Low-Field MRI Super-Resolution With Densely Engineered U-Net++ Network: Improving Resolution and Contrast of Portable MRI With Nested U-Net Architecture, Enabling Low-Cost Bedside Neurological Imaging on a Global Scale

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Low-field (LF) MRI scanners have the power to revolutionize medical imaging by providing a portable and cheaper alternative to high-field MRI scanners. However, such scanners are usually significantly noisier and lower quality than their high-field counterparts. This prevents them from appealing to global markets. The aim of this project is to improve the SNR and overall image quality of low-field MRI scans (called super-resolution) to improve diagnostic capability and, as a result, make it more accessible. To address this issue, we propose a Nested U-Net neural network architecture super-resolution algorithm that outperforms previously suggested super-resolution deep learning methods with an average PSNR of 78.83 ± 0.01 and SSIM of 0.9551 ± 0.01. Our ANOVA 34 paired t-test and Post-Hoc Tukey test demonstrate significance with a p-value < 0.0001 and no other network demonstrating significance higher than 0.1. We tested our network on artificial noisy downsampled synthetic data from 1500 T1 weighted MRI images through the dataset called the T1-mix. Four board-certified radiologists scored 25 images (100 image ratings total) on the Likert scale (1-5) assessing overall image quality, anatomical structure, and diagnostic confidence across our architecture and other published works (SR DenseNet, Generator Block, SRCNN, etc.). Our algorithm outperformed all other works with the highest MOS, 4.4 ± 0.3. We also introduce a new type of loss function called natural log mean squared error (NLMSE), outperforming MSE, MAE, and MSLE on this specific SR task. Additionally, we ran inference on actual Hyperfine scan images with successful qualitative results using a Generator RRDB block.

Awards Won:

Second Award of $2,000