Abstract

An optical test-bench is described that emulates the effects of propagating monochromatic light through atmospheric turbulence. Unperturbed planar wavefronts, when imaged through an optical system, define a diffraction limited point spread function (PSF). Phase perturbations are introduced using a liquid crystal spatial light modulator (LC-SLM). The LC-SLM is programmed with a dynamic phase screen to generate a spatially variable PSF. A microcontroller is used to scroll a windowed region of the LC-SLM, generating spatio-temporal phase perturbations from one or more point sources. A novel method is proposed to measure phase modulation using an electrically addressable LC-SLM. Phase perturbations are introduced using an SLM have been measured using a curvature wavefront sensor. Applications for this testbench include atmospheric tomography and image restoration using the spatially variable PSF [2]. By cascading multiple SLMs, the simulation of multi-conjugate systems is feasible.

Results

- Phase modulation was obtained using a near diffraction limited PSF by varying a single aberration, i.e., wavefront tilt, and measuring centroid displacements using a wavefront sensor.
- A linear phase region exists between LCD intensity levels 3 to 10.
- A subset of LCD values could be employed for phase modulation, where linear phase response can be obtained.

Conclusion and future work

Non-specialised components can be used to build a turbulence generator and construct an optical testbench. An SLM has been built using a commercial LCD and microcontroller interface. Phase variations introduced using an SLM have been measured using a curvature wavefront sensor. Applications for this testbench include atmospheric tomography and image restoration using the spatially variable PSF [2]. By cascading multiple SLMs, the simulation of multi-conjugate systems is feasible.

Currently, the system is constrained in terms of dynamic range and speed of operation. Expanding this basic capability with the adaptation of new technology and hardware modules is planned for future research.

References