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A GENERAL PARADIGM FOR CONSTRUCTING ADAPTIVE AND EFFICIENT MULTISPECTRAL IMAGING FILTERS: APPLICATIONS TO NUCLEAR MAGNETIC RELAXOMETRY IN BRAIN

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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, under investigation. Unlike the classical nonlocal filtering approaches [1,2], our formalism permits incorporation of adaptive fusion operators to calculate and merge the frame-dependent weights within the multispectral images. We show that the conventional, and widely used, multispectral nonlocal means filtering represents only a special case of our generalized framework. Through extensive numerical and in-vivo analyses, conducted on NMR images for myelin water fraction (MWF) determination, we demonstrate the flexibility and superior performance of our formalism for accurate and precise MWF 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 compared to the conventional approaches. We also provide a mathematically based formulation for the calculation of the weight of the central voxel 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 outstanding issue. This work opens the way to further stabilize quantitative MR imaging for advanced applications in many fields such as preclinical and clinical investigations. We note that, beside MR imaging applications, our filtering paradigm is readily applicable to other multispectral imaging modalities.

References

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