Artificial Intelligence-powered Multimodality Medical Imaging: Challenges and Opportunities

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Abstract: 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. This 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 imaging. 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 by reducing artefacts 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 AI-based 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. Future research plans at Óbuda University will also be highlighted.