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THE CAOS PROBLEM-SOLVING ENVIRONMENT: LAST NEWS

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Abstract. We present recent developments of the CAOS problem-solving environment (PSE), an IDL-based software tool complete of a global graphical interface, a general utilities library, and different specialized scientific packages going from end-to-end and analytical simulations to image simulation/reconstruction, with specialization to given instruments.

Keywords: adaptive optics, numerical simulations, image reconstruction, LINC-NIRVANA, SPHERE

Introduction

The name CAOS ("Code for Adaptive Optics Systems") was originally used to describe the Software Package CAOS which permits end-to-end numerical modeling of adaptive optics (AO) systems. Since a few years it also describes the CAOS problem-solving environment (PSE), which allows to clearly separate in its own bosom the scientific part of the original Software Package CAOS from the global interface and global structure of the tool, permitting also to complete the whole suite with a number of other Software Packages covering a wider area of astronomical-optics-related scientifical topics: image reconstruction/deconvolution with the Software Package AIRY ("Astronomical Image Reconstruction in interferometrY"), deconvolution specialized for the LBT LINC-NIRVANA instrument with the Software Package AIRY-LN ("AIRY for LINC-NIRVANA"), simulation of the data delivered by the VLT SPHERE instrument with the Software Package SPHERE, analytical AO modeling with the Software Package PAOLAC ("PAOLA within CAOS"), and multiple-reference AO simulations with the Software Package MAOS ("Multiple-reference Adaptive Optics Simulations").

The CAOS PSE is composed of a global graphical interface (the CAOS Application Builder, which permits to connect together modules from the various Software Packages installed), a library of utilities (the CAOS Library), and the Software Packages (each of them being a collection of modules). Within the CAOS Application Builder, the modules from each Software Package can be selected and placed in order to compose a simulation project by combining together the modules and defining the corresponding data flow. The IDL code implementing the simulation program is automatically generated and the whole structure of the simulation is saved as a project that can be restored for latter modifications and/or parameters upgrading.

The CAOS Library and the CAOS Application Builder

Since the first (and last) global presentation of the CAOS PSE (Carbillet et al. 2004), the CAOS Library has been completed with routines permitting to deal with low-light-level (LLL) CCDs, and a global noise addition routine usable from any Software Package in the same exact manner. On its side, the CAOS Application Builder has benefited from important debugging, leading to a very stable version of it since 6.0. In addition, since version 7.0, and by taking advantage from the Virtual Machine feature of IDL, one can also now build an IDL-licence-free executable made from any simulation project and which can be run afterwards on machines with neither the CAOS PSE installed, nor even IDL licensed.

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The Software Package CAOS - end-to-end AO modeling

This is the original part of the whole CAOS PSE. It has been deeply described in a paper published in 2005 (Carbillet et al. 2005) (see also Carbillet and Riccardi (2010a) for the wavefront generation issue), and it is clearly now in a full exploitation phase. Recent developments mainly include densified-pupil capabilities and the possibility of using the LLLCCD routines when simulating the pyramid sensor (Carbillet and Riccardi 2010b).

The Software Package AIRY - image simulation & reconstruction

Developments since the original paper (Correia et al. 2002) were numerous and concerned, among others, blind deconvolution implementation, regularizations, accelerations, point-spread function extraction, high-dynamic-range and super-resolution capabilities assessments, boundary effects mitigation, etc. Next to come are a new module for Strehl-constrained blind deconvolution (Desiderà and Carbillet 2009), another one for the rotation of images, and modifications to the existing modules in order to simulate multi-frame images and common CCD defects (and associated data reduction).

The Software Package PAOLAC - analytical AO modeling

This is the last developed package of the whole CAOS PSE. It is completely based on the well-known analytical model PAOLA (Jolissaint et al. 2006), being a simple embedment of it (Carbillet et al. 2010). Further work includes extending the existing modules to the whole capabilities offered by the original code PAOLA and implementation of its brand new close-loop feature (Jolissaint 2010).

Other packages

The Software Package MAOS is still in its β version, but some modules are being used for GLAO simulations (Carbillet et al. 2009).

On the other hand, the Software Package SPHERE (Carbillet et al. 2008) and the Software Package AIRY-LN (Desiderà et al. 2008), like the Software Package PAOLAC, were absolutely not foreseen in any way in 2004. But, unlike the other packages presented here, they are not publicly distributed because completely dedicated to a particular instrument: SPHERE on the VLT and LINC-NIRVANA on the LBT, respectively. While the Software Package SPHERE has already attained its final version and has been already well exploited, the Software Package AIRY-LN is in its plain development phase and begins to be exploited now.

Availability of the code

The whole CAOS PSE, except from its instrument-dedicated packages, is freely distributed, and can be downloaded from http://fizeau.unice.fr/caos.

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