QuaSI: Quantile Sparse Image Prior for Spatio-Temporal Denoising of Retinal OCT Data

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Abstract. Optical Coherence Tomography (OCT) is a standard non-invasive imaging modality widely used in opthalmology. Due to its high spatial resolution OCT has become a standard imaging technique. However, speckle noise caused by photon interference during the acquisition is its major drawback. To this end, we propose a spatio-temporal denoising algorithm using the quantile sparse image (QuaSI) prior that is based on quantile filtering [1]. For OCT denoising, the median filter is used as it faciliates structure preservation and handles non-Gaussian noise. An energy minimization formulation is developed including the QuaSI prior coupled with the total variation prior. The proposed alternating direction method of multiplier scheme enables efficient optimization with the non-linear QuaSI prior. To tackle the non-linearity of the median filter, a linearization of the filter is computed. The median operator is replaced by a matrix-vector operation that can be optimized directly.
The proposed spatio-temporal denoising algorithm is evaluated on two data sets. We compare our method to the well known BM3D as well as current OCT noise reduction algorithms, namely Bayesian estimation denoising, averaging of registered B-scans, and wavelet-multi-frame denoising. The publicly available pig eye data set comprises 35 eye positions with 13 B-scans each. We also investigate denoising on clinical data from 14 human subjects. The proposed algorithm achieved the best denoising performance on both data sets in terms of all measures.

References

1. Schirrmacher F, Köhler T, Husvogt L, Fujimoto JG, Hornegger J, Maier AK. QuaSI: Quantile Sparse Image Prior for Spatio-Temporal Denoising of Retinal OCT Data. Procs II MICCAI. 2017; p. 83–91.