Patch-based super-resolution for arterial spin labeling MRI
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In clinical conditions, ASL images are often acquired at low resolutions (LR). This implies partial volume effects (PVE), limiting the validity of cerebral blood flow (CBF) quantifications.

We propose an adaptation of a super-resolution algorithm1, taking advantage of a high resolution (HR) structural image to reconstruct CBF maps at a higher resolution, without increasing the acquisition time.

The proposed algorithm therefore consists in:

• a 3rd order spline interpolation to increase the image dimensions
• iterations between the non-local patch-based regularization and an original data fidelity term until convergence

\[ X_{t+1}^{i} = \frac{1}{Z_i} \sum_{j \in V_i} X_j^i \exp \left( -\frac{\|N(S_i) - N(S_j)\|^2}{2\sigma_i^2} \right) + \frac{\|N(X_j^i) - N(X_j^i)\|^2}{2\sigma_i^2} \]

with \( N(X_j) \) a 3x3x3 neighborhood, \( V_i \) a 7x7x7 search volume around voxel \( i \), \( \sigma_i \) the empirical variance and \( Z_i \) a scaling parameter.

In order to validate the ability of the algorithm to retrieve a HR image, we applied it to an original HR CBF map downsampled by a factor of 2 in each direction.

The dimensions of the CBF maps were also increased using nearest neighbor, trilinear and 3rd order spline interpolation as a matter of comparison.

The following images present the CBF maps obtained with the different methods:

From left to right: HR CBF image, nearest neighbor, trilinear, 3rd order spline and super-resolution reconstructions

The original HR CBF map being considered as the reference image, the quality of the reconstructions was evaluated by calculating the PSNR between this reference and the generated images.

PSNR between the reference HR CBF map and the maps reconstructed using nearest neighbor, trilinear, 3rd order spline and the proposed super-resolution algorithm.