Confirmed keynote

Pr. Julius MUSCHAWECK

JMO GmbH, Germany

Freeform optics for illumination: past, present, and future

Freeform optics for illumination, pioneered over 20 years ago, are now widely used to light up streets, automobiles, architecture and more. But many questions remain: Do we have good, accessible design methods, especially for extended sources? Do we have proven processes to estimate and specify tolerances, to ensure full production yield without overengineering? The talk discusses the progress of design and manufacturing methods over the last 30 years, shows the knowledge gaps we're suffering from, and concludes with an outlook to a non-obvious but exciting new approach for coherent light: What happens when we combine freeform surfaces with scattering and spatial light modulation?

Pr. Simon THIBAULT

Laval University, Canada

Future of optical system and lens design in the AI era

The arrival of ChatGPT, Google Bard, and other highly advanced artificial intelligence model show us just how brilliantly tasks can be reproduced by those engines. So, it's legitimate to wonder how our field (or any fields) might be affected in the future. We've already seen the beginnings of the possibilities, notably with LensNet, which provides optical designers with starting points for common cases; we can also study a solution space of certain type of lenses using deep learning ; and more recently, papers on the use of deep learning to simulate the entire chain of an optical system from object to final image processing, including tasks such as recognition. These latest end-to-end simulations have shown that in some cases, it is even necessary to redefine the optical optimization criteria to maximize certain computer tasks. In short, the computer doesn't necessarily need a good image in terms of MTF to perform its task. In this context, how the future will be affected or enhanced by these new AI approaches. In this presentation, I will first give a brief history of how AI has impacted optical system design since 40 years.

Wednesday, October 9

Time Slot	Company	Presenter	Presentation title
10:00	ONERA	Thierry FUSCO	Welcoming session
10:10	FO-RS	Roland GEYL	Presentation of the association
10:30	Univ Laval	Simon THIBAULT	Future of optical system and lens design in the AI era
11:10	ONERA	Pauline TROUVÉ	Multi-task deep-codesign of a monocular RGB-D camera
11:30	TRT	Sebastien HERON	Black box evolutionary optimization design of complex optical systems
11:50		**Lunch**	
14:00	ONERA	Alice FONTBONNE **webinar**	FORMIDABLE: a differential ray tracer with NURBS capabilities
14:40	ONERA	Guillaume DRUART	Automatic method of exploring the landscape of freeform dioptric optical problems using the SMS method
15:00	SYNOPSYS	Adrien TOZZOLI	Aberration-based freeform optimization approach: a Freeform Reflective Triplet example
15:20	UNIVERSIDADE VIGO	Juan Valencia ESTRADA	Maps of local torsions as a descriptor of a free-form surface
15:40		**Coffee break**	
16:10	JMO GmbH	Julius MUSCHAWECK	Freeform optics for illumination: past, present, and future
16:50	RAYMAPR	Boris THIBERT	Nonimaging optics and optimal transport
17:10		**end**	

Invited speakers

- ONERA - Pauline TROUVÉ

Multi-task deep-codesign of a monocular RGB-D camera

In recent years, advanced co-design methods have been introduced to optimize optical and neural network parameters simultaneously for various individual tasks, such as high dynamic range, extended depth of field (EDOF), depth from defocus (DfD), object detection, and pose estimation. Specifically, at ONERA, we have been focusing on the co-design of a 3D camera that exploits chromatic aberration for DfD. This type of camera is designed to generate both an accurate depth map using defocus blur and a high-quality image—two tasks that typically require different optimal optical settings. As a result, the co-design of this system must address a multi-task scenario, involving two neural networks: one for depth estimation and the other for image restoration. In this talk, we present our approach to this design. We begin by describing the co-design tools developed at ONERA, based on the differentiable ray tracer Formidable to simulate the imaging system response across field angles. Then, we present our findings on the deep co-design of a chromatic Cooke triplet lens, assessing performance for DfD and EDOF tasks within a unified, parallel, and collaborative optimization framework, demonstrating how the results of one task can benefit the other.

- TRT - Sebastien HERON

Black box evolutionary optimization design of complex optical systems

Freeform optics bring new degrees of freedom to optical systems and require the abilities both to describe any surface (continuous or not) and to optimize their shape together with the geometry of the entire system. This increases the number of variables, and therefore the complexity of the fitness function to be minimized in order to obtain highest optical performance. Most proprietary algorithms from commercial solutions cannot handle more than tens of variables and/or noisy function landscape limiting the implementation of such free-form in optical systems. Here, CMA-ES algorithm is coupled to parallel computation of ray tracing simulations able to cover the high computational demand. The benefits of such state-of-the-art evolutionary optimization algorithms is a one-step convergence by exploring the entire landscape of solutions without the need of any starting optical architecture.

- ONERA - Alice FONTBONNE

FORMIDABLE: a differential ray tracer with NURBS capabilities

FORMIDABLE (Freeform Optics Raytracer with Manufacturable Imaging Design cApaBiLitiEs) is an optical design library with differential ray tracing and Non-Uniform Rational B-Splines (NURBS) optimization capabilities under European Software Community License (ESCL). The principle of this library and several examples of its application will be presented.

- ONERA - Guillaume DRUART

Automatic method of exploring the landscape of freeform dioptric optical problems using the SMS method

We present an automated method of finding different freeform dioptric starting systems, working in the infrared region, for further optimization in commercial optical design software. Our developed method couples the simultaneous multiple surface (SMS) method, introduced by Benítez and Miñano, with automatic optimization in Zemax OpticStudio. The method allows an optical designer to explore the merit function (MF) landscape of freeform optical problems. In this article, we apply our method to a size, weight, and power (SWaP) problem

Invited speakers

- SYNOPSYS - Adrien TOZZOLI

Aberration-based freeform optimization approach: a Freeform Reflective Triplet example

Different approaches exist to design using Freeforms. This presentation illustrates one approach to optimize of a Freeform Reflective triplet, using an aberration-based design process.

- UNIVERSIDADE VIGO - Juan Camilo VALENCIA ESTRADA

Maps of local torsions as a descriptor of a free-form surface

Pentacam® corneal topographer measures anterior and posterior corneal elevations with a resolution of 500 nanometers. Corneal surfaces are expressed as Zernike coefficients. Here, we find that the Zernike coefficients, as obtained by the Pentacam®, can also be used to generate a different kind of map that, as we find, may be useful in ophthalmic praxis. These maps lead to the interpretation of corneal deterioration and some corneal diseases by pointing out the high-density aberration zones on the cornea. Here, the torsion map proposed by the authors is just a particular case of a geodesic torsion. The torsion map allows for quantifying both local astigmatism and the principal planes' deviation with respect to the meridional plane. From a freeform optical designer's point of view, the knowledge of torsion maps can accelerate the design optimization process. Besides, from a manufacturing point of view, the obtained elevation maps can lead to the identification of, for instance, materials in-homogeneities and local deformations and the identify the surface to be modified to enhance the optical system.

- RAYMAPR - Boris THIBERT

Nonimaging optics and optimal transport

The goal of nonimaging optics is to design optical components, such as mirrors or lenses, that transfer a given light source to a prescribed target light. When the light source is punctual or collimated, these problems amount to solve second order non linear partial differential equations, that are known as Monge-Ampère type equations. In this talk, I will show how these equations are connected to the optimal transport theory and can be solved using a geometric discretization. I will also present the design of different kinds of mirrors or lenses that allow to transfer any punctual or collimated source to any target.