FEWHA for the MORFEO instrument: Balancing between reconstruction quality and run-time

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Abstract

The MORFEO instrument of ESO's Extremely Large Telescope (ELT) aims at a good correction over a large field of view. Hence, it requires a tomographic estimation of the atmospheric wavefront disturbance. The Finite Element Wavelet Hybrid Algorithm (FEWHA) is a so called two step control algorithm in which the computation of deformable mirror (DM) commands from sensor measurements is split into atmospheric tomography and mirror fitting. In contrast, direct methods precompute one large control matrix, which allows to directly calculate the commands from measurements. Especially for large telescopes such matrix-based approaches become computationally very demanding. Within FEWHA the atmospheric tomography problem is discretized with wavelet and bilinear bases yielding sparse operators. This sparse system is solved using the conjugate gradient method including optimization techniques to reduce the number of iterations. The turbulent layers then need to be fitted to the DMs in order to obtain the commands. This mirror fitting step can be avoided when reconstructing the layers directly at the altitudes of the DMs. However, this limits the number of layers and might decreases the reconstruction quality. Reconstructing more layers improves the quality, but comes with an additional problem that needs to be solved and thus increases the run-time. In this talk we consider the MORFEO instrument with two different configurations namely three DMs and two DMs. For both we provide an optimal configuration of FEWHA, which balances between reconstruction quality and run-time.

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