Binocular adaptive optics system with dynamic convergence control

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Purpose

There is current interest in using adaptive optics (AO) to determining the effect of higher-order monochromatic aberrations on dynamic accommodation control; see for example [1-3]. So far, such studies have been carried out using monocular systems. In real-life situations, however, accommodation occurs binocularly and with associated convergence. Although a binocular AO system has been reported [4], it does not possess dynamic control of convergence. The aim of this work is to develop a binocular AO system with dynamic convergence control.

System Design

A schematic of the system is shown in Fig. 1. The wavefront sensing light is an 830 nm laser diode (Access Pacific, UK). The beam first passes through a diffuser to reduce speckle [5], before being split into two beams so that one laser source can be used for both eyes. Convergence is controlled using two galvanometer scanners (Model 6880, Cambridge Technology, UK), each of which is conjugate to the center of rotation of each eye. To determine the magnitude of eye rotation the pupils are imaged onto a CCD camera (Retiga Exi Fast, QImaging, Canada). This camera is also used to simultaneously measure the positions of the Shack-Hartmann spots for both eyes. Having one camera reduces the system cost and software complexity. Aberrations are manipulated using two 52-actuator magnetic deformable mirrors (Imagine Eyes, France). The mirrors are conjugated to the eyes' pupils using 90° off-axis parabolic mirrors (OAPMs). Each OAPM is mounted on a rotation platform so they can be angled in order to induce minimal aberrations. The desired angles were determined by modeling the system in Zemax.

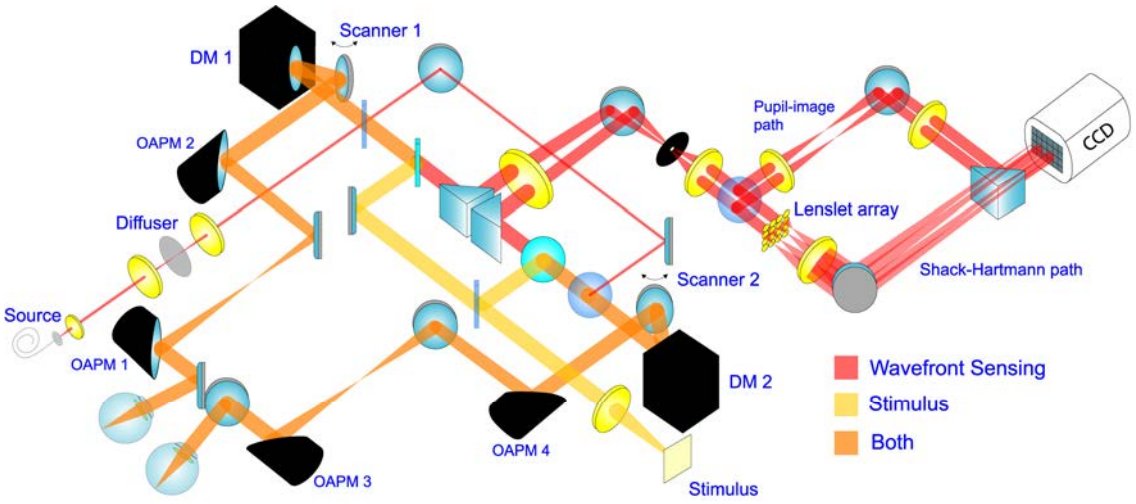

Fig. 1. Schematic of the binocular adaptive optics system.

A photograph of the system is shown in Fig. 2. All components are mounted on a two foot by three foot breadboard.

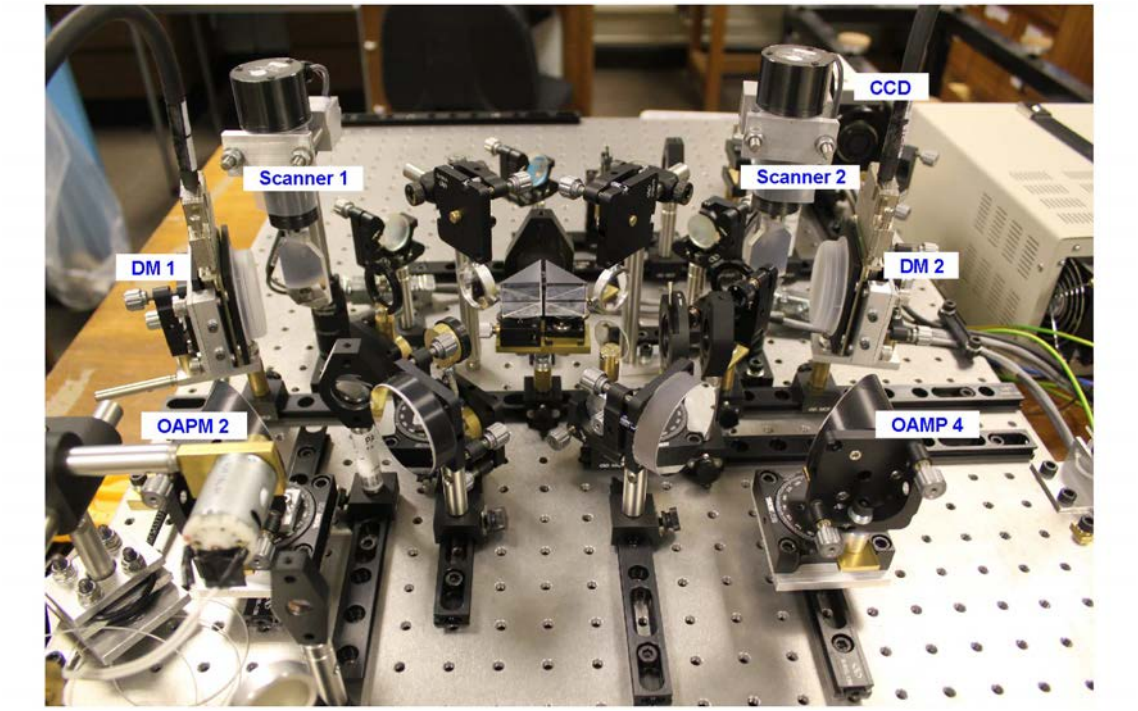

Fig. 2. Photograph of the binocular adaptive optics system.

Conclusions

We have designed and constructed a binocular AO system with dynamic convergence control. The next step will be to validate the system using artificial eyes and real eyes. Following this, experiments will be carried out to elucidate the role of monochromatic aberrations in binocular dynamic accommodation control.

References

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