A Forward-and-Backward Diffusion Process for Adaptive Image Enhancement and Denoising

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Signal and image enhancement is considered in the context of a new type of diffusion process that simultaneously enhances, sharpens and denoises images. The nonlinear diffusion coefficient is locally adjusted according to image features such as edges, textures and moments. As such it can switch the diffusion process from a forward to a backward (inverse) mode according to a given set of criteria. This results in a forward-and-backward (FAB) adaptive diffusion process that enhances features while locally denoising smoother segments of the signal or image. The proposed method, using the FAB process, is applied in a super-resolution scheme.

We further generalize the FAB method for color processing in the Beltrami framework, by adaptively modifying the structure tensor that controls the non-linear diffusion process. The proposed structure tensor is neither positive definite nor negative, and switches between them according to image features. This results in a forward-and-backward diffusion flow where different regions of the image are either forward or backward diffused according to the local geometry within a neighborhood.

Keywords: scale-space, image enhancement, color processing, Beltrami flow, anisotropic diffusion, inverse diffusion.