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EDITORIAL

Deep learning in multimodal medical imaging for cancer detection

Priti Bansal[1] · Vincenzo Piuri[2] · Vasile Palade[3] · Weiping Ding[4]

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The number of cancer cases is rising at a higher pace than ever all over the world. Multimodal medical imaging is used to diagnose different type of cancers using Magnetic Resonance Imaging (MRIs), Computed Tomography (CT) scans, Whole Slide Images (WSIs), etc. Manual detection of cancers using imaging is a time-consuming process and is highly dependent on the expertise of the doctor/consultant. Considering the higher mortality rate associated with the late detection of cancer, a computer-aided diagnosis (CAD) system that can detect cancer accurately within time constraints is essential, as early detection is the key to cure cancer.

Deep learning models (DLMs) have shown great potential in the field of medical imaging for cancer diagnosis as well as cancer treatment management. To improve the accuracy of cancer detection, DLMs are preferred over traditional methods for performing various image processing tasks, such as extraction of handcrafted features, image segmentation to find the region of interest (ROI), etc., but there is still a long way to go.

The major challenges faced by researchers in this field are twofold.

✉ Priti Bansal
priti.bansal@nsut.ac.in

Vincenzo Piuri
vincenzo.piuri@unimi.it

Vasile Palade
ab5839@coventry.ac.uk

Weiping Ding
ding.wp@ntu.edu.cn

[1] Department of Information Technology, Netaji Subhas University of Technology, New Delhi, India

[2] Department of Computer Science, University of Milan, Milan, Italy

[3] Centre for Computational Science and Mathematical Modelling, Coventry University, Coventry, UK

[4] School of Information Science and Technology, Nantong University, Nantong 226019, China

The first one is related to the inaccessibility of adequate and large datasets for a proper training of DLMs, imbalanced datasets, presence of noise, image quality, etc. One of the main reasons behind the inaccessibility of proper datasets owes to the privacy of patients, due to which many organizations are reluctant to share their data publicly. This problem can be solved using federated learning techniques. Also, a number of pre-processing techniques can be employed to deal with dataset imbalance and noise removals. Fuzzy theory plays a vital role in dealing with uncertainty and ambiguity present in medical images.

Another challenge is that DLMs are computing resource intensive, which makes them unsuitable for handheld devices. Recently, the entire world has experienced COVID-19 pandemic, which was making people confined to their homes. As a result, it is necessary to design lightweight DLMs with optimized architectures that can be implemented on handheld devices and used by patients at home for an initial diagnosis. In addition to this, a lot of hyperparameters need to be tuned for improving the performance of DLMs. This can be achieved by using metaheuristic algorithms, which were proven to be robust including for solving multi-objective problems.

This topical collection is aimed at exploring techniques that can be used to overcome the challenges faced by researchers working on deep learning for multimodal medical imaging. Our aim was to motivate researchers in this field to submit high-quality manuscripts to solve the above challenges so that further progress can be made in this domain.

Each manuscript in this topical collection has made a significant contribution and assisted in progressing ahead in addressing the challenges encountered by the researchers in the field of medical imaging and DLMs, but there is still a long way to go. We are confident that the papers published in this topical collection will provide an insight to the researchers in the field of medical imaging and DLMs.

The first paper in this collection is by Guang Yang et al., who proposes a region-based Evidential Deep Learning (EDL) segmentation framework to quantify segmentation uncertainty that helps to improve the reliability and robustness of segmentation. They propose a new evaluation metric called soft uncertainty error overlap (sUEO) for uncertainty estimation that assess the model's ability to localize segmentation errors easily.

In the next paper, Mohammad Mehedi Hassan et al. compared three Explainable Artificial Intelligence (XAI)-based approaches for computer-aided COVID-19 identification. The comparison considers three different aspects, namely input perturbation, selectivity and continuity. This paper provides an insight about how XAI proves to be a valuable asset to deliver out-of-the-box explanations about the inner mechanisms of deep neural networks.

The paper by Liping Liu et al. develops an Ischemic Stroke Computed Tomography-Encoder-Decoder Network (ISCT-EDN). This is a deep-learning model used for fully automatic ischemic lesion segmentation of Non-Contrast Computed Tomography (NCCT) images of acute ischemic stroke (AIS) patients after they undergo endovascular therapy (EVT). This model helps in identifying the infarct lesions, calculating the infarct volume and assisting clinicians in diagnosis and treatment. Experimental results show that ISCT-EDN outperforms other state-of-the-art segmentation models on several segmentation evaluation metrics.

Muhammad Attique Khan et al. proposed a deep learning framework for multiclass classification of skin lesions. Two deep-learning models are used for feature extraction. Once the features are extracted, feature selection is performed on both the feature vectors using the proposed Entropy-Slime Mould algorithm, and the selected features are fused using the Serial-Threshold fusion technique. Finally, classification is performed using various classifiers to compare their performance.

The fifth paper, by Jinghong Xu et al., proposes an Adaptive fuzzy Gray Level Co-occurrence Matrix (GLCM) segmentation and Fuzzy-based Capsule neural Network (F-CapsNet) for segmentation and classification of skin lesion images. Various image pre-processing steps are also applied to remove dark frames, the Vignette effect, hair artifacts, etc., from the dermoscopy images in order to improve their quality.

In the next paper by Miguel Ángel Molina-Cabello et al., a feature density method that estimates the feature density by means of histogram calculation is used as an estimation model of uncertainty. This is evaluated on binary classification of mammograms.

The paper by Fayaz Ali Dharejo et al. presents a new dermoscopic image datasets for melanoma detection, called Nail-Melanoma-350. This dataset is used to train and evaluate seven deep learning models using transfer learning.

In the next paper by Hamid Alinejad Rokny et al., the Monte Carlo Dropout (MCD) algorithm is employed to design an uncertainty-aware deep neural network. The proposed algorithms assign high predictive entropy to erroneous predictions and enable the model to optimize the hyper-parameters during training, leading to improved uncertainty quantification.

In the final paper of this collection, Lin Qi et al. present a two-stage progressive unsupervised domain adaptation network (TSP-UDANet) for cross-modality cardiac image segmentation based on generative adversarial learning. The proposed model is evaluated on three different cross-modality multi-objective medical image segmentation tasks that include MMWHS (unpaired MRI and CT images), MS-CMRSeg (cross-modality MRI images), and M&Ms (cross-vendor MRI images) datasets.

This topical collection proved to be successful because of the efforts and contributions of a lot of people in various roles. The guest editors appreciate all the authors for their invaluable contributions. We would like to express our sincere gratitude to the reviewers for providing instrumental and constructive feedback to the authors. We would like to take this opportunity to thank the Editor-in-Chief and the editorial team, who selflessly guided us during the entire process of this topical collection. The entire journey would not have been possible without their guidance and support. Last but not the least, we very much hope that readers of this topical collection will find it useful and that this collection will provide new insights and research avenues to researchers in this domain.