

Simulation of Lightguide with 1D-1D Pupil Expander and Real Gratings

Abstract



With the development of new applications in the area of augmented & mixed reality (AR & MR) the use of light guide systems has seen growing interest. In order to guide the light from the source to the intended eyebox a configuration with a separated 1D-1D pupil expansion in combination with different kinds of surface relief gratings are used. The design of these gratings in regard to efficiency and uniformity is therefore one of the major challenges in the design process of AR/MR devices. In this use case we demonstrate how to include real grating structures in VirtualLab Fusion, from the initial grating design to the application on the lightguide surface.

Task Description

Source

- 532nm wavelength
- 1 mm × 1 mm diameter

Eye Pupil Expander

- rectangular grating
- 268.7 nm period
- angle 45°
- material: resin (n=1.8)

Configuration A: C

fill factor 50% height: 300nm

3

Configuration B: fill factor 58% height: 200nm





Incoupling grating

- slanted grating
- 380nm period
- material: resin (n=1.8)



System Building Blocks – Light Guide Component

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The shown configuration with the *Light Guide Component* can be generated with the *Layout* Design tool, very handily. More information on this topic can be found under (Light Guide Toolbox Gold needed):

Light Guide Layout Design Tool

	Diffractive Optics +	Gratings	[(़ झ झ) Laser Resonators →	Light Guides +	Light Shaping -	전압 About VirtualLab 않음 License Informati 당양 Update Informati	Fusion on ion
			Setups	Simulati	on		
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Incident Light Light Guide Outgoing Ligh	it			General	Design	entine Analysis	
Absolute Position (of Incoupling Grating)	-10 mm		-5 mm	Design (Hololens 1 T	ype Layout)	
Position Outcoupling Grating	11 mm		8 mm	📕 k-La	yout Visualiz	zation	
Thickness of Light Guide 500 µm			📱 Layo	out Design			
Design for Reflection				🕑 Grat	ting Design		
Light Guide Medium							
S-LAH79_Ohara_2016 in Homogeneous M	t	C	View				
Grating Parameters							
Orientation Incoupling Grating			0°				
Fixed Incoupling Period	ſ		290 pm				
Period Incoupling Grating	l		500 nm				
Deflection Angle of Eye Pupil Expander	l		90°				
Creat	e Result						
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System Building Blocks – Components

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with the help of the grating-specific of	optical setup.	. Atterwards the			
designed grating can be loaded into the corresponding region of the				٢	>
Light Guide Component More information in the following Use Case				Periodic Stack; Stack Period 380 nm ×	100 fm
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Construct a Lightguide Component f	rom Real Gr	atings			

System Building Blocks – Channel Configuration

3D View: Optical Setup	- 🗆 ×
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For each individual grating region it is possible to configure the specific channels and diffraction orders that will be considered during the simulation of the desired lightguide.

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	Add Order Remove Order Tools 🖓 🗸	Add Order Remove Order Tools 🆓 🗸
	Validity: 🕑	OK Cancel Help

Summary – Components...



of Optical System	in VirtualLab Fusion	Model/Solver/Detected Value
1. Source	Plane Wave Source	Truncated Ideal Plane Wave
2. Incoupler	Slanted Grating in Rectangular Region	Fourier Modal Method
3. Eye Pupil Expansion	Rectangular Grating in Simple Polygon Region	Fourier Modal Method
4. Outcoupler	Rectangular Grating in Rectangular Region	Fourier Modal Method
5. Eye	Camera Detector	Energy Density

Simulation Results

Reference – Ideal Case



Results – Configuration A

To demonstrate the effects of grating efficiency on the overall characteristics of the lightguide we used two different configurations of the EPE grating. In configuration A we use gratings with a higher efficiency for the +1st order, which is diffracted towards the outcoupler. This means, most of the light will be diffracted after only a few interactions. Hence, while the overall efficiency will be higher, the uniformity of the distribution in the eyebox may suffer.



Results – Configuration B

When using gratings with a lower efficiency of the +1st order in the EPE, a smaller fraction of the total energy will be diffracted towards the outcoupler with each interaction. This results in better uniformity, at the cost of reduced efficiency.



Aperture Effects



Polarization Effects in Eyebox



Propagation through the light guide with numerous interactions with real (and therefore polarization sensitive) gratings will affect the polarization state of each individual footprint. Due to the physical optics techniques of VirtualLab Fusion, these effects are considered, accurately.

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VirtualLab Fusion Technologies



