Denoising of Sphere- and SO(3)-valued Data by Relaxed Tikhonov Regularization

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Manifold-valued signal- and image processing has received attention due to novel image acquisition techniques. Recently, a convex relaxation of the Tikhonov-regularized nonconvex problem for denoising circle-valued data has been proposed by Condat (2022). In this talk, we show, based on Schur complement arguments, that this variational model can be simplified while leading to the same solution. Our simplified model can be generalized to higher dimensional spheres and to SO(3)-valued data, where we rely on the quaternion representation of the later one. Standard algorithms from convex analysis can be applied to solve the resulting convex minimization problem. As proof-of-the-concept, we use the alternating direction method of minimizers to demonstrate the denoising behavior of the proposed method.

Additionally, we can use our relaxation for TV-regularization on spheres and the SO(3) in an Euclidean-embedded point of view. As in the Tikhonov-like regularization, we can observe the tightness in many cases, but lose the later one in general. Comparisons for the null and one-dimensional sphere, and proof-of-the-concepts for the two-dimensional sphere and the SO(3) are done.

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References

[1] Laurent Condat (2022), *Tikhonov regularization of Circle-Valued signals*, IEEE Transactions on Signal Processing, Vol. 70