A Benchmark for Despeckling Filters

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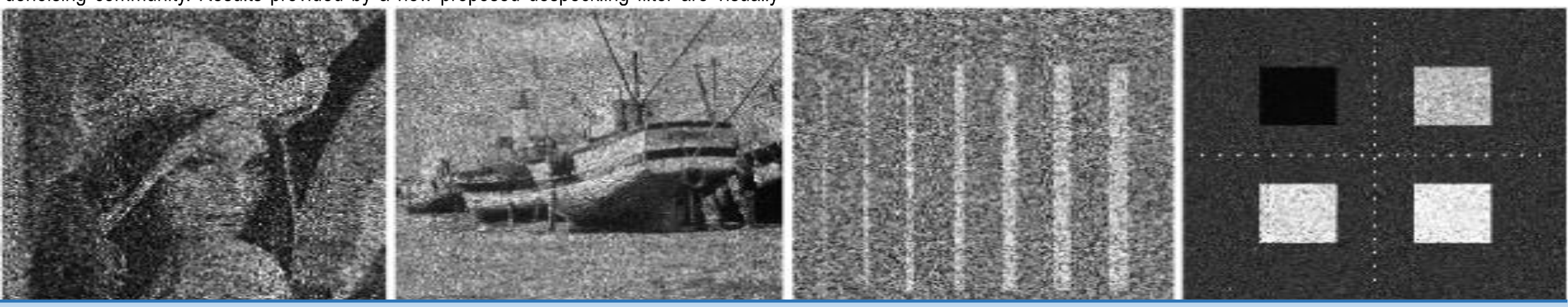
Abstract

The validation of filters for SAR image denoising is mostly performed through personal choices of experimentation on a set of author-selected synthetic and true SAR images, which makes the objective elucidation of their benefits over well established filtering methods a hard task. Following the example of other scientific fields, this situation can be alleviated by providing a set of reference images to test new methods on thorough quantitative measures of quality. We propose an extensible benchmark for speckle denoising techniques. We also stress the need to establish a repository with a pool of error-free and correctly coded denoising filters and quality estimators.

The Standard Approach to Validate a Proposed Despeckling Filter

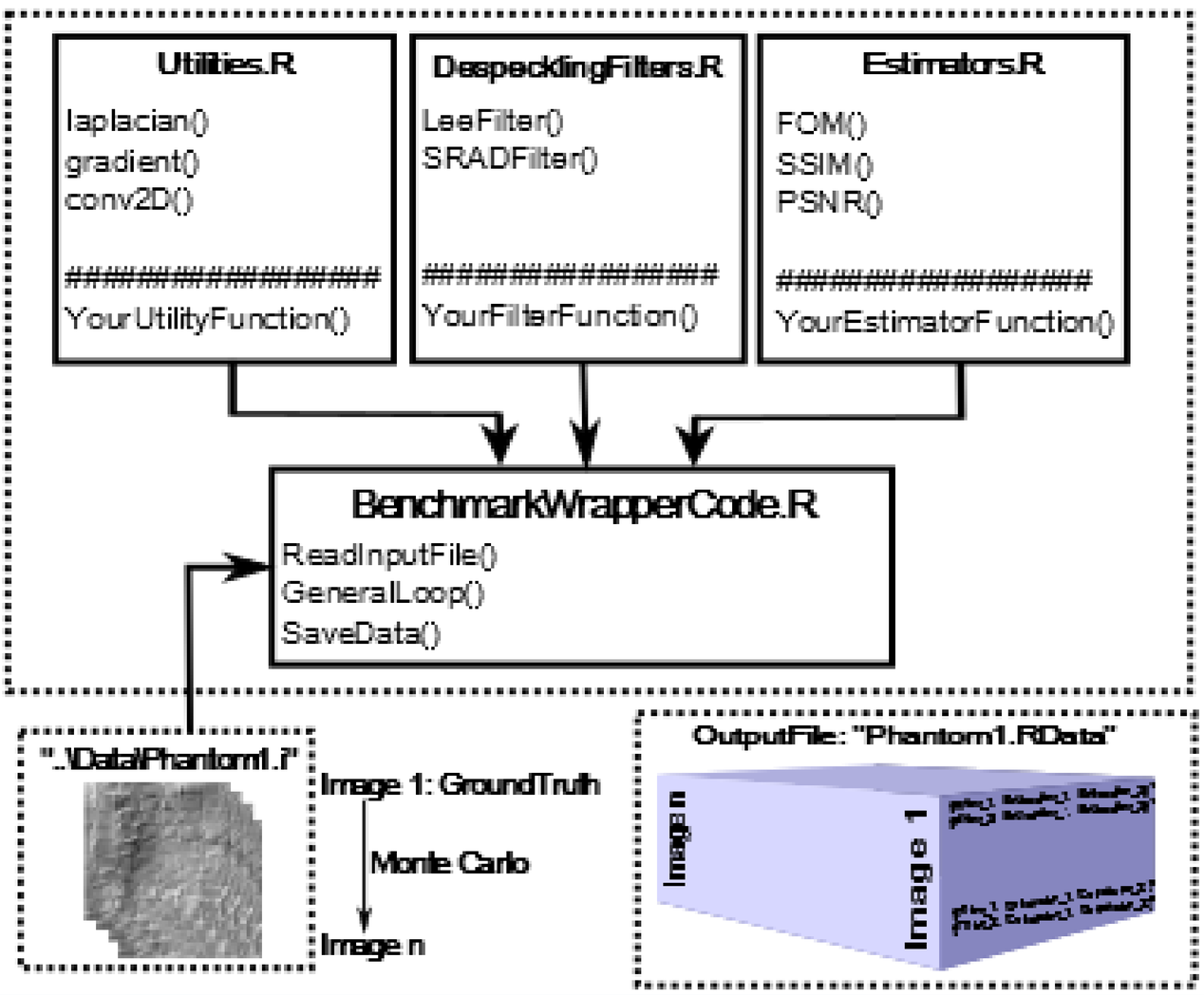
Recent research on SAR despeckling filters [1, 2] brings out what is the core of this proposal: **every new filter is tested based solely on authors' personal experience on the subject**. This kind of personal experimental setup is indeed supported by the **authors' experience** in the field. Images shown below are widely used as benchmark in the denoising community. Results provided by a new proposed despeckling filter are visually compared with other filters and the performance of filters is quantified by well-known image quality-indexes, e.g. the PSNR, Peak Signal-to-Noise Ratio. Then, results for true SAR data are also **compared visually** and through some **numerical estimators** (preservation of mean and reduction of variance measures within a homogenous area).



Designing the Benchmark

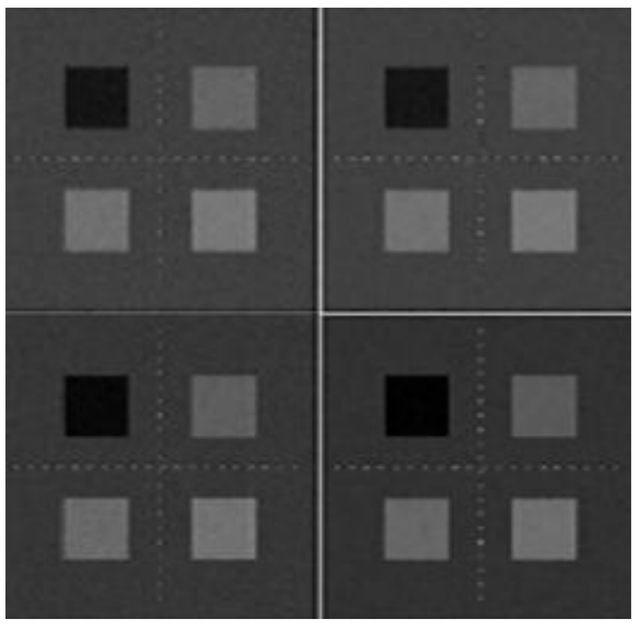
We propose a complete **open source easy-to-use freely available SAR benchmark** which includes a statistical approach to filter analysis. The benchmark comprises controlled data, a set of **well known despeckling filters**, and a set of widely-used image quality indexes. The filters have been carefully coded with special attention to the authors' specifications. The same applies to the implementation of the estimators. The design of the **benchmark** is modular in order to easily incorporate new data sets, new filters and new estimators. **None of these properties has been considered in previous research**. Our benchmark also includes scripts which make the analysis of the huge amount of data obtained a relatively easy task. The benchmark can be run online at http://articlesarbenchmark.lccv.ufal.br/demo/.

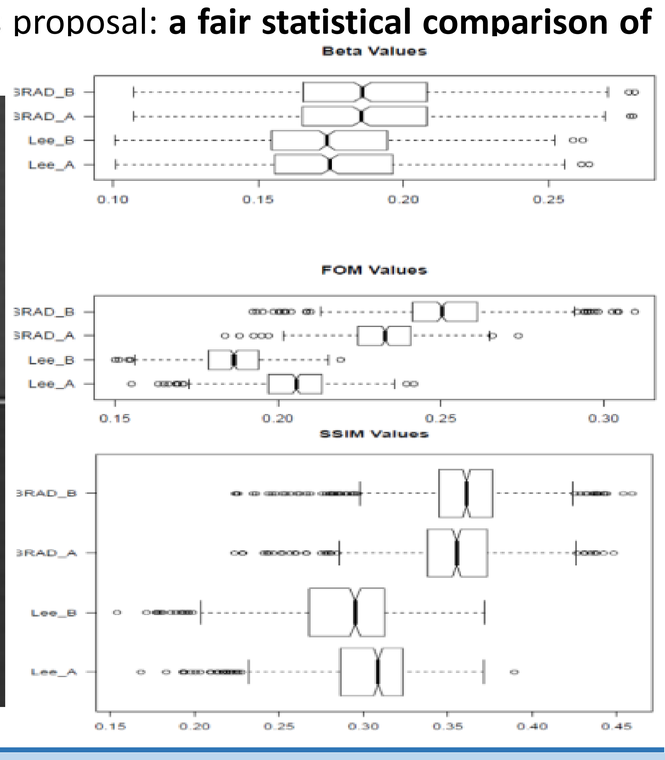
The benchmark has been coded in the **R** programming language [3].



Experimental Results

We show some of the results obtained running the benchmark (500 simulated 100 x 100 images following the design) using the **Lee** [4] and **SRAD** [5] filters, and measuring their quality with the FOM, SSIM and, edge correlator indices. Figures below show the main objective of this proposal: **a fair statistical comparison of the filters under test.**





Conclusions

We presented a methodology **for testing SAR despeckling filters** in a statistical sound sense. A novel and realistic easy-to-generate synthetic SAR dataset has been designed for evaluating the performances of filters. The **evaluation of a filter** is performed running a simple R-script program. This work can be **naturally extended** to include more filters and more estimators due to the modular design of the benchmark and the R-scripts. Additionally, the methodology proposed can be applied **to design a filter** by combining the benchmark with an optimization method.

References

[1] L. Gomez et al. : Supervised constrained optimization of Bayesian nonlocal means filter with sigma preselection for despeckling SAR images, IEEE Trans. Geosci. Remote Sens., Vol. 51, no. 8, pp.4563-4575, 2013.
[2] S. Parrilli et al. : A nonlocal SAR image denoising algorithm based on LLMMSE wavelet shrinkage, IEEE Trans. Geosci. Remote Sens., Vol. 50, no. 2, pp.606-616, 2012.
[3] http://www.r-project.org/.
[4] J. S. Lee et al. : Improved sigma filter for speckle filtering of SAR imagery, IEEE Trans. Geosci. Remote Sens., Vol. 47, no. 1, pp.202-213, 2009.
[5] Y. Yu and S. T. Acton : Speckle reducing anisotropic diffusion, IEEE Trans. Image Processing, Vol. 11, no. 11, pp.1260-1270, 2002.

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