



FAST RAY TRACING OF SEGMENTED FREE-FORM LENSES

Task

Non-rotationally symmetric free-form optics are increasingly being used in consumer products. In order to reduce weight and material consumption as well as production time and, thus, costs, the industry is using fresnelization to minimize the component size of the optics. Since some of the light is refracted at the segment boundaries, the quality of the image decreases; however, the effect can be reduced by adapting the segment boundaries to the optics and the light source. This is particularly true for free-form optics since the high number of degrees of freedom means that the contour lines do not usually have rotational symmetry. The design of an individual fresnelization is based on repeatedly imaging the segmented free-form lens by means of ray tracing, which requires high computing power because there are many degrees of freedom of the free-form optics as well as the additional fresnelization.

Method

To design fresnelized free-form optics, the Chair for Technology of Optical Systems at RWTH Aachen University implemented a problem-adapted algorithm that allows efficient ray tracing. The segmentation is automatically calculated from the freeform surface and can, thus, be used as the basis

for a multi-target function optimization procedure. Not only is the image quality of the segmentation taken into account, but also manufacturing constraints and the thickness of the lens. The developed program can be run on a conventional PC.

Results

For different applications, different fresnelization strategies can be considered, such as segmentation of the curved or flat side of the lens and segmentation along geometric curves or contour lines.

Applications

The method implemented here can be used for various consumer products, e.g. cameras of mobile phones or headlights in cars. Current work on the fresnelization of free-form optics focuses on the reduction of the moiré effect in heads-up displays.

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- 1 *Design of a segmented free-form optic.*
- 2 *Simulated intensity distribution of a segmented free-form optic before (l.) and after (r.) the reduction of the moiré effect.*