

PROBLEMS OF INTEREST

- ❖ Optical wave propagation through atmosphere
- ❖ Adaptive beam control

RESEARCH ISSUES

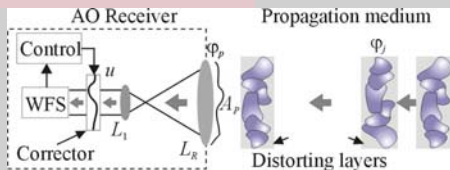
- ❖ System architecture
- ❖ Control algorithms
- ❖ Numerical models
- ❖ System performance: resolution, efficiency, field-of-view, ...

APPLICATIONS

- ❖ Directed energy
- ❖ Laser communication
- ❖ Astronomy
- ❖ Atmospheric and underwater imaging

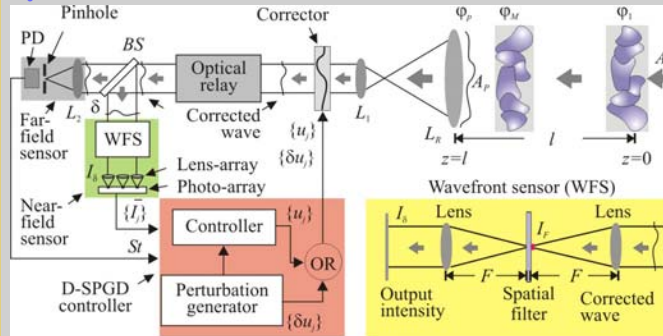
APPROACH

- ❖ Analytical analysis
- ❖ Numerical simulations
- ❖ Experimental study



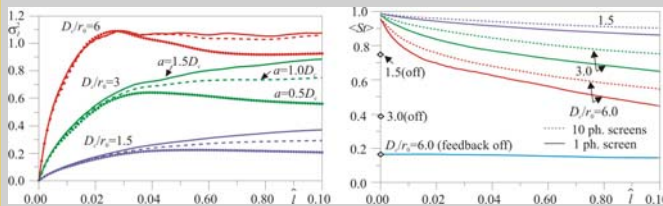
NARROW FIELD-OF-VIEW ADAPTIVE RECEIVER SYSTEM

System Architecture



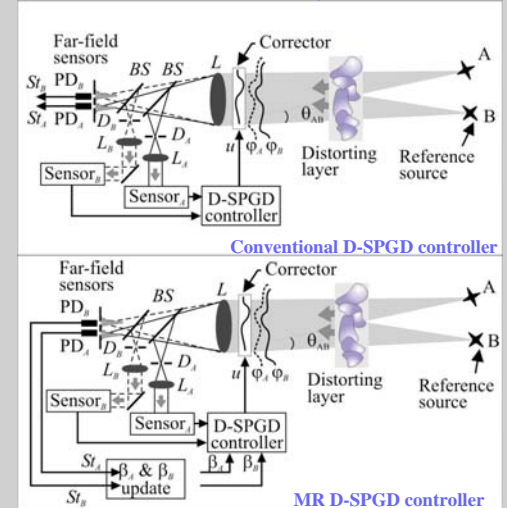
Representative Results

❖ Impact of intensity scintillation



EXTENDED FIELD-OF-VIEW ADAPTIVE RECEIVER SYSTEM

Multi-reference (MR) D-SPGD Systems



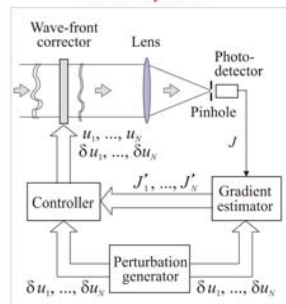
MR D-SPGD controller

$$u_j^{(n+1)} = u_j^{(n)} - \gamma \left[\frac{\partial \langle I \rangle}{\partial u_j} \right]_{j=1, \dots, N}$$

$$\frac{\partial \langle I \rangle}{\partial u_j} = \frac{\partial \langle I \rangle}{\partial u_j^{(A)}} + \frac{\partial \langle I \rangle}{\partial u_j^{(B)}}$$

CONTROL ALGORITHMS

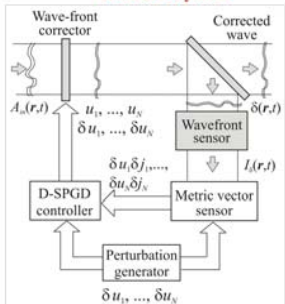
SPGD System



SPGD Controller

$$u_i^{(n+1)} = u_i^{(n)} - \gamma \delta J^{(n)} \delta u_i$$

D-SPGD System



D-SPGD Controller

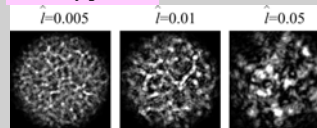
$$u_i^{(n+1)} = u_i^{(n)} - \gamma c_i \delta I_{out}^{(n)} \delta u_i$$

$$\mathcal{I} = \frac{1}{S} \int_{\Omega_c} \mathcal{I}(\mathbf{r}) d^2\mathbf{r}$$

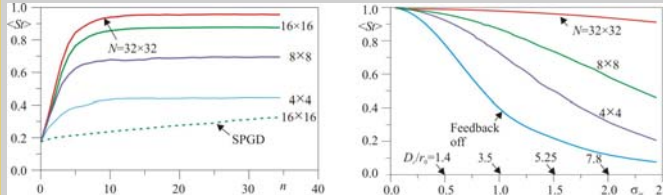
$$\mathcal{I}(\mathbf{r}) = I^2(\mathbf{r}) \text{ or } I(\mathbf{r})^2 \text{ or } I(\mathbf{r})$$

$$\hat{l} = l/l_d, \text{ where } l_d = 0.5ka^2$$

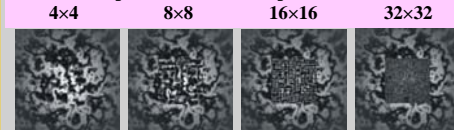
Intensity patterns



❖ Resolution v.s. efficiency



Interference patterns of residual phase after 40 iterations



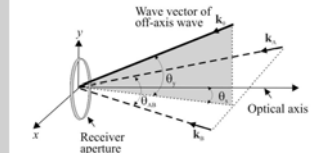
$$\mathcal{I} = \frac{1}{M} \prod_{j=1}^M \mathcal{I}_j^{1/2}$$

$$\mathcal{I}_j = \int_{\Omega_c} S^{(j)} \mathcal{I}_j(\mathbf{r}) d^2\mathbf{r}$$

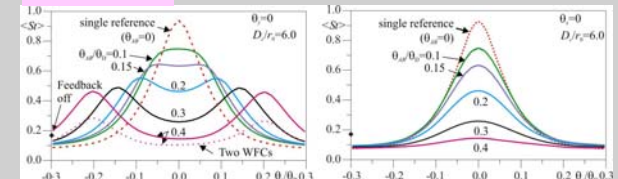
Representative Results

❖ Two-reference system

- \$\tilde{D} = D_c / l\$
- \$\tilde{\theta}\$: isoplanatic angle



Performance



Impact of turbulence strength and propagation distance

