Auxiliary free space optical communication project to ensure continuous transfer of data for DAG the 4m telescope

Onur Keskin FMV Isik University (Turkey); **Cahit Yesilyaprak** Ataturk University (Turkey);
Sinan Kaan Yerli Orta Doğu Teknik Üniversitesi (Turkey)

9912-248

INTRODUCTION

DAG auxiliary free space optical communication system will use a model based and experimentally evaluated AO based optical communication scheme. The good agreements between the numerical and experimental evaluation of data transfer between Alice (transmitter) and Bob (receiver) will ensure the successful implementation of the methodology.

One of the challenges in free-space communication systems arises from the temporal and field-dependent evolution of the atmospheric turbulence. The angle of arrival methodology will be used to define the mean slope (the first derivative) of the turbulent wavefront. This will enable us to investigate the agreement of the spatio-temporal properties of the generated turbulence with Kolmogorov and Von Karman theories. Furthermore, the turbulence emulator will generate the optical effects of the atmospheric turbulence to the wavefront that will used test the AO control system.

A conventional adaptive optics system, regardless whether it is used for astronomical imaging or for laser beam propagation, consists of three principal components: (i) a wavefront sensor to detect the optical disturbance; (ii) a tip/tilt (TT) and/or deformable mirror (DM) to correct for the optical disturbance; and (iii) actuator command electronics to acquire the sensor information, compute the required corrective action, and to control the tip/tilt and/or deformable mirror. In free-space communication systems AO can be used in different architectures; one approach can be the use of AO at the receiver end of the communication link: In this scheme, a tip/tilt mirror can be employed to adjust the position offsets of the incoming distorted wavefront by counteracting the apparent motion of the beam. Tip/tilt correction is usually sufficient if the detector area is large enough not to clip the focal spot.

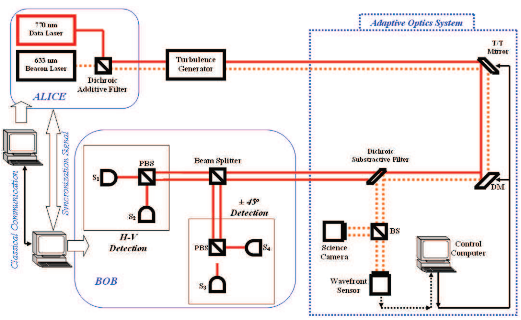
METHODOLOGY

To increase the total power of light collected on the receiver end of the communication scheme, an AO based transmitter is also required as the receiver only compensates for the present distortions on the incoming beam entering receiver telescope’s aperture. This adaptive transmitter can be used to pre-compensate the transmitted wavefront against turbulence induced beam spreading.

An AO based transmitter can be realized in two ways;

(i) the feedback data, on the sensed wavefront distortions, can be acquired from Bob and sent to Alice to optimize the pre-compensation of the transmitted beam. The feedback signal’s intermission due to the propagation time represents a fundamental constraint to this approach, and limits its practicability to shorter link distances;

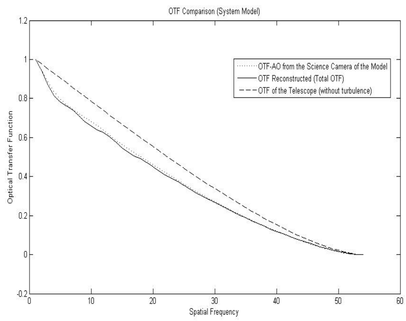
(ii) an auxiliary laser, generated from Bob, can be employed to measure the level of atmospheric distortion on the light propagating through stations. The controller interprets the wavefront data, and determine necessary adjustments of the tip/tilt mirror and of the DM. The control system enhances the beacon’s beam quality in the transmitter end and the beam is sent back to the receiver using the same AO elements.



CONCLUSIONS

As the communication set-up is still on the progress, the numerical modeling of the AO performance is performed via PSF reconstruction. The adapted methodology has the advantage of a PSF estimation based on the data measured synchronously with the observation.

The Phase of the wavefront is measured to calculate the average structure function. From the structure function the OTF of the system is calculated, and the ones obtained from the modeled science camera of the system are compared with the reconstructed OTF.



It must be added that these preliminary results do not include the aliasing error effect.

FUTURE WORK

The numerical results will be further investigated on the experimental test bench while both on the numerical model and the experimental model aliasing error will be observed. The accomplishments of the implementation will lead to the establishment of baseline theoretical and experimental performance. This knowledge will be used to improve the outcome of the FSO system to be used as an auxiliary system for data transfer between DAG telescope and Ataturk University in the line of sight of 12 km distance.

Acknowledgement: *Authors would like to thank Republic of Turkey, Ministry of Development; FMV Isik University, Istanbul /Turkey; Atatürk University, Erzurum/Turkey; Orta Doğu Teknik Üniversitesi, Ankara/Turkey; Astrophysical Research and Application Center (ATASAM), Erzurum/Turkey; FMV Işık University, Center of Optomechatronics Application and Research (OPAM), Istanbul/Turkey for their support throughout the project.*