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Editorial

Introduction to the special section on Medical Image Processing with Deep Learning (SI-mip)

1. Background

Initially, from the 1970s to the 1990s, medial image processing was done with low-level pixel processing and mathematical modeling for specific tasks. At the end of 1990s, machine learning techniques, such as supervised learning, feature extraction and classification, became increasingly popular in medical image analysis. Despite its advantages by employing machine learning, there still exist high entry barriers to non-experts who intend to exploit machine learning methods for medical image processing due to the lack of a solid background on either medical or machine learning. Over the past decade, medical image processing with deep learning has witnessed a tremendous amount of attention. Deep learning has lowered the barriers by absorbing the human-engineering step into a simple and unified learning scheme, and providing exciting solutions for medical image analysis problems.

This special section aims at emphasizing the efficacy of deep learning in medical image analysis applications. We received 34 papers in response to the CFP, covering a wide range of topics from video processing to X-ray image analysis. Ten papers were rigorously selected based on peer reviews. The selected papers focus on research perspectives that present new, yet concrete, ideas that could benefit ongoing research. Each paper was reviewed by at least two reviewers and went through at least three rounds of reviews. The brief contributions of these papers are discussed below.

2. Papers in the special section

The first paper by Ozturk and Akdemir [1] presents a Convolutional Neural Network (CNN) model to identify cancerous areas on whole-slide histopathological images. A median filter has been proposed as the pre-processing step and found superiority over many other popular pre-processing methods. By training on 23,040 images and testing on 5056 images, the proposed CNN model achieves an AUC of 97.7%.

The second paper by Guo et al. [2] predicts bone age using X-ray image. To handle the problem of poor-quality X-ray image, the authors introduce three new model architectures to improve image quality. Finally, they complete the bone age prediction task via a network entitled 'BoNet+' which is based on a densely connected convolutional network.

In the third paper, Nadimi et al. [3] improves ZF-Net to localize colorectal polyps in images captured during wireless colon capsule endoscopy. They first select ZF-Net from 5 different architectures and change the process with new SGDM and learning rate. Experiments are conducted on 11,300 capsule endoscopy images and they achieve accuracy of 98.0%, sensitivity of 98.1% and specificity of 96.3%.

X-ray image evaluation of rheumatoid arthritis typically is performed by trained medical staff requires several minutes per patient. In the fourth paper, Rohrbach et al. [4] propose to complete such job via an improved VGG16 network, with pre-trained features learning from ImageNet. Bone erosion is evaluated by Ratingen score and 102,265 cropped grayscale images are used for the classification. To handle the imbalanced dataset, they adopt weights for the loss function and use a balanced accuracy. Experimental results show that the proposed model is as good as a human expert.

Optical coherence tomography (OCT) is widely used in clinical ophthalmology. Gholami et al. [5] in the fifth paper propose an open-access dataset containing more than 500 high resolution OCT images categorized into classes such as Normal, Macular Hole, Age-related Macular Degeneration, Central Serous Retinopathy, and Diabetic Retinopathy. In addition, a Graphical User Interface (GUI) which can be used by clinicians for manual (and semi-automated) segmentation is proposed.

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The sixth paper by Guan et al. [6] proposes a network to detect arm bone fracture via X-ray images. They first employ feature pyramid to process images in different scales and then adopt image processing to improve the input image quality. Finally, the authors adaptively change the receptive field to find more fractures. Comparisons with several state-of-the-art methods on MURA dataset verify the superiority of this method.

To efficiently complete pre-cancerous tissue abnormality analysis, the seventh paper by Awan [7] proposes a two-stage CNN, detection and classification. The main contribution of this paper is to train a model using the features which vary across the different classes, rather than from correlated features. The proposed CNN improves the classification by 10%.

In the eighth paper, Sirazitdinov et al. [8] focus on pneumonia localization from a large-scale Chest X-ray database. An ensemble of two CNNs, RetinaNet and Mask R-CNN, is proposed and other techniques such as post-processing and bounding box confidence thresholding are also employed. A total of 26,684 images are tested and the proposed method achieves 0.793 in terms of recall.

In the ninth paper, Cai et al. [9] propose a deep convolutional feature fusion scheme to detect lesion from CT scans. The authors adopt a one-state framework accompanied with 3D context such as texture, contour and shape to detect lesions. Experiments on the DeepLesion dataset which consists of 10,594 CT studies of 4427 unique patients are performed.

The last paper by Kablan et al. [10] proposes a fully convolutional neural networks for pleural effusion cell nuclei segmentation. They first fine-tune several popular segmentation networks such as FCN, SegNet, and U-Net, and then adopt feature ensemble from the fine-tuned networks. Experiments on a new dataset containing 120 PE cytology images verify the effectiveness of the proposed method.

3. Final thoughts

To conclude, this special section provides some state-of-the-art techniques that cover a wide scope in medical image processing with various input sources (regular image, video, X-ray image) on different tasks (detection, prediction, evaluation). All contributions provide various suggestions for future research, although these research works offer only a small fraction of deep learning for medical image processing. The guest editors sincerely hope that the articles included in this special section can inspire future research on this topic.

We wish to express our sincere thanks to the editor-in-chief for giving us the chance to organize this special issue. Also, we want to thank to the editorial office staffs for their excellent and professional support. Finally, we appreciate all the authors who made this special section possible, and to the reviewers for their thoughtful contributions.

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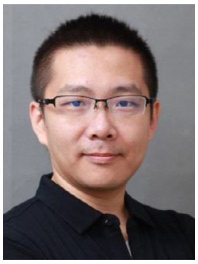

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