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Editorial

Development of multimodal neuroimaging markers for neurological disorders – Part 2

Kelvin K.L. Wong[a,*], Defeng Wang[b] and Peipeng Liang[c]
[a] *School of Medicine, Western Sydney University, Sydney, New South Wales, Australia*
[b] *Research Center for medical image computing, Department of imaging and interventional radiology, The Chinese University of Hong Kong, Hong Kong*
[c] *Department of Radiology, Xuanwu Hospital, Capital Medical University, Beijing, China*

The second part of the special issue includes 5 articles. Among them, two evaluate the treatment effect using imaging techniques including fMRI and optical positioning system (OPS), and three address the issues related to development and application of new methods for improving the accuracy and efficiency of neuroimaging data analysis.

Tumour tracking and radiotherapy are the most implemented technique in the treatment of brain cancer. However, patient-positioning accuracy continues to be an inevitable question in radiotherapy. In order to improve treatment efficacy, Zhou et al., reported a study that focused on the comparison of Cone Beam CT and OPS positioning in radiotherapy of phantom experiment [1]. To illustrate the positioning accuracy of OPS, a clinical trial using EPID was designed, and the comparative results of patient-positioning accuracy between using conventional positioning method and OPS was reported. In the end, the authors gave a report about the influence to the radiotherapy caused by the deviation of positioning in the radiotherapy and the OPS as a novel image guidance technology. The study concluded that, OPS had higher precise than conventional positioning methods, compartively fast, and efficient positioning method with respect to the CBCT guidance system.

On the other hand, Li et al., investigated the dose parameter comparison for hippocampus protection between dual arc VMAT and 7F-IMRT for patients with brain metastases from lung cancer under the whole brain radiotherapy [2]. In this study, a region with a margin of 4 mm around hippocampus was proposed to be regarded as a virtual organ at risk (OAR) to reduce the dose received by hippocampus, which ensures that, the patients do not lose learning and memory functions and enhance their life qualities [3]. Two types of radiotherapy plans (i.e., dual arc VMAT and 7F-IMRT) were designed. An analysis and comparison of DVH curves was made for two plans and the statistical analyses were performed to compare dose parameters. The dose parameters include CI and HI of the target, the maximum dose of OARs (i.e., hippocampus, eyes, lens and optic nerve), MU, and treatment time [4].

*Corresponding author: Kelvin Kian Loong Wong, School of Medicine, Building 30, Western Sydney University Campbelltown Campus, Narellan Rd & Gilchrist Dr, Campbelltown NSW 2560, Australia. Tel.: +61 4620 3620; E-mail: kelvin.wong@westernsydney.edu.au.

In this research, we can learn which radiotherapy technique is more suitable for hippocampus protection under the whole brain radiotherapy. Meanwhile, the target clinical requirements can be met and OARs can be protected to the maximum.

Finally, since the multimodality neuroimaging can generate huge amount of image data, how to quantitatively process and analyse the image data in order to optimally extract useful and reliable clinical markers remains a big challenge in the field. Thus, this special issue also includes three methodological articles that aimed to develop new neurological image and data processing tools, which applied to image denoising and image segmentation. Such tools are the basic processing steps for medical image visualization and processing, image feature computation, and selection selection, which plays an important role for disease classification and development of multi-feature based machine learning models for predicting disease prognosis. Wang et al., proposed a new feature selection method by combining the normalized mutual information (NMI) and fisher discriminant ratio [5]. Although machine learning techniques have been widely used to classify fMRI data in the studies of exploring brain cognition or brain disease diagnosis [6, 7], the classification performance still needs to be to be improved as it is always restricted by the high dimensional property and noises of the fMRI data. In the proposed method, the normalized mutual information was used to evaluate the relationships between features then the fisher discriminant ratio was applied to calculate the importance of each feature involved. Experimental results based on two fMRI datasets revealed that the proposed method yielded the highest classification performance.

Chen et al., investigated a new multi-scale non-local denoising method applying to neuroimaging [8]. Noise exists in neuroimages due to several reasons such as, the movement of scanning equipment and patients. Therefore, removing noises from neuroimages is increasingly important to clinical diagnosis [9]. Non-local means algorithm can remove neuroimage noise in a unique way that is contrary to traditional techniques. However, this method suffers from high computational complexity. In this study, a multi-scale non-local means method was proposed, in which adaptive multi-scale technique was implemented. In the proposed method, the input image is divided into small blocks based on each selected scale then the noise in the given pixel is removed by using only one block. This can overcome the low efficiency problem caused by the original non-local means method. The proposed method was compared with the ones by the original and the improved non-local means denoising method. Experimental results show that the new method is faster than the original and the improved non-local means method. The study also proved that, the new method is robust enough to remove noise in the neuroimaging applications.

The last article on neurological image processing focuses on brain MRI segmentation. Elazab et al., proposed a new modified version of the well-known Fuzzy c-means clustering to segment the brain MR images [10]. Since focusing on brain tissue segmentation for MRI is a necessary step for brain quantification [11] and a prerequisite procedure for studying brain tumour growth [12], authors proposed a robust kernelized local information fuzzy c-means clustering algorithm that runs on the image histogram instead of the image grayscales, and utilized a Gaussian radial basis kernel as a metric function to replace the Euclidean distance. The study also presented a new method that can efficiently combine both local grayscale and spatial information of the pixel's neighbourhood to damp the extent of noise and produce more homogenous regions. Based on multiple experiments in terms of different types and levels of noises, the study demonstrated that the new image segmentation was significantly more robust to noise and thus better preserved image details (cerebrospinal fluid) with low computational complexity.

In summary, the two parts of this special issue includes 10 selected papers contributed by researchers with a wealth of knowledge in different neurology research and neuroimaging research fields, which we hope that can provide readers with valuable sources of information on the recent progress in multimodal neuroimaging markers for neurological disorders and neurological image data processing as well. We also hope this special issue will provide a platform for researchers, clinicians, and healthcare professionals to collaborate on some research areas with the aim of promoting medical study of the neurological functions and related brain diseases. In addition, it can be used as a valuable source of references for researchers to conduct more advanced studies in neuroscience.

References

[1] H. Zhou, J. Shen, B. Li, J. Chen, X. Zhu, Y. Ge and Y. Wang, Analysis of precision in tumor tracking based on optical positioning system during radiotherapy, *J Xray Sci Technol* **24** (2016), 443–455.

[2] J. Li, X. Tang, B. Wang, X. Chen, D. Chen and L. Chai, Comparison between Dual Arc VMAT and 7F-IMRT in the protection of hippocampus for patients during whole brain radiotherapy, *J Xray Sci Technol* **24** (2016), 457–466.

[3] D. Palma, et al., Volumetric modulated arc therapy for delivery of prostate radiotherapy: Comparison with intensity-modulated radiotherapy and three-dimensional conformal radiotherapy, *International Journal of Radiation Oncology* Biology* Physics* **72**(4) (2008), 996–1001.

[4] V. Gondi, W.A. Tomé and M.P. Mehta, Why avoid the hippocampus? A comprehensive review, *Radiotherapy and Oncology* **97**(3) (2010), 370–376.

[5] Y. Wang, J. Ji and P. Liang, Feature selection of fMRI data based on normalized mutual information and fisher discriminant ratio, *J Xray Sci Technol* **24** (2016), 467–475.

[6] C. Gaser, et al., BrainAGE in mild cognitive impaired patients: Predicting the conversion to Alzheimer's disease, *PloS One* **8**(6) (2013), e67346.

[7] W. Huf, et al., On the generalizability of resting-state fMRI machine learning classifiers. *Front Hum Neurosci* **8**, 502. doi: 10.3389/fnhum.2014.00502

[8] Y. Chen, C. Wang and L. Wang, Multi-scale non-local denoising method in neuroimaging, *J Xray Sci Technol* **24** (2016), 477–487.

[9] N. Sadeghi, et al., Analysis of the contribution of experimental bias, experimental noise, and inter-subject biological variability on the assessment of developmental trajectories in diffusion MRI studies of the brain, *NeuroImage* **109** (2015), 480–492.

[10] A. Elazab, Y.M. Abdulazeem, S. Wu and Q. Hu, Robust kernelized local information fuzzy c-means clustering for brain magnetic resonance image segmentation, *J Xray Sci Technol* **24** (2016), 489–507.

[11] N. Sharma and L.M. Aggarwal, Automated medical image segmentation techniques, *Journal of Medical Physics* **35**(1) (2010), 3.

[12] E.D. Angelini, et al., Glioma dynamics and computational models: A review of segmentation, registration, and in silico growth algorithms and their clinical applications, *Current Medical Imaging Reviews* **3**(4) (2007), 262–276