

# Regularity for a Denoising Model on Manifolds

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## Abstract

In this joint work with Esther Cabezas-Rivas and Vicent Pallardó-Julià, we study existence, uniqueness, and regularity of minimizers for a manifold-constrained variant of the Rudin–Osher–Fatemi (ROF) model for image denoising. Despite its frequent appearance in the applied literature, this model has so far lacked a rigorous analytical foundation. The associated Euler–Lagrange equations give rise to a system of elliptic PDEs with Neumann boundary conditions.

Our results can be viewed as an extension of the regularity theory for  $p$ -harmonic maps, originating in the seminal works of Eells–Sampson and Schoen–Uhlenbeck, to the critical case  $p = 1$ . We establish optimal regularity for the manifold-constrained model, generalizing the known Euclidean scalar theory to vector-valued maps, to manifold targets, and to curved domains, without requiring convexity of the boundary. The proofs hinge on a deep interplay between geometric and analytical techniques. We further present regularity results of independent interest, including the one-dimensional setting (with applications to signal denoising), local Lipschitz estimates relevant to image processing, and global Lipschitz regularity for a perturbed model motivated by fluid mechanics.