Edge, Structure, and Frequency Refinement for MRI Super Resolution Reconstruction Using Dual Domain Feature Fusion Network

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Abstract. Recently, deep convolutional neural networks have been used to address the super resolution image reconstruction problems in general. Moreover, various types of CNNs which are base on ResNet, DenseNet, etc, have been proposed to generate super resolution image for 2D MRI applications. One of the greatest challenges is how to design an suitable network framework and loss function tailored for MRI applications, especially for reconstruction of the edge information provided by high frequency components in k space. Recent studies suggest that using perceptual feature space loss and k space loss to capture such informative elements from edge, respectively. However, the quality of reconstructed super resolution 2D MR image is limited cause the the features could not be extracted and represented by only simply adding loss function in both image field and k space. Besides, lots of the super resolution approaches are trained by using low resolution image generated by applying Gaussian blur kernel with down sampling, which can not represent the process measured by the MRI machine in the real world. Such inconsistencies lead to performance degradation in the reconstruction of super resolution MR image as well. In this paper, we design a dual domain deep learning model which fuse the feature extracted from both additional information space and image field together with attention mechanism and train these models by using low resolution images which are created by emulating how they should be made in the real world, reveal the reconstruction of super resolution MR image could achieve better performance by exploring more information in additional information space rather than stacking more loss components in loss function. We also tailor multiple deep learning models which have been proposed recently, e.g. Bi-cubic Interpolation, SRCNN, U-ResNeXt, DDBPN, RDN, RCAN, SAN, etc, as baseline references.

Keywords: MRI · Super Resolution Reconstruction · Deep Learning · U-ResNeXt · DDBPN · RDN · RCAN · SAN · Pixel-wise MSE Loss · Dual Domain Network · Frequency Domain(k space) · SSIM · Gradient map · Edge Quality Loss

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