Three PhD positions
on illumination optics design

Short description

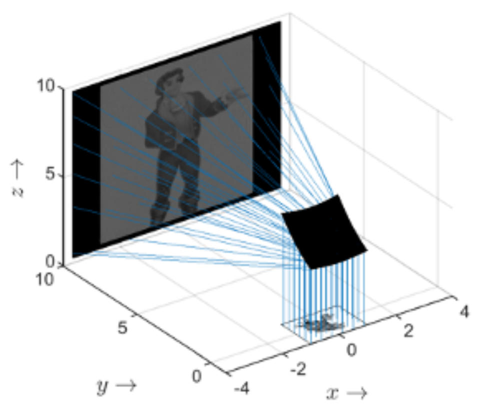
Are you eager to use your math skills to design optical systems for sustainable high-tech devices for billions of people?

Job description

The Computational Illumination Optics group is one of the few mathematics groups worldwide working on optical design problems from illumination optics. The team has a healthy portfolio of PhD positions and close collaborations with industrial partners. It consists of four full FTEs at Eindhoven University of Technology and one part-time professor.

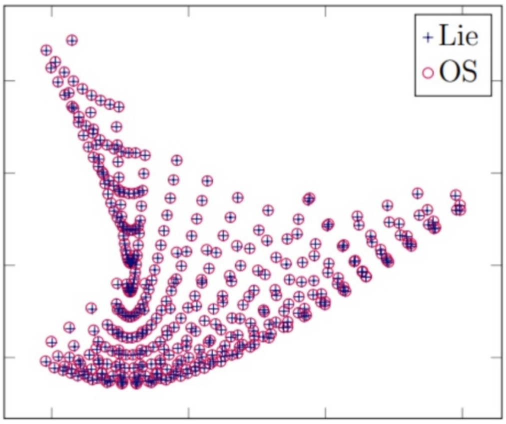
The group has three research tracks: **freeform design**, **imaging optics** and **improved direct methods**; for more details see https://www.win.tue.nl/~martijna/Optics/. The following mathematical disciplines are important in our work: geometrical optics, ray tracing, (numerical) PDEs, transport theory, nonlinear optimization, Lie operators and Hamiltonian systems.

Freeform design: The goal in freeform design is to compute the shapes of optical surfaces (reflector/lens) that convert a given source distribution, typically LED, into a desired target distribution. The surfaces are referred to as freeform since they do not have any symmetries. The governing equation for these problems is a fully nonlinear PDE of Monge-Ampère type.



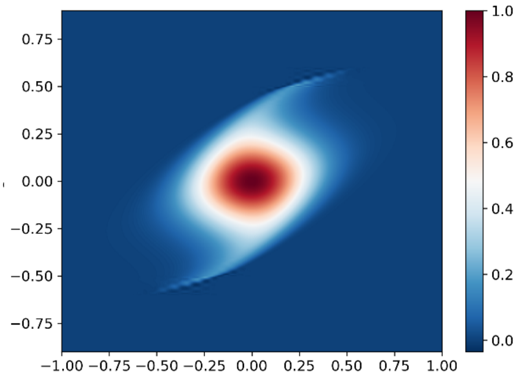
Key publication: Anthonissen, M. J. H., Romijn, L. B., ten Thije Boonkkamp, J. H. M., & IJzerman, W. L. (2021). *Unified mathematical framework for a class of fundamental freeform optical systems.* Optics Express, 29(20), 31650-31664. https://doi.org/10.1364/OE.438920

Imaging optics: The second research track is imaging, where the goal is to form a very precise image of an object, minimizing aberrations. Light propagation is described in terms of Lie transformations.



Key publication: Barion, A., Anthonissen, M. J. H., ten Thije Boonkkamp, J. H. M., & IJzerman, W. L. (2022). *Alternative computation of the Seidel aberration coefficients using the Lie algebraic method*. Journal of the Optical Society of America A, Optics, Image Science and Vision, 39(9), 1603-1615. https://doi.org/10.1364/JOSAA.465900

Improved direct methods: Direct methods, such as ray tracing, compute the target distribution given the source distribution and the layout of the optical system. These methods must be embedded in an iterative procedure to compute the final design and are based on Monte-Carlo simulation. They are known to have slow convergence. Using the Hamiltonian structure of the system and advanced numerical schemes for PDEs, we are working on more efficient and accurate methods.



Key publication: van Gestel, R. A. M., Anthonissen, M. J. H., ten Thije Boonkkamp, J. H. M., & IJzerman, W. L. (2021). *An energy conservative hp-method for Liouville's equation of geometrical optics*. Journal of Scientific Computing, 89, [27]. https://doi.org/10.1007/s10915-021-01612-x

PhD vacancies
As part of the research program *Optical coherence; optimal delivery and positioning* (OPTIC) we offer three PhD projects:

- **OPTIC1 Finite-source Monge-Ampère**
  For an ideal source — point source or perfect parallel beam — it is known how to directly compute the freeform surfaces that convert a given light distribution at the source into a required target distribution. In applications where a real source does not match these ideals, an iterative procedure is needed to consider the finite extent of the source. In this project we aim to directly compute optical surfaces for finite sources.
- **OPTIC2 Multi-beam freeform**
  For ideal sources and light rays that follow a single path from light source to target screen, we know how to compute the required freeform surfaces (lenses or reflectors).
  In this project we will develop a Monge-Ampère-based algorithm to design 3D optical systems where light beams can be split and rays may follow different paths. This is important for applications as it may lead to more compact designs.
- **OPTIC3 Surface scattering with 3D Monge-Ampère**
  For ideal sources and ideal optical surfaces (perfect lens or perfect mirror) we can solve the Monge-Ampère equation to find the shapes of the surfaces. Scattering elements send light rays in multiple directions and can be used to reduce glare in optical systems. However, current design methods that include scattering use a slow iterative process.
  In this project we will develop fast direct design methods for 3D optical systems with scattering surfaces.

Job requirements

We are looking for talented, enthusiastic PhD candidates who meet the following requirements:

- A master's degree in (applied) mathematics or (applied) physics.
- Experience with solving ordinary and partial differential equations numerically.
- Experience with programming (C, C++, Python, Matlab or alike).
- Creative pro-active team player with good analytical skills.
- A research-oriented attitude.
- Ability to work in an interdisciplinary team and interested in collaborating with industrial partners.
- Motivated to develop your teaching skills and coach students.
- Fluent in spoken and written English (C1 level).

Conditions of employment

A meaningful job in a dynamic and ambitious university, in an interdisciplinary setting and within an international network. You will work on a beautiful, green campus within walking distance of the central train station. In addition, we offer you:

- Full-time employment for four years, with an intermediate evaluation (go/no-go) after nine months. You will spend 10% of your employment on teaching tasks.
- A research position in an enthusiastic and internationally renowned research group.
- Salary and benefits (such as a pension scheme, paid pregnancy and maternity leave, partially paid parental leave) in accordance with the *Collective Labour Agreement* for Dutch Universities, PhD scale (min. € 2770, max. € 3539).
- A year-end bonus of 8.3% and annual vacation pay of 8%.
- High-quality training programs and other support to grow into a self-aware, autonomous scientific researcher. At TU/e we challenge you to take charge of your own learning process.
- An excellent technical infrastructure, on-campus children's day care and sports facilities.
- An allowance for commuting, working from home and internet costs.
- A Staff Immigration Team and a tax compensation scheme (the 30% facility) for international candidates.

Information and application

About us

Eindhoven University of Technology is an internationally top-ranking university in the Netherlands that combines scientific curiosity with a hands-on attitude. Our spirit of collaboration translates into an open culture and a top-five position in collaborating with advanced industries. Fundamental knowledge enables us to design solutions for the highly complex problems of today and tomorrow.

Curious to hear more about what it's like as a PhD candidate at TU/e? Please view the video https://youtu.be/J76a-oN5YW8?si=kCmfrm5yzMgMjRC1

Information

Do you recognize yourself in this profile and would you like to know more?
Please contact the hiring manager dr.ir. Martijn Anthonissen, m.j.h.anthonissen@tue.nl.

Visit our website for more information about the application process or the conditions of employment. You can also contact HRServices.MCS@tue.nl.

Are you inspired and would like to know more about working at TU/e? Please visit our career page.

Application

We invite you to submit a complete application by using the apply button. The application should include a:

- Cover letter in which you describe your motivation and qualifications for the position.
- Curriculum vitae and the contact information of three references.

We look forward to receiving your application and will screen it as soon as possible. The vacancies will remain open until the positions are filled.