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VARIATIONAL PDE-BASED MODELS FOR IMAGE FILTERING AND INPAINTING

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Abstract. This work represents a survey of the main image denoising and inpainting techniques based on variational (enery-based) schemes that lead to nonlinear partial differential equation (PDE) –based filtering models. The variational denoising and restoration approaches are described first. Then, the energy-based structural image reconstruction models are surveyed here. Some of our own variational techniques proposed in these closely related image processing and analysis domains, will be also briefly described in this article.

Keywords: image denoising and restoration, nonlinear PDE-based model, variational technique, structural inpainting, numerical approximation algorithm.

1. Introduction

Image noise removal and inpainting represent important and still-challenging image processing fields that are also closely related. An overview on these domains is provided in this research work.

The image denoising and restoration represents the process of eliminating the electronic noise, which is a random variation of color information or brightness, from the 2D image signal [1]. There exist many types of image noise, the most popular of them being the 2D additive white Gaussian noise (AWGN), which represents a statistical noise having a PDF equal to that of the normal distribution and its major source arises during the acquisition and transmission processes.

Finding an effective noise reduction method still constitues a challenge in the image processing area. Such a filtering scheme has to optimize the trade-off between noise removal, detail preservation and avoiding undesired effects, like blurring or staircasing.

The classic denoising models, such as 2D Gaussian or Averaging filters, generate the blurring that corrupts the edges, corners and other features [1]. Therefore, the partial differential equation (PDE) - based filtering algorithms were introduced to solve properly this issue. The nonlinear PDE-based techniques have proved to be a great solution for this filtering task, providing effective detail-preserving restorations [2, 3]. They perform a directional diffusion that is degenerate along the gradient direction and has a smoothing effect along but not across the image boundaries. Some of these nonlinear diffusion-based models follow variational

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