Simulation of Waveguide with a Complex 2D Exit Pupil Expansion
Abstract

Two-dimensional (2D) exit pupil expansion, as a key technology for near-to-eye display, can be realized by using diffractive gratings. Together with the in- and outcoupling gratings, it makes a complex 2D layout on both sides of the waveguide. As an example, a 2D exit pupil expander, which consist of both idealized and real gratings, is constructed and modeled. Uniformity at the exit plane of the waveguide is shown, and the PSF and MTF at the imaging plane are also evaluated.
How to evaluate the PSF and MTF at the focal plane of the eye, with the complex waveguide structure included?

- **2D pupil expansion grating**
  - idealized
  - period 320.49 nm
  - rotated by 45°
  - diffraction efficiencies
    - $\mathcal{R}_0 = 50\%$, $\mathcal{R}_1 = 10\%$

- **Incoupling grating**
  - idealized
  - period 453.24 nm
  - diffraction efficiency $\mathcal{T} + 1 = 80\%$

- **Outcoupling grating**
  - real slanted grating
  - period 453.118 nm
  - slanted angle 35.11°
  - fill factor 0.453
Results

Simulation including:
- propagation through waveguide with complex grating configurations
- diffraction efficiency calculation at real gratings by FMM
- multiple diffraction orders
till the exit plane of waveguide, takes less than 10 seconds!
Results

ray tracing spot diagram

field tracing

Partially illuminated aperture is taken into account.
Results

PSF coherent

PSF incoherent

Coherence property can also be included.
Results

MTF coherent and MTF incoherent comparison between 1D MTF for coherent and incoherent cases.
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