THE 13th INTERNATIONAL CONGRESS ON MRI &
30th ANNUAL SCIENTIFIC MEETING OF KSMRM &
7th ANNUAL MEETING OF ASMRM

ICMRI & ASMRM 2025

Illuminating the Invisible: Advances in MRI
OCTOBER 31 - NOVEMBER 1, 2025
Grand Walkerhill Seoul, Seoul, Korea
https://icmri.ksmrm.org/2025m/

MR Physics & Engineering 2

SY13-2

Target-Oriented Deep Learning Approaches for MRI Brain Imaging

Uk-Su Choi

Daegu Gyeongbuk Medical Innovation Foundation (K-Medi Hub), Korea

Deep learning has emerged as a transformative technology in neuroimaging, offering robust performance and significant efficiency gains compared to traditional statistical methods. Its capacity to learn complex hierarchical features directly from data overcomes the limitations of conventional approaches, such as subjective feature selection and time-consuming manual processing. While deep learning has been successfully applied to tasks like brain segmentation and parcellation, the performance of these models is fundamentally dependent on the characteristics of the training data. This dependency necessitates a target-oriented strategy to address specific clinical and research challenges that general-purpose models often fail to resolve adequately. This lecture introduces two specialized deep learning models designed for distinct, challenging applications in MRI brain imaging, underscoring the efficacy of a targeted developmental approach.

To address these specific needs, we developed two novel deep learning frameworks. The first, ‘deepParcellation’ is a 3D U-Net-based model designed to overcome the limitations of existing tools in analyzing brain images of elderly East Asians, a population with unique morphometric characteristics. The model was trained on a large-scale, heterogeneous dataset, including extensive Korean regional cohort data, to ensure robustness and specificity. The second model, ‘deepPGSegNet’ was developed for the precise segmentation of the pituitary gland in healthy individuals. To manage challenges posed by its small size and limited annotated data, we implemented a patch-based training strategy and utilized targeted data augmentation. Our models demonstrated significant performance improvements. The deepParcellation model showed superior accuracy compared to conventional models, with lower failure rates and higher DICE scores, particularly in elderly and East Asian datasets. Critically, it exhibited enhanced sensitivity in detecting structural biomarkers associated with Alzheimer's disease, indicating its potential for improved early diagnosis. The deepPGSegNet model achieved high segmentation accuracy and its clinical utility was validated by successfully replicating established findings, including gender-based differences in pituitary volume and its negative correlation with chronological age.

These findings highlight the substantial benefits of a target-oriented approach in developing deep learning applications for neuroimaging. By tailoring model architecture and training datasets to specific populations and anatomical structures, we can overcome the generalization limits of existing methods. These specialized models not only provide more accurate and reliable segmentation but also enhance the detection of subtle, clinically significant biomarkers. This targeted strategy holds significant promise for advancing neuroimaging research and improving diagnostic precision in diverse clinical contexts, from neurodegenerative diseases to endocrinological studies.

Keywords: Deep learning, MRI brain imaging, Neuroimaging, Brain parcellation, Brain segmentation