JOINT RECONSTRUCTION OF PET-MRI BY PARALLEL LEVEL SETS

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Abstract

Recent advances in technology have enabled us to combine imaging systems. Positron emission tomography (PET) and magnetic resonance imaging (MRI) scanners can be combined to *simultaneously* image function and anatomy of the human body [1]. As function follows anatomy the images to be reconstructed are expected to share a lot of information. By coupling these two inverse problems we aim to exploit the shared information in the data [2]. Similarly shared structures have been exploited in a joint framework in colour image processing [3, 4], geophysics [5, 6] and image registration [7].

Joint reconstruction of two imaging modalities can be posed as a joint minimization problem

$$(u^*, v^*) \in \operatorname{argmin}_{u,v}\, d_{PET}(Au, f) + d_{MRI}(Bv, g) + \alpha\, \Psi(u, v) \quad (1)$$

where the data fidelities depend on the noise models considered and Ψ expresses our prior knowledge about the state of u and v [3]. One way of modelling the shared structure in the two modalities is to say that the spatial gradients in both images align or equivalently the images having *parallel level sets* [3]. This can be achieved by setting the prior to be

$$\Psi(u, v) = \int |\nabla u|\, |\nabla v| - |\langle \nabla u, \nabla v \rangle|. \quad (2)$$

As Ψ vanishes when one of the images is flat this prior is not guaranteed to have a regularizing effect. By smoothing the norms, i.e. $|x| \approx [\![x]\!] := (|x|^2 + \beta^2)^{1/2}$ for some $\beta > 0$ local smoothness can be incorporated.

We present results for joint reconstruction of PET and MRI where the PET operator is modelled to be a blurred Radon transform and MRI is an under-sampled Fourier transform. The results indicate that within our framework *both* reconstructions are sharper with less errors in regions of shared edge information than separate reconstructions.

References

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