A Multimodal Dense U-Net for Accelerating Multiple Sclerosis MRI

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Fast MRI for Multiple Sclerosis

High-quality acquisition of magnetic resonance (MR) images requires the sampling of the entire *k*-space.

Data in the *k*-space encode information on spatial frequencies and are captured line by line, thus requiring long scanning time.

Slow MRI may introduce motion artifacts, besides increasing the healthcare cost and limiting the availability of scanners.

One possibility to reduce the scanning time is to capture few *k*-space lines and reconstruct the undersampled image.

We propose to reconstruct MR images by exploiting the joint information provided by different kinds of undersampled input.

We focus on multiple sclerosis MRI, in which lesions can be observed through T2 Weighted (T2W) and FLAIR sequences.

The joint use of FLAIR and T2W images increases the reconstruction efficiency, especially in the lesion region.

The proposed method exploits the multimodal approach of deep neural networks.

It focuses on the data acquisition and processing stages to reduce the execution time of the MR analysis.

The Proposed Multimodal Dense U-Net Architecture

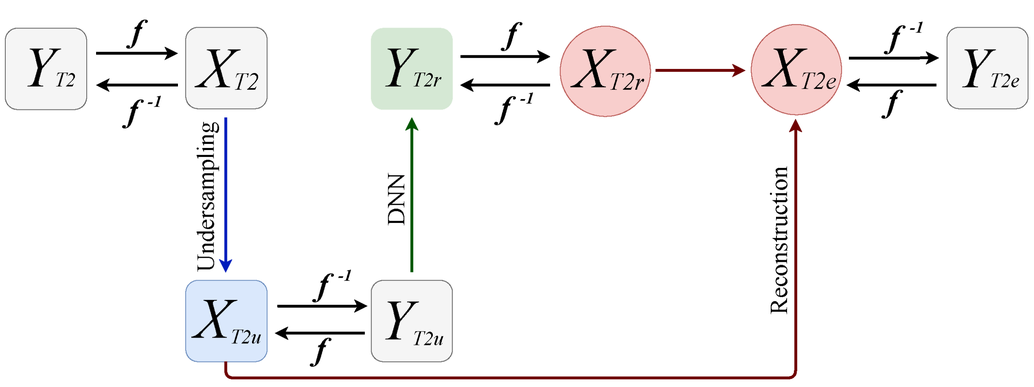

Figure 1. General framework of the proposed approach.

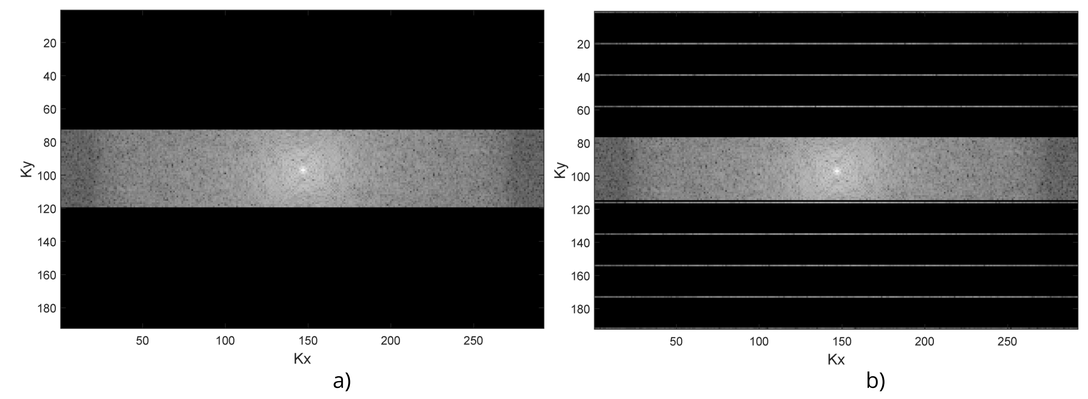

Figure 2. Proposed undersampling approach: a) classic mask and b) the proposed mask, which selects the 80% of the total samples from the center. Both the masks are obtained by setting an undersampling factor $k = 4$.

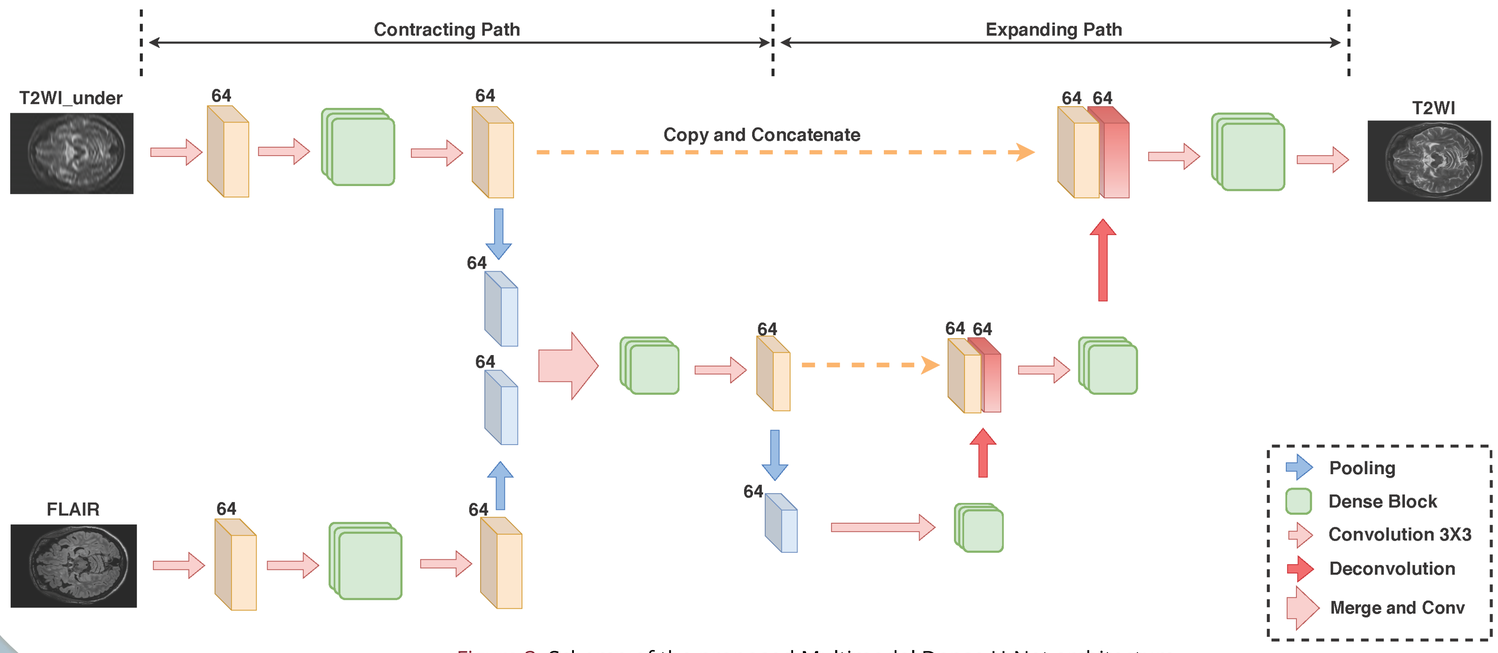

Figure 3. Scheme of the proposed Multimodal Dense U-Net architecture.

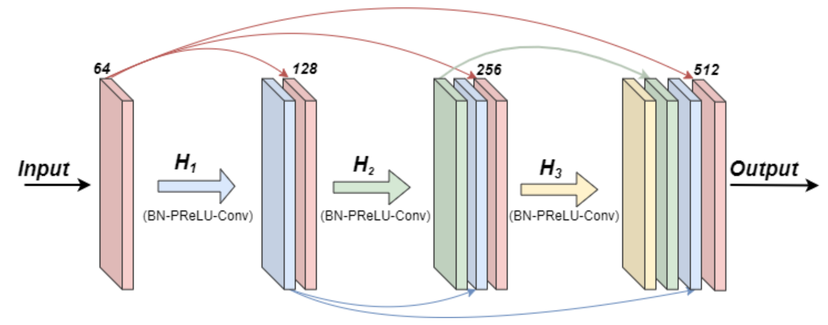

Figure 4. Scheme of the dense block used in the proposed MDU. The exponential GR allows an expansion of the size of the feature maps that effectively increases the depth of the entire network by improving the flow of features between the levels.

Experimental Results for $K = 4$ and $K = 8$

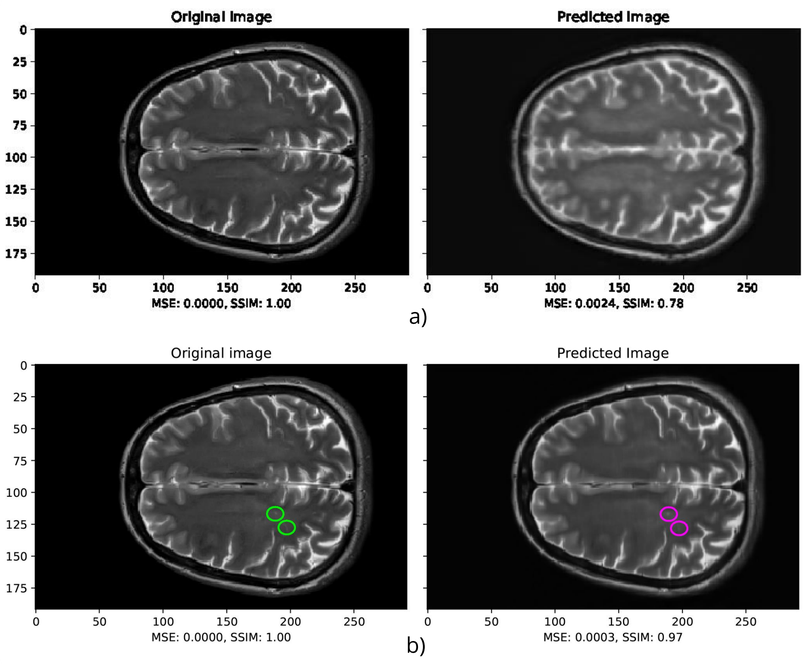

Figure 5. Results of the image reconstruction (Y_{T2r}) with an undersampling factor of $k = 4$ using: a) a Dense U-Net and b) the proposed Multimodal Dense U-Net. The proposed MDU allows a 93% lesion reconstruction.

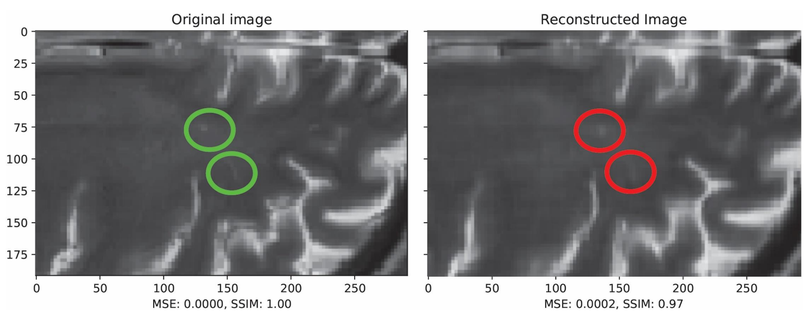

Figure 6. Results of the image reconstruction after the post processing (Y_{T2e}) with an undersampling factor of $k = 4$. The MDU yields now a 97% lesion reconstruction.

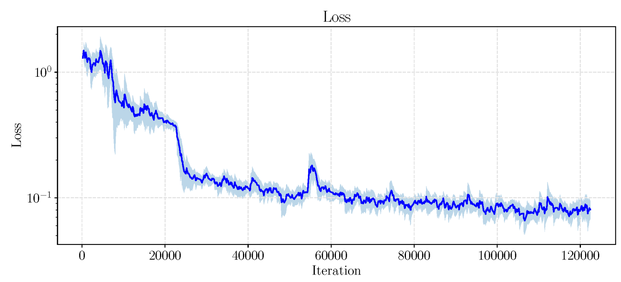

Figure 7. Loss function for the proposed Multimodal Dense Unet with $k = 4$.

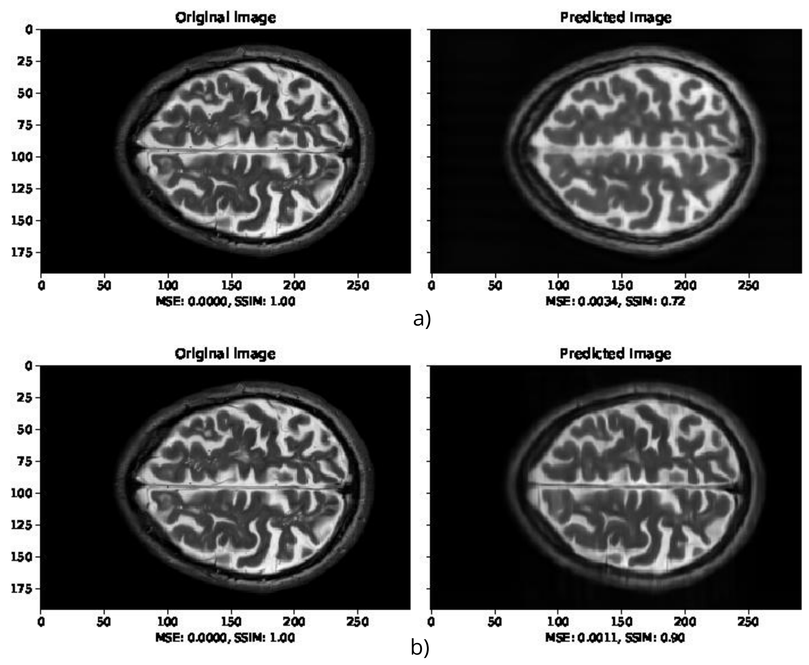

Figure 8. Results of the image reconstruction with an undersampling factor of $k = 8$ using: a) a Dense U-Net and b) the proposed Multimodal Dense U-Net.

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