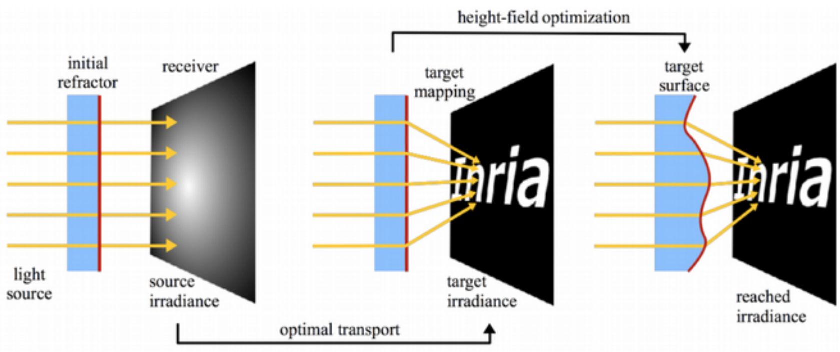
Sujet de stage niveau Master 2

Free Form Lense Design



Nowadays, it is relatively easy to prototype refractors (e.g., lenses or small windows pane) with arbitrary surface shapes using either subtractive [1,2] or additive [3] technologies. This opens the doors for countless novel applications and more efficient devices in various domains such as architecture, design, displays, lights, optical systems, etc. However, designing the shape of the refractor to reach some desired objectives remains a challenging problem. Indeed, a slight change of the refractive surface can produce strong and non-local effects on the refracted image making it impossible to design the shape of the refractive surface by hand. There is thus a high demand for efficient numerical tools to automatically infer the refractive surface to reach some goals, possibly under some constraints.

Up to now, this problem has been attacked as follows (see figure above). Given a known collimated light source, an initial flat refractive surface, and a planar and diffuse receiver with a target irradiance map, the problem is to find the shape of the refractive surface such that the source irradiance is mapped to the target through optical refraction. The state of the art method solving this problem [4] first computes a bijective mapping between the source and target distributions using an optimal transport solver (fig. 1), and then seek for a height-field surface reproducing this mapping trough the Snell-Descartes law of refraction. However, this approach exhibits several shortcomings :

- It ignores uncertainties in the setup (light source, relative positions, fabrication error, etc.).
- The stability of the solution to small input changes is ignored.
- Fresnel effect and reflectance properties of the receiver are ignored.
- etc.

The goals of this internship are:

1) Implement a state of the art solver (already done at 80%).
2) Experiment with the fabrication process.
3) Quantify the aforementioned sources of errors and investigate approaches to reduce the largest ones.
4) Investigate more sophisticated designs to relax some of the constraints (e.g., planar receiver, monochromatic light source) or achieve new application (e.g., focus-free projection).

This is a vast topic, and the focus of the internship will be adjusted according to the candidate motivations.

Technical skills : C++, knowledge in numerical methods, knowledge in optical design.

Références

[1] Pauly et al. 2013. Controlling caustics. Glass Performance Days.

[2] http://prototechasia.com/en/casestudy

[3] https://www.luxexcel.com

[4] Schwartzburg et al. 2014. In ACM TOG (Siggraph),
see http://lgg.epfl.ch/publications/2014/Caustics for videos.

Contact

Gaël Guennebaud : gael.guennebaud@inria.fr