Machine learning for a non modulated pyramid wavefront sensor

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Abstract

Most of the future single conjugate adaptive optics systems for the extremely large telescopes will use pyramid wavefront sensors and will face the challenge of measuring and controlling the turbulence and the differential piston. We know that this kind of sensor has a non linear response that cannot be fully exploited by linear reconstruction. In particular this is valid for a non-modulate pyramid wavefront sensor that has some advantage in terms of sensibility, but it is strongly affected by non-linearities. For this reason we explore the possibility of using a reconstruction method based on neural networks.
Our goal is to replace the usual linear reconstructor which is normally obtained as the pseudo-inverse of the interaction matrix, with a non-linear one which has the form of a deep neural network. The network architecture and its training strategy are tailored for our problem, while the data used for the network training and its performance evaluation were produced in end-to-end simulation. We will show the promising results obtained for the open loop reconstruction and the preliminary analisys performed in the perspective to apply this method in closed loop operations.

Keywords: Pyramid wavefront sensor, Simulation, Machine learning, Neural network, Reconstructor

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