DELFT UNIVERSITY OF TECHNOLOGY

# Deformable mirror & Control

SC4045 CONTROL FOR HIGH RESOLUTION IMAGING

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## 1 DEFORMABLE MIRROR

The deformable will be modelled according to an analysis made on the adaptive optics system present in the Keck Observatory [1, § 2.C]. The influence function of the mirror (*i.e.*, what happens to the height of the mirror when an input of 1 V is supplied to the actuator) is given by the following function:

$$S(x,y) = \left\{ \frac{w_1}{2\pi\sigma_1^2} \exp\left[\frac{-(x^2+y^2)}{2\sigma_1^2}\right] + \frac{w_2}{2\pi\sigma_2^2} \exp\left[\frac{-(x^2+y^2)}{2\sigma_2^2}\right] \right\} 0.470\,\mu m, \tag{1.1}$$

where, according to [1], the values for the constants are $w_1 = 2$, $w_2 = -1$, $\sigma_1 = 0.54$, and $\sigma_2 = 0.85$.
After having determined the static deformable mirror model that relates inputs $u$ with phase $\phi_{\text{DM}}$ in the following way

$$\phi_{\text{DM}} = Hu, \tag{1.2}$$

where $H$ represents the influence matrix, you should perform the following tasks:

1. Compare the approximation power of its surface with that of a perfect mirror (a perfect mirror can describe the reconstructed phase perfectly).

2. Check the influence of the number of actuators in terms of approximating power.

## 2 CONTROL

Regarding the control methodologies, start by implementing the classical AO approach described in [2, § 4.1]. Once the method is in place

1. tune the controller and analyse the influence of its proportional an integral gain. (If you do not have a control background recall what a PID controller does.)

2. analyse the influence of different delays using the same controller.

The methodology to implement data-driven approaches will be explored in a posterior stage of the project.

# References

[1] M. A. van Dam, D. L. Mignant, and B. A. Macintosh, "Performance of the keck observatory adaptive-optics system," *Appl. Opt.*, vol. 43, pp. 5458–5467, Oct 2004.

[2] M. Verhaegen and V. Verdult, *Filtering and System Identification: A Least Squares Approach.* New York, NY, USA: Cambridge University Press, 1st ed., 2007.