Distributed Identification for AO

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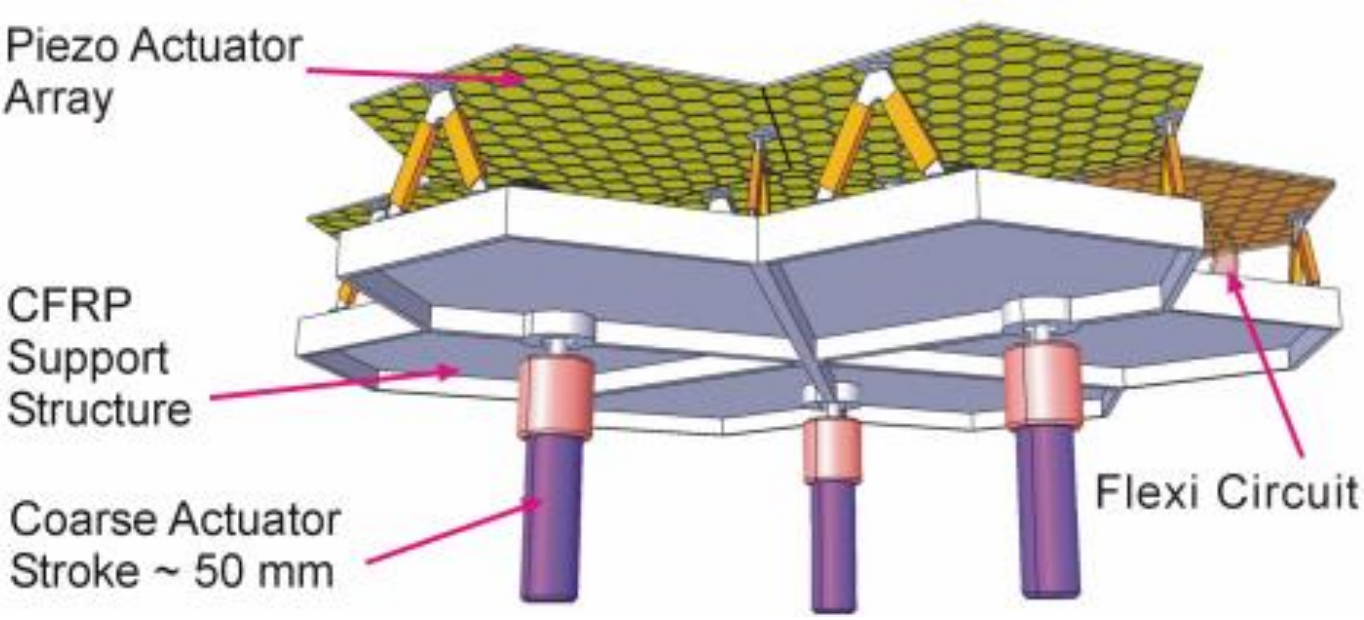

Distributed Identification of a Large Segmented Mirror for Adaptive Optics

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Introduction

Atmospheric turbulence distorts the observations of astronomical telescopes, which must be compensated for using adaptive optics systems. Current adaptive optics systems for astronomical telescopes consist of a so-called wavefront sensor, a control system and a deformable mirror that can minimize the negative effects of atmospheric turbulence on the astronomical observations. One interesting type of new deformable mirrors that are being design for large scale adaptive optics are segmented deformable bimorph mirrors. An example of such a design developed at the Active Structures Laboratory in Brussels is presented in the figure above. The wavefront sensor, however, does not directly measure the wavefront but rather its slopes. It is the process of wavefront reconstruction that aims to reconstruct the original wavefront from the slopes measured by the wavefront sensor.

Research Question

The challenge of this MSc thesis is to develop an identification procedure to identify the static or when necessary the FIR relationship between the actuator inputs and the wavefront sensor readings such that that the relationship is sparse. The sparsity could be induced with the novel class of L1 regularization methods. Challenges are however the dimensionality of the problem with number of actuators and sensors in the order of 10000 or more and the calculation of the pseudo inverse of the solution.

This research fits within the developments of a new class of distributed control methodologies developed at the Delft Center of Technology. Parts of these developments were recently awarded with the best PhD thesis of the European Consortium on Embedded, Networked or Distributed Control. The distributed controller is implemented on an array of computing units to be able to deal with the large scale dimensionality of the problem.

The goal of the thesis is:

1. Literature study of Adaptive Optics for Astronomy applications and distributed calculations on a GPU. [a course is given in Delft running 31st januari, contact with Prof. Cees Vuik, EWI).
2. Distributed wavefront reconstruction as outlined in [1].
3. Develop an identification method for identfying the model of a large scale segmented mirror – static and FIR dynamic
4. Develop distributed controller for the case the mirror is a static device with a delay.
5. Write the thesis.

Literature

[1] C. Visser, M. Verhaegen, ""Wavefront reconstruction in adaptive optics systems using nonlinear multivariable splines," JOSA A Vol. 30-1: 8295, 2013
[2] R. Bastaits, G. Rodrigues, B. Mokrani and A. Preumont, "Active Optics of Large Segmented Mirrors: Dynamics and Control."
[3] PhD thesis R. Bastaits. [PDF] "Extremely Large Segmented Mirrors: Dynamics, Control and scale effects" (http://scmero.ulb.ac.be/Publications/Thesis/R_Bastaits_PhD_Thesis10.pdf)