LEARNING PDE MODELS FOR IMAGE FILTERING

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ABSTRACT

We focus on learning optimized partial differential equation (PDE) models for image filtering. In our approach [1], the gray-scale images are represented by a vector field of two real-valued functions and the image restoration problem is modeled by an evolutionary process such that the restored image at any time satisfies an initial-boundary value problem of cross-diffusion with reaction type. The coupled evolution of the two components of the image is determined by a nondiagonal matrix that depends on those components. A critical question when designing a good performing filter lies in the selection of the optimal coefficients and influence functions which define the cross-diffusion matrix. We propose to take a PDE based on a nonlinear cross-diffusion process and turn it into a learnable architecture in order to optimize the parameters of the model. In particular, we use a back-propagation technique in order to minimize a cost function related to the quality of the denoising process, while we ensure stability during the learning procedure. Consequently, we obtain improved image restoration models with solid mathematical foundations. The learning framework and resulting models are presented along with related numerical experiments and image comparisons.

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REFERENCES

[1] Sílvia Barbeiro, Diogo Lobo *Learning Stable Nonlinear Cross-Diffusion Models for Image Restoration* Journal of Mathematical Imaging and Vision 62, 223-237, 2020.

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