained hand gestures while suppressing the effect of color–depth misalignment. Unlike existing approaches that independently process RGB-D images, a dual-path depth-aware attention network that learns a fingerspelling representation in separate RGB and depth paths, and progressively fuses the features learned from the two paths, is proposed.

In the article by Oblak *et al*., "Learning to predict superquadric parameters from depth images with explicit and implicit supervision," the authors build on contemporary neuroscience literature that acknowledges that complex shapes are represented as spatial arrangements of individual 3-D parts in the human visual system. They present a novel solution for recovering volumetric primitives from depth images, where they focus on the recovery of superquadrics, a special type of parametric model that can describe a wide variety of 3-D shapes using only a few parameters. They present a new learning objective that relies on the superquadric (inside-outside) function and develop two learning strategies for training convolutional neural networks capable of predicting superquadric parameters. The first uses explicit supervision and penalizes the difference between the predicted and reference superquadric parameters. The second strategy uses implicit supervision and penalizes differences between the input depth images and depth images rendered from the predicted parameters.

In the article by S. J. Kim *et al*., "Towards fast and accurate object detection in bio-inspired spiking neural networks through Bayesian optimization," the authors present a threshold voltage balancing method for object detection in spiking neural networks, which utilizes Bayesian optimization to find optimal threshold voltages in spiking neural networks. They specifically design Bayesian optimization to consider important characteristics of spiking neural networks, such as latency and number of synaptic operations. Furthermore, they introduce two-phase threshold voltages to provide faster and more accurate object detection, while providing high energy efficiency.

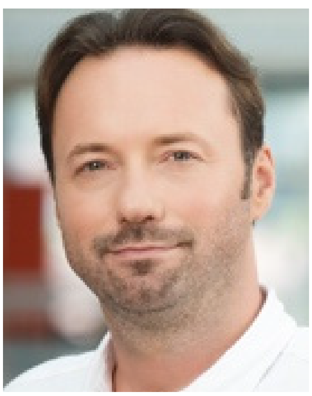
In conclusion, the Guest Editors of this Special Section hope that it will benefit the scientific community and contribute to the knowledge base. They express their gratitude to the authors for their contributions, to the volunteering referees for their dedication, and to the whole IEEE ACCESS editorial staff for their support.

PETER PEER, *Lead Editor*
Faculty of Computer and Information Science
University of Ljubljana
1000 Ljubljana, Slovenia

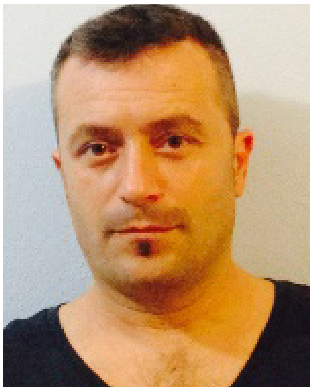
CARLOS M. TRAVIESO-GONZÁLEZ, *Guest Editor*
Institute for Technological Development
and Innovation in Communications
University of Las Palmas de Gran Canaria
35017 Las Palmas de Gran Canaria, Spain

VIJAYAN K. ASARI, *Guest Editor*
Department of Electrical and
Computer Engineering
School of Engineering
University of Dayton
Dayton, OH 45469, USA

MALAY KISHORE DUTTA, *Guest Editor*
Centre for Advanced Studies
Dr. A.P.J. Abdul Kalam Technical University
Lucknow 226031, India



PETER PEER (Senior Member, IEEE) received the Ph.D. degree in computer science from the University of Ljubljana in 2003. He is a Full Professor with the Faculty of Computer and Information Science, University of Ljubljana, Slovenia, where he heads the Computer Vision Laboratory, coordinates the Double Degree Study Program with Kyungpook National University, South Korea, and serves as the Vice-Dean of Economic Affairs. After completing the Ph.D. degree, he was an Invited Researcher at CEIT, Donostia-San Sebastian, Spain. He teaches courses on operating systems, game technology and virtual reality, and image-based biometry. He is currently a Guest Professor at North-Caucasus Federal University, Russia. His research interests include biometrics and computer vision. He participated in several national and EU-funded research and development projects and has published more than 100 research articles in leading international peer-reviewed journals and conferences. He was a Co-Organizer of the Unconstrained Ear Recognition Challenge in 2017 and 2019, and the Sclera Segmentation Benchmarking Competition in 2020. He is a member of EAB and IAPR, while at IEEE he also served as the Chairman of the Slovenian IEEE Computer Chapter for four years. He serves as an Associate Editor for IEEE ACCESS and *IET Biometrics*, and as a Topics Editor for *MDPI Applied Sciences*.



CARLOS M. TRAVIESO-GONZÁLEZ received the M.Sc. degree in telecommunication engineering from the Polytechnic University of Catalonia (UPC), Spain, in 1997, and the Ph.D. degree from the University of Las Palmas de Gran Canaria (ULPGC), Spain, in 2002. He is a Full Professor and the Head of the Signals and Communications Department, ULPGC, where he has been teaching subjects such as signal processing and learning theory since 2001. His research interests include biometrics, biomedical signals and images, data mining, classification systems, signal and image processing, machine learning, and environmental intelligence. He has participated in more than 48 international and Spanish research projects, some of them as the head researcher. He was the Vice-Dean of the Higher Technical School of Telecommunication Engineers, ULPGC from 2004 to 2010, and the Vice-Dean of Graduate and Postgraduate Studies from March 2013 to November 2017. He is the coauthor of four books, a co-editor of 25 proceedings books, and a guest editor of eight JCR-ISI international journals and nearly 24 book chapters. He has over 450 articles published in international journals and conferences (82 of them indexed in JCR, ISI, and Web of Science). He has published seven patents with the Spanish Patent and Trademark Office. He has been a Supervisor of nine Ph.D. theses (11 more are under supervision) and 130 master's theses. He won the ''Catedra Telefonica'' Award in Modality of Knowledge Transfer in the editions of 2017, 2018, and 2019, and in the Modality of COVID Research in 2020. He is the Founder of the IEEE IWOBI conference series and the President of its Steering Committee and the InnoEducaTIC conference series. He is the President of the APPIS conference series. He is an Evaluator of Project Proposals for European Union (H2020); Medical Research Council (MRC), U.K.; L'Agence Nationale de la Recherche (ANR), France; Spanish Government (ANECA); DAAD, Germany; Argentinian Government; and Colombian Institutions. He has been a reviewer for many different indexed international journals (>70) and conferences (>240) since 2001. He has been a member of the IASTED Technical Committee on Image Processing since 2007, and a member of the IASTED Technical Committee on Artificial Intelligence and Expert Systems since 2011. He was the APPIS 2020 General Chair, the ACM APPIS 2019 General Chair, the IEEE IWOBI 2019 General Chair, the IEEE IWOBI 2018 General Chair, the APPIS 2018 General Chair, the InnoEducaTIC 2017 General Chair, the IEEE IWOBI 2017, the IEEE IWOBI 2016 General Chair, the IEEE IWOBI 2015 General Chair, the InnoEducaTIC 2014 General Chair, the IEEE IWOBI 2014 General Chair, the IEEE INES 2013 General Chair, the NoLISP 2011 General Chair, the JRBP 2012 General Chair, and the IEEE ICCST 2005 Co-Chair. He is an Associate Editor of the *Computational Intelligence and Neuroscience* journal (Hindawi) and *Entropy* (MDPI).

VIJAYAN K. ASARI received the M.Tech. and Ph.D. degrees in electrical engineering from the Indian Institute of Technology, Chennai, in 1984 and 1994, respectively. He is currently a Professor of electrical and computer engineering and the Ohio Research Scholars Endowed Chair in Wide Area Surveillance at the University of Dayton (UD), Dayton, OH, USA. He is the Director of the Center of Excellence for Computational Intelligence and Machine Vision (Vision Lab), UD. Prior to joining UD in February 2010, he worked as a Professor of electrical and computer engineering at Old Dominion University, Norfolk, VA, USA, for ten years. He worked at the National University of Singapore from 1996 to 1998, and led a Research Team for the development of a vision-guided micro-robotic endoscopy system. He also worked at Nanyang Technological University, Singapore, from 1998 to 2000, where he led the computer vision and image processing related research activities with the Center for High Performance Embedded Systems. He holds four patents and has published more than 700 research articles, including 116 peer-reviewed journal articles in the areas of image processing, pattern recognition, machine learning, deep learning, and high performance embedded systems. He has supervised 30 Ph.D. dissertations and 45 M.S. theses over the last 20 years. Several graduate students are currently working with him on different sponsored research projects. He is a fellow of SPIE and a member of the IEEE Computational Intelligence Society. He received several teaching, research, advising, and technical leadership awards. He is the co-organizer of several SPIE and IEEE conferences and workshops.

MALAY KISHORE DUTTA is currently the Director of the Centre for Advanced Studies, Dr. A.P.J. Abdul Kalam Technical University, Lucknow, India, where he is also a Professor of computer science and engineering. He has coauthored over 270 indexed research articles in international journals and conferences. He was involved as the principal investigator for five funded research projects and has filed ten patents. He has guided three Ph.D. students (six ongoing) and 26 M.Tech. dissertations. He is on the reviewer panel and editorial panel of many prestigious journals. He headed the Amity School of Engineering and Technology, and under his headship, this institution secured 34th overall position and 19th position in the research category in the MHRD-NIRF ranking (All India Official Ranking) of engineering schools in 2018. His interests include artificial intelligence, especially deep learning, image processing, computer vision and pattern recognition, medical informatics, audio signal processing, bio-medical signal processing applications, and multimedia signal processing: tools and applications, applications of signal processing, and AI in biotechnology. He was the General Chair of the International Conference IEEE Signal Processing and Integrated Networks (http://amity.edu/spin2018/).

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