Adventures in Deep Learning-assisted Multimodality Medical Imaging Wonderland

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Summary

Positron emission tomography (PET), x-ray computed tomography (CT) and magnetic resonance imaging (MRI) and their combinations (PET/CT and PET/MRI) provide powerful multimodality techniques for *in vivo* imaging. Tis talk presents the fundamental principles of multimodality imaging and reviews the major applications of artificial intelligence (AI), in particular deep learning approaches, in multimodality medical image analysis. It will inform the audience about a series of advanced development recently carried out at the PET instrumentation & Neuroimaging Lab of Geneva University Hospital and other active research groups. To this end, the applications of deep learning in five generic fields of multimodality medical imaging, including imaging instrumentation design, image denoising (low-dose imaging), image reconstruction quantification and segmentation, radiation dosimetry and computer-aided diagnosis and outcome prediction are discussed. Deep learning algorithms have been widely utilized in various medical image analysis problems owing to the promising results achieved in image reconstruction, segmentation, regression, denoising (low-dose scanning) and radiomics analysis. This talk reflects the tremendous increase in interest in quantitative molecular imaging using deep learning techniques in the past decade to improve image quality and to obtain quantitatively accurate data from dedicated standalone (CT, MRI, SPECT, PET) and combined PET/CT and PET/MRI imaging systems. The deployment of DL-powered methods when exposed to a different test dataset requires ensuring that the developed model has sufficient generalizability. This is an important part of quality control measures prior to implementation in the clinic. Novel deep learning techniques are revolutionizing clinical practice and are now offering unique capabilities to the clinical medical imaging community. Future opportunities and the challenges facing the adoption of deep learning approaches and their role in molecular imaging research are also addressed.

Short Biography

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Habib Zaidi is Chief physicist and head of the PET Instrumentation & Neuroimaging Laboratory at Geneva University Hospital and full Professor at the medical school of the University of Geneva. He is also a Professor at the University of Groningen (Netherlands), the University of Southern Denmark (Denmark) and Óbuda University (Hungary). His research is supported by the Swiss National Foundation, the European Commission, private foundations and industry (Total 10M+ US$) and centres on hybrid imaging instrumentation (PET/CT and PET/MRI), computational modelling and radiation dosimetry and deep learning. He was guest editor for 14 special issues of peer-reviewed journals and serves and serves as founding Editor-in-Chief (scientific) of the *British Journal of Radiology (BJR) | Open*, Deputy Editor for *Medical Physics* and is on the editorial board of leading journals in medical physics and medical imaging. He has been elevated to the grade of fellow of the IEEE, AIMBE, AAPM, IOMP, AAIA and the BIR. His academic accomplishments in the area of quantitative PET imaging have been well recognized by his peers since he is a recipient of many awards and distinctions among which the prestigious (100'000$) *2010 Kuwait Prize of Applied Sciences* (known as the *Middle Eastern Nobel Prize*). Prof. Zaidi has been an invited speaker of over 170 keynote lectures and talks at an International level, has authored over 420+ peer-reviewed articles (h-index=76, >22'000+ citations) in prominent journals and is the editor of four textbooks.