Automated adaptive optical system for laser beam shaping using spatial light modulator

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Introduction

- Conventional adaptive optical systems are generally used to obtain the diffraction-limited focal spot in the far field. However, there are a few tasks when the desired intensity distribution should be obtained at the target plane
- One of the promising ways to achieve this is to use adaptive optical tools and methods that allow to obtain the desired intensity distribution of the light by controlling its wavefront.
- The idea of this work is to automate the process of the desired intensity distribution formation by means of setting the control signals to the phase-only spatial light modulator (SLM) and getting the feedback signal from the intensity analyzer placed at the focal plane of the focusing lens.

Beam shaping algorithm

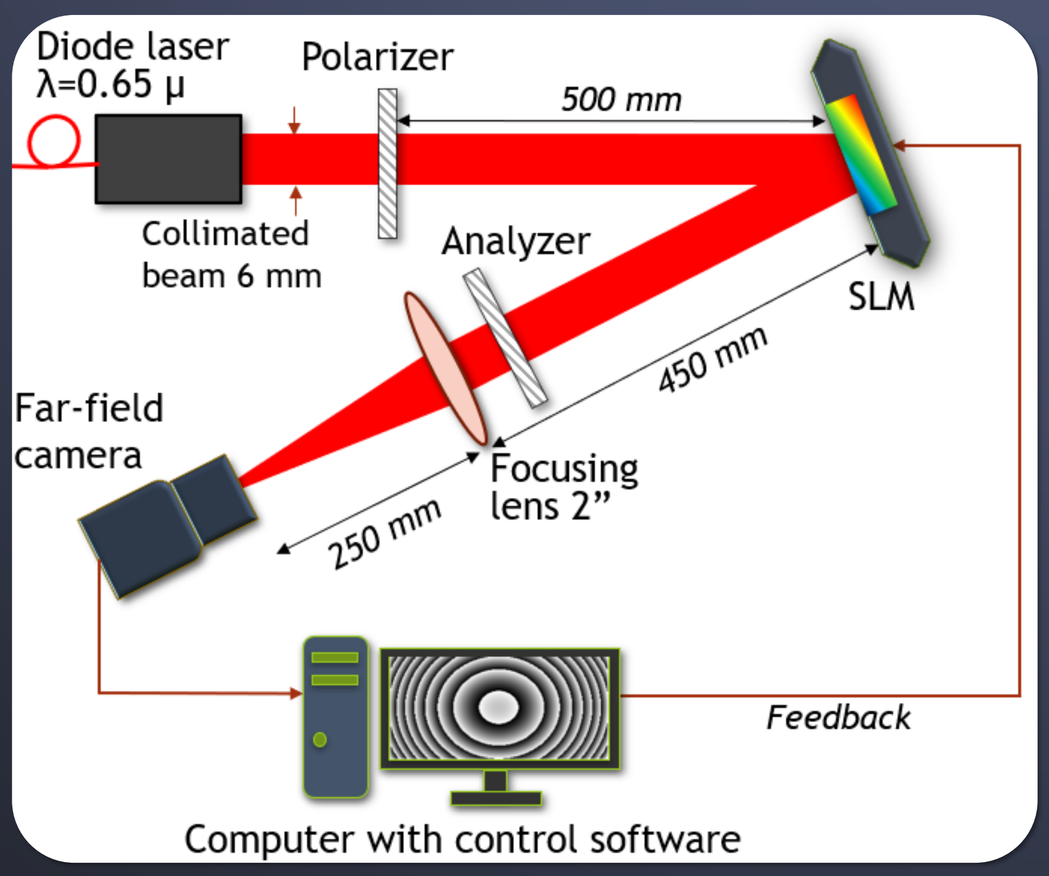
The intensity distribution I(x,y) could be considered either as Gaussian or as a flat one, and initial phase distribution $\varphi(x,y)$ was flat at starting point. Far field was calculated by combining the phase and intensity distributions using the principle of free space propagation:

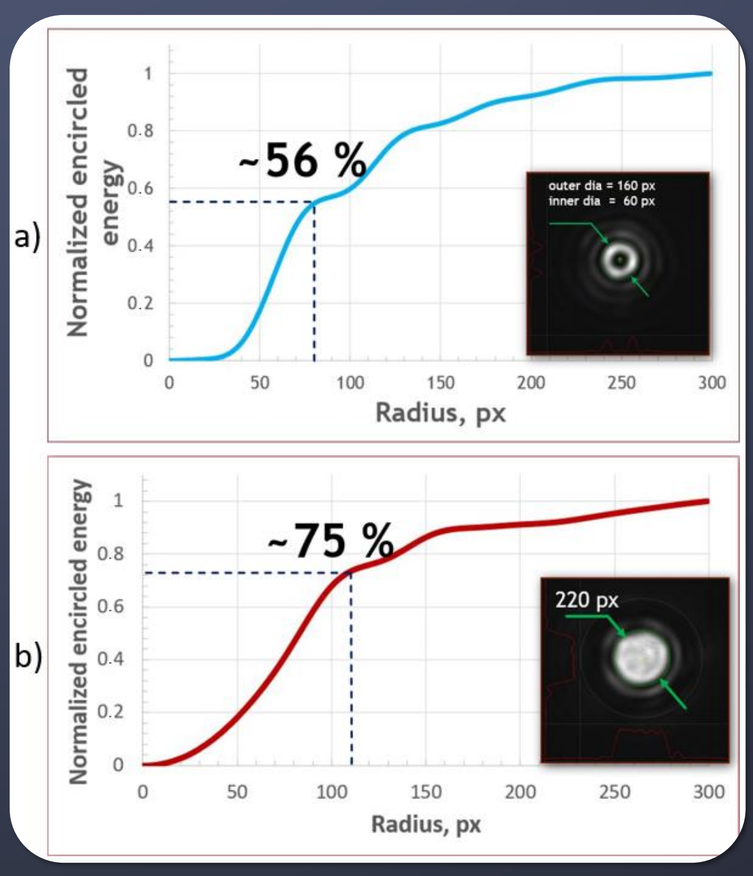
$$I_{simulated}(k_x, k_y) = \left| \int dxdy \sqrt{I(x,y)} \cdot exp\left(2\pi i \cdot \frac{\varphi(x,y)}{\lambda}\right) \cdot exp \quad -2\pi i(k_x x + k_y y) \right|^2,$$

The main steps of the intensity distribution formation algorithm (based on hill-climbing algorithm [16]) are as follows:

•Analytically calculate Idesired (it depends upon the desired shape of beam),
•Simulate far-field shape Isimulated using formula (1),
•Compute merit function Φ (Idesired, Isimulated) using formula (2),
•Select new Zernike coefficients and calculate new phase distribution φ(x,y) according to Zernike coefficients,
•Calculate new Isimulated,
•Compute new merit function Φ (Idesired, Isimulated),
Repeat steps 4-6 until the best Zernike coefficients are found.

Results





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