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Inverse Problems in Image Processing

(Problemas Inversos en Procesamiento de Imágenes)

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Abstract

This thesis presents several contributions to a variety of image processing problems, mostly related to the recovery and restoration of image content information lost during the image formation process. These sort of restoration problems are usually ill-posed inverse problems, whose solutions rely on the use of appropriated prior information that can model features and properties of the images to be recovered, also regularizing the optimization process towards an unique solution. Under this framework, the key to obtain tentative advances in solving this imaging related ill-posed problems is to discover the most suitable priors that may best match the desired characteristics of the images, which unfortunately would not always lead to straightforward solutions or implementations. In this manner, the main contributions of the present thesis can be summarized as: the development of a new adaptive color space, the definition of a reliable framework for subpixel registration for real superresolution applications, the proposal of a total variation prior for the nonuniformity restoration problem, the model-based Bayesian formulation for compressive imaging recovery, and the introduction of an iterative algorithm for image restoration that is able to combine several nonstationary priors. The obtained results reinforce the importance of using *a priori* information that can really represent the structural nature of the data to be recovered. This is usually satisfied in all the presented situations, which also finally have led to satisfying and promising results. Nevertheless, we would like to highlight the results exhibited by the proposed novel iterative restoration algorithm, which represents an important advance to the current state-of-the-art in the field of image restoration. The foregoing makes clear that further advances in developing more sophisticated priors that would better model features, such as sharpness and textures in the recovered images, will not only improve current imaging systems profit and performance, but would also allow the development of novel imaging architectures with less physical constraints.