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Parallel faceted imaging in radio interferometry via proximal splitting (Faceted HyperSARA)

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Upcoming radio interferometers are aiming to image the sky at new levels of resolution and sensitivity, with wide-band image cubes reaching close to the Petabyte scale for SKA. Modern proximal optimization algorithms have shown a potential to significantly outperform CLEAN thanks to their ability to inject complex image models to regularize the inverse problem for image formation from visibility data. They were also shown to be parallelizable over large data volumes thanks to a splitting functionality enabling the decomposition of data into blocks, for parallel processing of block-specific data-fidelity terms involved in the objective function. In this work, the splitting functionality is further exploited to decompose the image cube into spatio-spectral facets, and enable parallel processing of facet-specific regularization terms in the objective. The resulting "Faceted HyperSARA" algorithm is implemented in MATLAB (code available on the Puri-Psi webpage [1]). Simulation results on synthetic image cubes confirm that faceting can provide a major increase in parallelization capability when compared to the original HyperSARA approach, at a negligible cost in imaging quality. A proof-of-concept reconstruction of a 15 GB image of Cyg A from 7.4 GB of JVLA data, utilizing 496 CPU cores on a HPC system for 53 hours, illustrates the reconstruction performance of the proposed approach on real data. We also demonstrate that Faceted HyperSARA can be combined with a dimensionality reduction technique, enabling utilizing only 31 CPU cores for approximately the same time to form the Cyg A image from the same data, while preserving reconstruction quality. This abstract summarizes a full paper by the authors [2].

References

[1] `https://basp-group.github.io/Puri-Psi/`.

[2] P.-A. Thouvenin, A. Abdulaziz, M. Jiang, A. Dabbech, A. Repetti, A. Jackson, J.-P. Thiran, and Y. Wiaux, "Parallel faceted imaging in radio interferometry via proximal splitting (Faceted HyperSARA)," *submitted to Monthly Notices of the Royal Astronomical Society*, February 2020, preprint arXiv:2003.07358 [astro-ph.IM].