Building and Testing of an Adaptive Optics System for Optical Microscopy

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Research Objective: An adaptive optics systems can correct the wave front distortion caused by the imperfection of optical elements and environment. The goal of this project is to build and test an AO system that can be integrated into high-resolution optical microscopy.

Introduction

- The system is built as a close-loop feedback with all the components and an controlling PC.
- The wavefront sensor measures the wavefront distortions.
- The deformable mirror responses to the sensed distortions and compensates them.

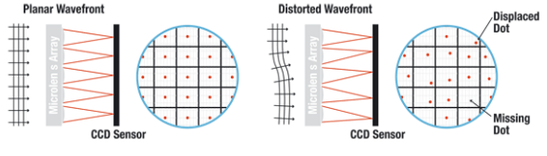
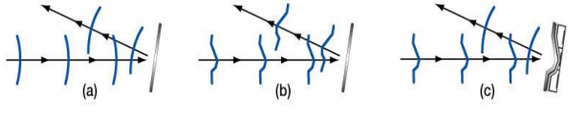


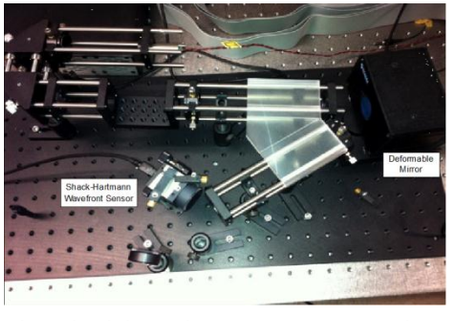
Diagram of the working principle of Shack-Hartmann Wavefront Sensor



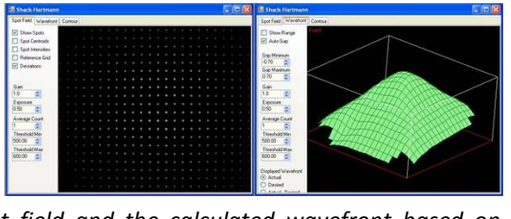
(a) Unaberrated wavefront is incident on a flat mirror surface; (b) A flat mirror is unable to compensate for any deformations in the wavefront; (c) A deformable mirror is able to modify its surface profile to compensate for aberrations [5].

Methodology

- The Thorlabs Adaptive Optics Kit is set up on a breadboard to form a close-loop.
- The system was used to correct some known distortions.
- Simultaneous distortion correction is also tested.



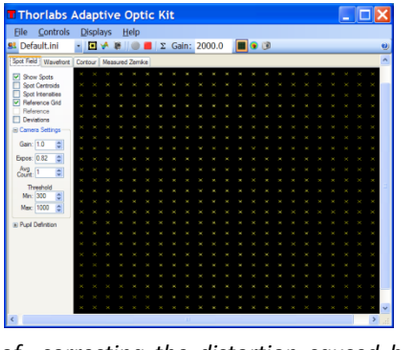
Set up of the Thorlabs Adaptive Optics Kit Closed-Loop Feedback AO System



The spot field and the calculated wavefront based on the spot field.

Conclusions

- A Shack-Hartmann wavefront sensor, a deformable mirror and other necessary optics hardware is combined to be working together.
- The controlling software is well implemented to form the feedback loop.
- The system can correct the wavefront aberrations caused by various spherical and cylindrical lens elements.
- The system is working properly and it can correct the wavefront distortion instantly.



Testing result of correcting the distortion caused by a drop sliding on a piece of glass. As the drop slides, the distortion was corrected instantly.