MUTANT: A new image filtering paradigm for improved parameters determination. Application to myelin water fraction mapping and sodium concentrations imaging

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Based on the Bayesian theorem, we introduced a new paradigm for the design of high-performance image filters. This comprehensive statistical framework is applicable to most imaging modalities where multispectral images, that is, frames with different contrasts, can be acquired from the same subject or sample. Unlike the classical nonlocal filtering approaches, our formalism permits incorporation of adaptive fusion operators to calculate and merge the frame-dependent weights within the multispectral images. We show that the widely used multispectral nonlocal means filtering represents only a special case of our generalized framework. Through extensive numerical and *in-vivo* analyses conducted on MR images for myelin water fraction (MWF) determination and sodium concentrations mapping, we demonstrate the flexibility and high performance of our formalism for accurate and precise parametric mapping. Our results indicate that the use of adaptive fusion operators provides an advanced degree of freedom for the multispectral filtering leading to higher quality filtering with details preservation in derived MWF maps as well as in the sodium images (Fig. 1). The later are used to derive concentration maps by biexponential inversion (data not shown). We also provide a mathematically based formulation for the calculation of the weight of the central voxel, the self-similarity, for which the signal intensity has to be restored. This issue has previously been overlooked, with only empirical solutions have been suggested. Our definition of the self-similarity here is easily extendable to various fusion operators and addresses this issue. This work opens the way to further improve quantitative MR imaging for advanced applications in many fields such as preclinical and clinical investigations. By tailoring itself to the characteristics of the noise and incorporating a priori information in the filtering process, this innovative approach paves the way for enhanced denoising filters that effectively emphasize the relevant information within multispectral images obtained with diverse instrumental settings, even obtained by other imaging modalities.

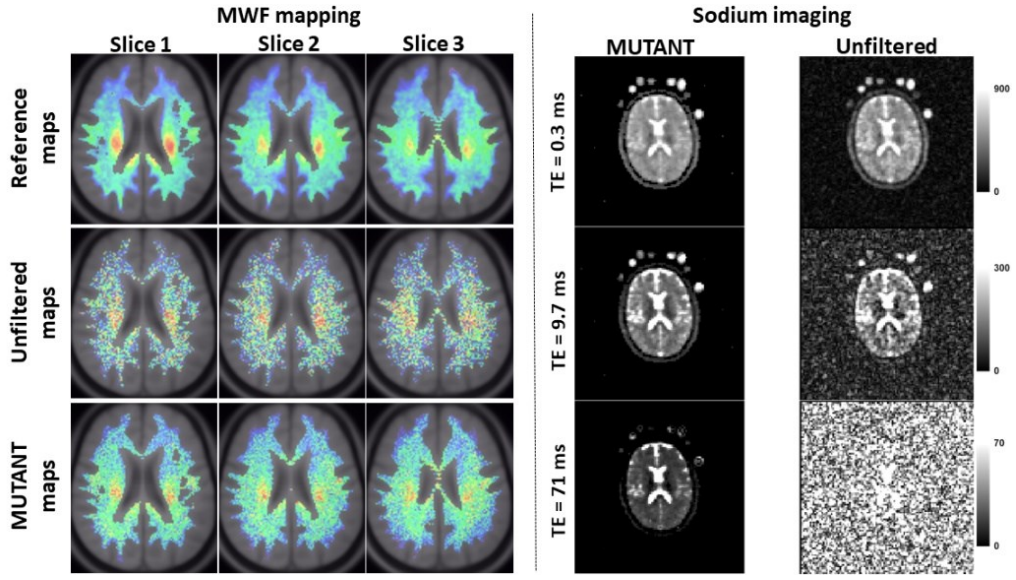

Figure 1. Left panel: example of reference MWF maps and derived MWF maps before or after the MUTANT filtering. Right panel: example of sodium images at three different echo times (TEs) before and after the MUTANT filtering.