ROBUST PRIORS FOR SMOOTHING AND IMAGE RESTORATION

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Abstract. The Bayesian method for restoring an image corrupted by added Gaussian noise uses a Gibbs prior for the unknown clean image. The potential of this Gibbs prior penalizes differences between adjacent grey levels. In this paper we discuss the choice of the form and the parameters of the penalizing potential in a particular example used previously by Ogata (1990, *Ann. Inst. Statist. Math.*, **42**, 403–433). In this example the clean image is piecewise constant, but the constant patches and the step sizes at edges are small compared with the noise variance. We find that contrary to results reported in Ogata (1990, *Ann. Inst. Statist. Math.*, **42**, 403–433) the Bayesian method performs well provided the potential increases more slowly than a quadratic one and the scale parameter of the potential is sufficiently small. Convex potentials with bounded derivatives perform not much worse than bounded potentials, but are computationally much simpler. For bounded potentials we use a variant of simulated annealing. For quadratic potentials data-driven choices of the smoothing parameter are reviewed and compared. For other potentials the smoothing parameter is determined by considering which deviations from a flat image we would like to smooth out and retain respectively.

Key words and phrases: Gibbs distribution, Gaussian and non-Gaussian smoothness priors, maximum a posteriori estimation, images with discontinuities, simulated annealing.