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Neural Networks and PCA coefficients to identify and correct aberrations in Adaptive Optics

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Static and quasi-static aberrations represent a great limit for high contrast imaging in large telescopes. Among them the most important ones are all the aberrations not corrected by Adaptive Optics (AO) system, called Non-Common Path Aberrations (NCPA).
An estimate of the NCPA can be obtained by a trial-and-error approach or by more sophisticated techniques of focal plane wavefront sensing.
In all cases, a fast procedure is desirable to limit the telescope downtime and to repeat, if needed, the correction procedure to cope with the temporal variation of the NCPA.
In this work, through simulated images, I will describe the application of a supervised NN for the mitigation of NCPA in high contrast imaging at visible wavelengths and I will apply this method to fast imagers such as SHARK-VIS, the forthcoming visible band high-contrast imager for LBT.
Preliminary results show a measurement accuracy of the NCPA of 2 nm RMS for each sensed Zernike mode in turbulence-free conditions, and 5 nm RMS per mode in presence of a residual turbulence corresponding to a WFE=42.5 nm RMS, a typical value during LBT AO system calibration. This measurement accuracy is sufficient to guarantee that, after correction, NCPA residuals in the system are negligible compared to the typical WFE >100 nm RMS of the best AO systems at large telescopes.
Our simulations show this method is robust even in the presence of turbulence-induced aberrations that are not labelled in the training phase of the NN.

Primary author: TERRERI, Alessandro (Istituto Nazionale di Astrofisica (INAF))

Co-authors: Dr ANTONIUCCI, Simone (INAF-OAR); Prof. DEL MORO, Dario (University of Tor Vergata); Dr GANGI, Manuele (manuele.gangi@inaf.it); Dr KASPER, Markus (ESO); Dr LI CAUSI, Gianluca (INAF-IAPS); MATTIOLI, Massimiliano (INAF-OAR); Dr PEDICHINI, Fernando (INAF-OAR); Dr PIAZZESI, Roberto (INAF-OAR); Dr STANGALINI, Marco (ASI); Dr TESTA, Vincenzo (INAF-OAR); Dr VIAVATTENE, Giorgio (INAF-OAR)

Presenter: TERRERI, Alessandro (Istituto Nazionale di Astrofisica (INAF))

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