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Guest Editorial: Special Issue on Machine Learning and Signal Processing

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1 Introduction

Machine learning (ML), especially deep learning (DL), has embraced significant progress in the last decade. ML has unleashed its potential in computer vision and natural language processing, pushing these two fields to a new level. Meanwhile, various ML approaches were also proposed for various signal processing applications. Therefore, the goal of this special issue is two-fold: (1) introducing fundamental theories and advanced frameworks for machine learning and signal processing; (2) and presenting novel machine learning techniques to advance the development of signal processing.

The special issue consists of nine invited articles, which are the extended versions of their preliminary works published at IEEE International Workshop on Machine Learning for Signal Processing (MLSP) 2021. The articles cover a broad range of topics. Below, we briefly summarize the articles selected for publication in this special issue.

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2 Organization and Overview

2.1 Machine Learning for Signal Processing

The article entitled "Generalizable features for anonymizing motion signals based on the zeros of the Short-Time Fourier Transform" presented a new approach based on the zero's distribution of the Short-Time Fourier Transform (STFT) to prevent privacy leakage. Motivated by the link that Gaussian analytic functions and time-frequency transform of Gaussian white noise share the same distribution of zeros, this work proposed to extract features from motion signals by detecting zeros of STFT. Then some of the zeros are selected and evaluated by using Random Forest for the final tasks (i.e., activity detection and re-identification). Experiments conducted on two datasets verified the effectiveness of the proposed approach.

In the article "Graph Normalized-LMP Algorithm for Signal Estimation Under Impulsive Noise", Yan et al. introduced an adaptive graph normalized least mean pth power (GNLMP) algorithm to estimate sampled graph signals under the impulsive noise assumption. Compared to the least-squares-based algorithms, the proposed GNLMP algorithm can reconstruct a graph signal corrupted by non-Gaussian noise with heavy-tailed characteristics. Experimental results demonstrated that the proposed GNLMP algorithm can converge faster and be more robust than its competitors, such as GLMS and GNLMS.

The article entitled "GC-Net: An Unsupervised Network for Gaussian Curvature Optimization on Images" proposed a novel unsupervised network termed GC-Net for Gaussian Curvature Optimization on images. GC-Net is composed of multiple residual convolution blocks and is trained with the loss function, which includes an image similarity term and a Gaussian curvature regularization term. Extensive experiments on the BSDS-500 dataset demonstrated that GC-Net achieves comparable or even better performance than the existing methods for Gaussian curvature optimization,

image compression, and edge-preserving smoothing. The effectiveness of GC-Net is also verified on both synthetic and real images.

2.2 Machine Learning for SAR Image Understanding

The article entitled "Comparison between equivalent architectures of complex-valued and real-valued neural networks - Application on Polarimetric SAR image segmentation" provided a comprehensive comparison between the Complex-Valued Neural Network (CVNN) models and the Real-Valued Neural Network (RVNN) architectures on the Oberpfaffenhofen Polarimetric Synthetic Aperture Radar (PolSAR) database. For a fair comparison, BBarrachina et al. introduced a novel definition related to an equivalent-Real-Valued Neural Network. The experimental results indicated that CVNN outperforms a capacity equivalent-RVNN across various architectures for classifying PolSAR images.

In the article "Context-Preserving Region-Base Contrastive Learning Framework for Ship Detection in SAR", Zhang et al. introduced a new approach for ship detection in SAR under an unsupervised domain adaptation setting. The proposed method has three key designs: A region-based contrastive learning module is used to distinguish the object from the background; a newly-designed pseudo feature generation network is then used to align features of the source domain (i.e., optical image) and the target domain (i.e., SAR image); and an additional multi-scale detection module is eventually used to predict SAR images based on refined features. Experimental results on four datasets demonstrated the effectiveness of the proposed framework.

2.3 Machine Learning and its Applications

The article entitled "Semi-supervised Few-shot Learning via Dependency Maximization and Instance Discriminant Analysis" introduced a semi-supervised approach for few-shot learning (FSL) by exploiting unlabeled data for performance improvement. A Dependency Maximization method is presented to maximize the statistical dependency between the embedded features of those unlabeled data and their softmax predictions. Moreover, an instance Discriminant Analysis strategy is proposed to evaluate the credibility of each pseudo-labeled example so that the most faithful ones will be selected to train the model. Extensive experiments are conducted on four widely-used datasets, and the results verify the effectiveness of the proposed approach.

The article entitled "Visual Tracking Based on Depth cross-correlation and Feature Alignment" proposed a novel object tracker named SimAPA for object tracking in unconstrained environments. SimAPA consists of three new modules, including the Adaptive Dilated Fusion module, Depth Pixel-Wise Correlation module, and Feature Alignment module, which are specifically designed to address the challenges from object tracking, such as fast motion and extensive scale variations. Extensive experiments on several public datasets (i.e., VOT2017, OTB100, LaSOT) demonstrated that the proposed object tracker SimAPA is effective.

The paper entitled "A combined multi-mode visibility detection algorithm based on convolutional neural network" introduced the improved DiracNet for the visibility detection task. A combined multi-mode algorithm is proposed to train the model in a short time with a relatively small number of samples. Experiments conducted on the atmospheric fine particle concentration data and haze video data demonstrated the effectiveness of the proposed method.

The article entitled "A novel recyclable garbage detection system for waste-to-energy based on optimized CenterNet with feature fusion" introduced a recyclable garbage detection system and contributed a recyclable garbage dataset. The proposed detection algorithm improves the baseline method CenterNet with feature fusion such that it can detect subtle features. Both YOLO and the original CenterNet model are adopted for comparison. Experiments conducted on the newly-collected dataset indicated promising results of the proposed algorithm.

3 Conclusion

The articles selected for publication in this special issue encompass a broad range of research topics related to machine learning and signal processing. We hope that this collection of articles will be helpful for both experts in the related fields and those interested in exploring the potential of machine learning technologies for signal processing related applications.

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