An Efficient and Accurate Super-Resolution Approach to Low-Field MRI via U-Net Architecture With Logarithmic Loss and L2 Regularization

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The medical field is becoming increasingly reliant on medical imaging for diagnostic procedures. Although traditional high-field MRI scanners produce high-quality images at high SNR, they are inefficient for emergency neuroimaging tasks and quick analysis of the patients' conditions. Low field (LF) MRI scanners are portable, cost-effective, and safer tools for non-invasive diagnostic imaging. Such scanners can be wheeled to the patient's bedside due to the low strength of the scanners (64 mT- brought down to 1/1000 of the magnetic field strength of traditional scanners). Here, I was able to generate high-resolution images from representative low SNR down-sampled scans via a machine learning approach. Traditional machine learning super-resolution (SR) reconstruction methods for medical imaging that utilize general architectures like static convolutional neural networks (SCNNs) or recurrent neural networks (ReCNNs) are unable to reconstruct precise anatomical figures. Hence, I proposed an SR U-Net to produce high-resolution images more accurately and efficiently. Unlike SCNNs and ReCNNs, U-Nets concave layers of the same shape to preserve feature upscaling which produces more anatomically correct results. My aim in this study was to accurately downsample high-resolution MRI scans to reflect image quality attainable at low field and utilize a machine learning reconstruction approach to increase their resolution. Here, I evaluated this novel approach on T1-weighted downsampled scans and actual LF MRI scans to demonstrate the efficiency of my network. Additionally, I incorporated a logarithmic loss component and L2 regularization to make the U-Net more efficient in learning and to prevent over smoothing.

Awards Won:

Second Award of $2,000

National Taiwan Science Education Center: Taiwan International Science Fair Special Award is a trip to participate in the Taiwan International Science Fair

Drexel University: Full tuition scholarship