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## Deep learning image burst stacking to reconstruct high-resolution ground-based solar observations

To study and resolve small-scale features in the solar atmosphere, ever larger telescopes are built, such as the European Solar Telescope (EST) or the Daniel K. Inouye Solar Telescope (DKIST). However, diffraction-limited observations are not feasible for large aperture telescopes because the Earth's turbulent atmosphere distorts the raw observations. Therefore, post-image reconstruction techniques must be applied to obtain high resolution, high quality observations.

We provide an AI tool based on deep learning which is capable of translating a short exposure image burst to a single high resolution high quality observation. The neural network we use was developed by Jarolim et al. (2023) and is based on a Generative Adversarial Network (GAN) that employs unpaired image-to-image translation. This allows translating a short exposure image burst consisting of 100 images to a single high quality observation in real time. This approach can outperform state-of-the-art methods such as speckle reconstruction and multi-frame blind deconvolution (MFBD).

We applied the tool to observation from the 1.5 m GREGOR telescope. The results demonstrate that our approach provides faster and more robust reconstructions by showing less artifacts compared to the speckle reconstruction method. We explicitly show that our neural network approach uses the information of 100 short exposure observations for the reconstruction.

### References:

Jarolim, R., Veronig, A., Pötzi, W. Podladchikova, T. (2023). "Instrument-To-Instrument translation: Instrumental advances drive restoration of solar observation series via deep learning." under revision, Nature Communications DOI: 10.21203/rs.3.rs-1021940/v1

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