Design of the optimized DOE to convert the Gausian beam to the uniform beam for holographic application

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1. Introduction

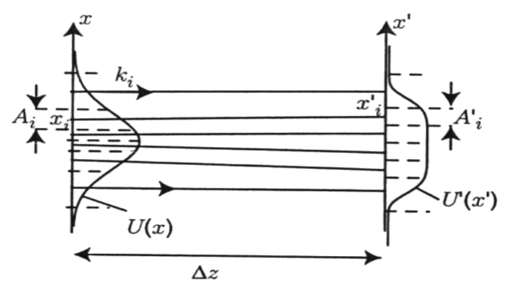
Diffractive optical elements (DOEs) are thin optical elements whose function derives from diffraction as opposed to reflection or refraction. Diffraction optics both supplement and complement refractive optics. That is that one can also use it in combination with refractive optics to enhance the overall performance of an optical system, although one can also use a DOE to replace refractive components. Most important is that one can design and fabricate DOEs to implement functions that refractive and reflective components can't.

One of these functions is a beam shaping skill which is distributed the light source(Laser) by converting the Gausian beam to the uniform beam. Here, the quantitative characterization of the laser beam intensity distribution shape is a great important for the different beams comparing, to analyze their transformation along the propagation path or as criteria for DOE synthesis. The important application can be distinguishing between the near field, Fresnel and Fraunhofer diffraction zones.

In this paper , we explain the processing for the Uniform beam shaping and mathematical processing for simulation. Finally, we will present the simulation results.

2. Processing for the Uniform beam shaping

For the design of the element which generates the desired amplitude distributions any of the design approaches, we suggest Interactive Fourier transform approaches. Alternative design approaches are based on space variant imaging configuration, generating so-called geometrical transforms of the incident beam[1][2]. The design approach commonly applied here is closely related to the ray-tracing approach. In order to describe the redistribution of the light amplitude by the geometrical transform, the redistribution of the rays is calculated. Each ray is supposed to carry the same amount of energy. The intensity distribution of both the incident optical field as well as the transformed field, are subdivided into equal energy intervals A_i ,each of which is the origin or end of an optical ray at Fig. 5



$$\int_{A_i} |U(x)|^2 dx = \int_{A_i'} |U'(x')|^2 dx' = \frac{1}{I}; \quad i = 1,2,...,I \qquad (1)$$

where $U(x)$ and $U'(x')$ are the incident and the transformed amplitude distribution with normalized intensity ($|U|^2 = 1$). From geometrical considerations we find the correlation between the ray directions and the optimized phase function $\phi(x)$

$$x_i' = x_i + \frac{\Delta z \lambda}{2\pi} k_x = x_i + \frac{\Delta z \lambda}{2\pi} \frac{d\phi(x)}{dx} \qquad (2)$$

Fig. 1 Geometrical transform described by a changing in density of optical rays

Thus, the k-vectors of the individual rays can be calculated. By partial integration for the k-vectors we achieve the phase distribution for the transforming element. For some specific situations this design approach yields analytic solutions for the phase profile of the beam-shaping element. A variety of numerical approaches for a more general solution of the problem have been suggested.

3.Mathematical processing for simulation

Through the part 3 we knew the theory of the beam shaping so For designing the optimized DOE for uniform beam shaping we applied the differential equation At Fig. 1[3]. Before solving that, we should know difference between radiant and flux(luminous). Here, the radiant is the total power of the radiation in included in the measurement process and the flux is only the visible range of radiation is included in the measurement process.

Table 1. Lens date for designing the DOE Lens

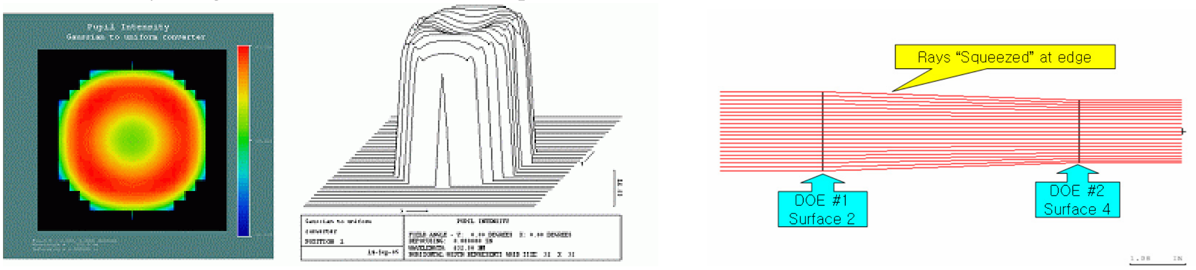
Table. 2. DOE Pattern factors

Lens Data	
EPD	2inch
WL	632.8nm
Lens Material(temperal)	‘PMAA’
Refrative index	(1.4892)

Lens surface		S2:STO	S4	Auto optimized constraits
DOE Pattern Factors	C1	-3.6013E-05	-3.9005E-05	Y S2 F1 R6 = 1.98017E-01
	C2	-1.2158E-02	1.3220E-02	Y S2 F1 R7 = 3.84521E-01
	C3	1.4359E-03	3.7835E-04	Y S2 F1 R8 = 5.49840E-01
	C4	-4.0547E-05	8.1671E-03	Y S2 F1 R9 = 6.87537E-01

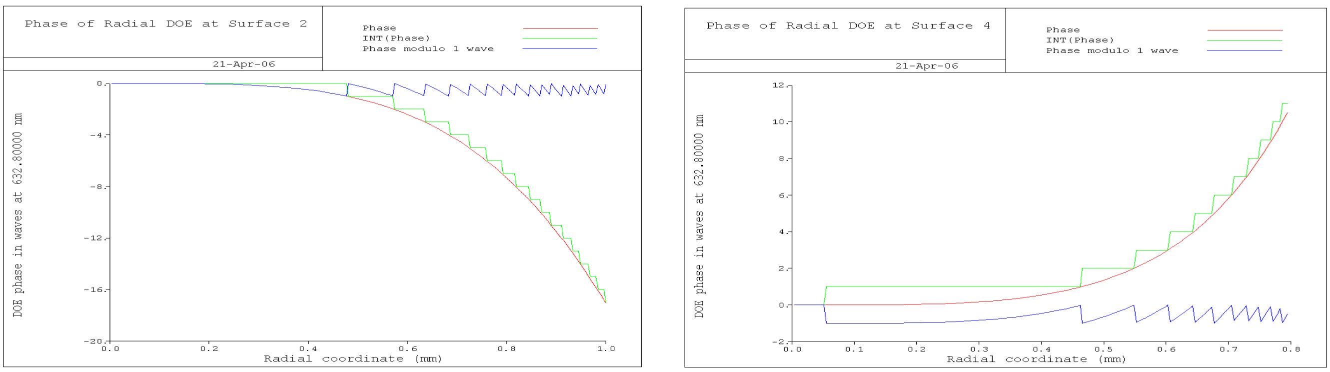
4. Simulation results

We simulated the DOE Lens system including the DOE pattern factors. Fig. 2 showed beam intensity were similarly constant. So we got the similarly Uniform beam. Fig. 2 showed we checked if ray tracing is right direction and shows Fresnel lens patters when we really design the DOE. But all data and pictures are simulated Results.



a) b) c)

Fig. 2 Simulated results a) 2 dimension beam ,b) 3 dimension beam intensity and c)Beam tracing when we emit the 21 rays



a) Surface 2(Doe #1) b)Surface4(Doe #2)

Fig. 3 Simulated Fresnel Lens Patterns

5. Conclusions

We found the beam tracing distributed all directions and made the similarly Uniform beam shaping. Now we just simulated the DOEs. So we need to have experiments in the future. But it is difficult to make the real DOE lens. First we make the mask to fabricate the lens. So we need to study more for fabricate and we will find the good material to get the Uniform shaping by comparing with simulations using different materials for holographic application(4).

Acknowledgments

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