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Blind image deblurring using jump regression analysis. (English) Zbl 1414.94012

Summary: Observed images are often blurred. Blind image deblurring (BID) is for estimating a true image from its observed but blurred version when the blurring mechanism described by a point spread function (psf) cannot be completely specified beforehand. This is a challenging “ill-posed” problem, because (i) theoretically speaking, the true image cannot be uniquely determined by the observed image when the psf is unknown, and (ii) practically, besides blur, observed images often contain noise that brings numerical instability to the image deblurring problem. In the literature, early image deblurring methods were developed under the assumption that the psf is known. More recent methods try to avoid this restrictive assumption by assuming that either the psf follows a parametric form with some unknown parameters, or the true image has certain special structures. In this paper, we propose a BID methodology, without imposing restrictive assumptions on the psf or the true image. It even allows the psf to change over location. Our method makes use of the hierarchical nature of blurring: image structure is altered most significantly around step edges, less significantly around roof/valley edges, and least significantly at places where the true image intensity function is straight. It pays special attention to regions around step and roof/valley edges when deblurring. Theoretical justifications and numerical studies show that our method works well in applications.

MSC:
94A08 Image processing (compression, reconstruction, etc.) in information and communication theory
62G05 Nonparametric estimation
62H25 Factor analysis and principal components; correspondence analysis
62H35 Image analysis in multivariate analysis

Keywords:
deconvolution; denoising; edges; jump-preserving surface estimation; local smoothing; nonparametric regression; principal components

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