A SURFACE SMOOTHING PROCEDURE FOR IMAGE RECONSTRUCTION

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Let v denote observations of an image f which are defined by $v = w + \varepsilon$ with $w = R(f)$. We estimate the image f in the presence of noise ε in situations where the operator R does not have a unique inverse. For indirect measurements of this kind, a surface smoothing procedure is proposed which reconstructs f directly in the image domain.

Standard methods find a solution for f implicitly by applying regularisation procedures of the form: minimise $\{\| R(f) - v \| + \lambda S(f)\}$. In contrast to this, in our approach the solution is arrived at explicitly: An `Inverse´ K of R is selected which transforms the observation domain into the image domain. Then a regulariser S from a class of non-linear functionals and a Lagrange parameter λ are used to construct the well-posed problem: minimise $\{\| K(v) - f \| + \lambda S(f)\}$ for a suitably chosen norm. In this form, the reconstruction problem is reduced to a direct surface smoothing procedure which is solved computationally using efficient and stable optimisation techniques.

Applications to radio astronomy are given, where R is the Fourier transform from N to M points $(N \gg M)$ and S is the second derivative or the entropy of f. The inverse K of R incorporates a low pass filter in the Fourier domain which is related to the error ε. This new procedure results in smooth reconstructions and is computationally much more efficient than existing algorithms.