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A Special Section on Approaches and Techniques for Biomedical Imaging—Part 1

It is a pleasure as Editors to introduce this special section on Approaches and Techniques for Biomedical Imaging which pursues to discussing the state-of-the art of research in the Biomedical Imaging Area, providing valuable insights on updated machine learning and image processing methods and their application to challenging biomedical problems. In general terms, this special section aims to accounting for outstanding research in biomedical imaging application in combination with Biological Mechanics [1–14] and relevant areas. However, although the practical biomedical interest is the main target of all papers selected, special attention has been devoted to theoretical and fundamentals of algorithms and methods discussed herein.

As Editors, it has not been an easy task to select the 20 papers due to the average high-level of most submitted manuscripts. It has been also our interest to cover a broad area of biomedical research, spanning from ultrasound to PET (Positron emission tomography) systems; from deterministic to probabilistic/fuzzy methods and also paying special attention to the paradigm provided by CNNs (Deep Convolutional Neural Networks).

Following our past Editorial guidelines, at least two reviewers—in occasions even 5 reviewers—assessed the quality of the papers, and those meeting the top standards were sent to a second round of reviews. Special care has been taken to plots, figures and algorithm descriptions included in this special section in order to provide a high-value visual impact to readers to ease its understanding.

The guest editors hope that the selected papers will provide the readers with useful examples of present research on some outstanding theoretical frameworks in the pattern recognition and machine learning context applied to Biomedical Imaging as well as in the challenging field of applications through practical and efficient algorithms.

The details of the accepted 20 papers are as follows:

Leyuan Zhou et al. design a multi-organs auto-contouring method based on Laplacian Support Vector Machines (LapSVM) to assist medical problems during radiation treatment. Auto-contouring is divided into two steps. One is to effectively segment image voxels into several groups, and the other automatically contours target organs according to the group labels. The experimental results verify that the proposed method achieves satisfied contouring accuracies upon abdominal magnetic resonance (MR) images.

Zheng Sun et al. present an adaptive focusing method based on time reversal (TR) improve the quality of endoscopic photoacoustic tomography (EPAT) reconstructions. Results of computer-simulation experiments indicate that the reconstruction quality is obviously improved compared with the case that the acoustic scattering is ignored in the standard TR reconstruction. A conclusion can be drawn that the image artifacts caused by the acoustic scattering can be significantly reduced with the proposed method.

Lin Zhou et al. propose a convolutional encoder–decoder network which allows the input of the image of any-size and produce the segmented mask of the same size effectively from the mammographic image without any preprocessing to detect various breast neoplastic. The experimental results demonstrate that the method provides much better segmentation performance than several compared methods.

Zhenyu Ping et al. suggest a transfer-learning-based support vector machine (TrSVM) method for epileptic electroencephalogram recognition. A large-margin-projected mechanism is integrated into a classical SVM model, which can be utilized to resist the loss of performances caused by the differences between data distributions. The experimental results confirm that TrSVM outperforms the existing related methods for epileptic electroencephalography (EEG) recognition.

Yin Dai et al. implement a cross-layer convolutional neural network to diagnose Parkinson's disease. The cross-layer convolutional neural network is used to learn and test the multi-modality fusion images, PET single-mode fusion images, T2-MRI single-mode fusion images respectively. The results show that the designed network is more suitable for the diagnosis of Parkinson's disease.

Qianyi Zhan et al. design the model Community-based Sentiment Analysis Method (ComSenti), which incorporates social relation among users and sentiment signals from terms into a unified framework to build an opinion mining problem in evaluating audience reaction about anti-smoking campaign, Tips on online social network. The proposed method ComSenti combines both social relation and textual sentiment signal. The results show that ComSenti has better performance than other methods.

Yongli Xu et al. apply a novel computer-aided diagnosis algorithm to extract glaucoma features from fundus images and optical coherence tomography (OCT) reports. It is validated that, on a real dataset of fundus images and OCT reports, using Shared

Feature Learning based on Prior Information (SFL-PI) for feature extraction and then using Multi-view ensemble classification (MvEC) for classification achieved state-of-the-art performance.

Ta Zhou et al. introduce a multi-layer Takagi-Sugeno-Kang (TSK) fuzzy system with fast aggregation training (ML-TSK-FA) based on the negative correlation learning theory to classify epileptic electroencephalograms (EEG) signals. Experiments show that the introduced classifier ML-TSK-FA is very suitable for EEG signal classification.

Aiguo Chen et al. propose a modified version of the fuzzy c means (FCM) algorithm, which is integrated the advantages of the conventional FCM clustering algorithm and the hidden Markov random field (HMRF) model to incorporate spatial information by using HMRF model and meanwhile overcome the disadvantages of noise sensitivity of the classical FCM algorithms. The robustness and effectiveness of the algorithm are demonstrated by a series of experiments on simulated and real medical images.

Wei Zhang et al. present a deep convolutional neural network (CNN) combined with a shearlet transform and denoising autoencoder to reduce noise in low-dose computed tomography (CT) images. Experimental results show that the method effectively suppresses noise, thereby preserving the edges and structures in low-dose CT images.

Zheng Sun et al. report a method based on variance contribution rate (VCR) to fuse raw ultrasonic echoes, photoacoustic signals and optical coherence tomography (OCT) interference signals for intracoronary ultrasound, intracoronary photoacoustic and intracoronary optical coherence tomography (ICUS-PA-OCT) combined imaging. Results indicate that the fused signals preserve rich information of the morphological structure and chemical composition of the tissues. The joint images display the morphology and location of the plaque tissues with high spatial resolution, contrast and sensitivity.

Yinmeng Wang et al. design a framework about array smoothing coherence factor (ASCF) and generalized coherence factor (ASGCF) methods in the plane-wave ultrasound imaging (PWUI). Results show that the ASCF and ASGCF methods obtained both higher contrast ratio and contrast-to-noise ratio over conventional coherence factor (CF) and generalized coherence factor (GCF) methods in both simulated and experimental studies.

Kaifa Zhao et al. explore a novel transfer fuzzy clustering (TFC)-back propagation neural network (BPNN)-leveraged tissue segmentation based attenuation correction (AC) method (TFC-NN-TSAC in short) for PET/MR images by jointly using TFC as well as BPNN. The experimental results demonstrate that the proposed TFC-NN-TSAC method has good performance of tissue segmentation for Dixon-based MR data, thereby owning nice AC performance for PET images.

Yi Huang et al. reveal a guided multiscale normalized cut (GMNC) method to segment vessel membranes in intravascular ultrasound (IVUS) frames. The results conclude that the average Hausdorff distance (HD), percentage of area difference (PAD) for media segmentation decrease, compared with the best one of three existing methods (the sequential algorithm based, the region detection based and the statistical model based). The mean of Jaccard measure (JM) also increases. It can be concluded that the GMNC has advantage in media segmentation.

Jinxia Ren et al. find a new needle detection algorithm by combining fuzzy enhancement with Hough transform used in ultrasound guided biopsy. Experimental results demonstrate that the method generally has higher detection accuracy than other compared methods in that it can provide 6.7% mis-detection rate and its mean length and angle errors are 8.8 pixels and 0.98 degree, respectively. Meanwhile, the implementation time of the proposed method is 25 ms. Indeed, the proposed algorithm can detect the linear surgical instruments accurately and meet the demand of clinical practices.

Zhou Fang et al. adopt an automatic 2D breast tumor segmentation method based on a fully convolutional network named M-Net combined with a phase-based active contour (PBAC) model to segment breast tumor from ultrasound images. The experimental results of M-Net + PBAC method achieve a Dice similarity coefficient score of 96.89%, and a Hausdorff distance (HD) of 6.96 pixels, which are the best segmentation performance compared with U-Net and V-Net.

Jinke Wang et al. propose a two-stage high-dimensional feature selection method, combing Bayesian Rough Set (BRS), Genetic Algorithm (GA) and Cuckoo Search (CS) for effective feature extraction of pulmonary tumors. Comparative experiments are implemented with conventional classification algorithms, and the results show that the proposed method can effectively improve the accuracy of the pulmonary tumor classification, while reducing the time-cost.

Dong Hua et al. develop an improved Rapidly-exploring random trees (RRTS)-based approach by combining the reachability-guided strategy, the greedy heuristic strategy and the central angle control method to force the paths generated by the proposed algorithm to be excellent enough and be clinically executable. The environment-adaptive sampling strategy is adopted to improve the computational efficiency and stability of the algorithm. The simulations and experiments demonstrate that the algorithm can perform the more stable and faster motion planning than the compared algorithms.

Yong Liang et al. recommend a novel feature calibration approach to improve cross-session classification performance in brain-computer interface (BCI) systems. Experimental results find that the proposed method has better general performance than state-of-the-art works in the task of cross-session motor imagery classification. This calibration method is expected to contribute to electroencephalogram (EEG) based cross-session BCI applications.

Guanglei Sheng et al. suggest an unsupervised clustering algorithm termed as multi-view multi-medoid fuzzy clustering (MVMVFC) for magnetic resonance images (MRI) segmentation. The clustering performance indicates that MVMVFC is a promising clustering algorithm and very effective for MRI segmentation compared with other multi-view clustering algorithms.

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