Hybrid Wavefront Sensor for Daytime Optical Communication

Principal Investigator: Lewis Roberts (383); Co-Investigators: James Wallace (326), Charlotte Guthery (University of Arizona), Michael Hart (University of Arizona)

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Objectives

We are building a new type of wavefront sensor (WFS) that combines the best features of the two most popular WFS types.

- The Pyramid WFS is able to observe very faint signals
- The Shack-Hartmann WFS can operate in highly turbulent conditions.

This is illustrated in Figure 1. The Hybrid WFS integrates elements of both with no moving parts and is able to synthesize an optimal correction signal from the two modes simultaneously.

Approach and Results

The University of Arizona had previously created a model of the Hybrid WFS. The main part of this project is to create a laboratory prototype of the system and then validate the model against the prototype.

The testbed was first designed in optical ray trace software. A block diagram of the system is shown in Figure 2. Over the last year, the testbed has been assembled and tested. The latest version of the testbed is shown in Figure 3. As expected with any testbed, there have been numerous issues uncovered through testing and analysis of the results. These issues have been addressed and testing continues.

When we are comfortable with the performance of the system, we will move to validate the model with data from the testbed. A partial version of some of the comparison between modeled and measured data is shown in Figure 4. This will then enable the model to be used to design operational systems.

Significance/Benefits to JPL and NASA.

There are two main uses of AO for NASA missions.

1. Optical-communication ground stations such as Laser Communication Relay Demonstration (LCRD)
2. Extreme Precision Radial Velocity measurements of exoplanets around host stars.

We believe that the hybrid WFS has the potential to improve both of those missions. In Year 2 of this project, we study the benefits for each mission.

Publications


References


Roberts Jr., L.C., et al., First results from the adaptive optics system from LCRD’s Optical Ground Station One. Proc. AMOS Conference (2018)