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Geometric Analysis meets Image Processing

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We study existence, uniqueness, and regularity of minimizers for a manifold-constrained version of the Rudin-Osher-Fatemi model for image denoising, which appears in multiple references of applied literature, but lacks analytical foundations. This leads to study a system of elliptic PDEs with Neumann boundary conditions.

Our outcomes can be regarded as the extension to the harder situation of p=1 of the regularity theory for p-harmonic maps, started by classical works of Eells-Sampson and Schoen-Uhlenbeck. In fact, we generalize the optimal regularity results for the classical Euclidean scalar model, without further requirements on the convexity of the boundary, in three different directions: vector-valued functions, manifold-constrained and curved domain. To achieve the results, it is crucial on a strong interplay between geometric and analytical techniques within the proofs.

Additionally, we provide variants of the regularity statement of independent interest: for 1-dimensional domains (related to signal denoising), local Lipschitz regularity (meaningful for image processing) and Lipschitz regularity for a perturbed model coming from fluid mechanics.

This is joint work with Salvador Moll and Vicent Pallardó-Julià.

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