SPIE Student Chapter
Univ Politécnica de Madrid Chapter

Activity Report

Advisor: Profesor Juan Carlos Minñano
President: Hamed Ahmadpanahi
Vice-President: Marta Victoria
Secretary: João Mendes Lopes

1 List of Members

Hamed Ahmadpanahi
Gonzalo Arranz Santamaria
Marina Buljan
Guillermo del Campo Jiménez
Jiayao Liu
Alexander Mellor
João Mendes-Lopes
Marta Victoria
Pablo Zamora
Appan Narasimhan Bharathwaj
Milena Nikolic

2 Yearly Activities

2.1 Optics Lecture:

We had 6 monthly lectures (every 2 month) highlighting pre-publication research. Students receive comments about their talks to enhance their presentation skills. (Attendance 15 to 20 people)

2.1.1 Pablo Zamora

Title: Aplanatic thin TIR lens

Abstract: Aplanatic designs present great interest in the optics field since they are free from spherical aberration and linear coma at the axial direction. Nevertheless nowadays it cannot be found on literature any thin aplanatic design based on a lens. This work presents the first aplanatic thin lens (in this case a dome-shaped faceted TIR lens performing light collimation), designed for LED illumination applications. This device, due to its TIR structure (defined as an anomalous microstructure as we will see) presents good color-mixing properties. We will show this by means of raytrace simulations, as well as high optical efficiency.

2.1.2 Jiayao Liu

Title: Single optical surface imaging designs with unconstrained object to image mapping

Abstract: Novel imaging designs with a single optical surface (either refractive or reflective) are presented. In some of these designs, both object and image shapes are given but mapping from object to image is obtained as a result of the design. In other designs, not only the mapping is obtained in the design process,

but also the shape of the object is found. In the examples considered, the image is virtual and located at infinity and is seen from known pupil, which can emulate a human eye.

In the first introductory part, 2D designs have been done using three different design methods: a SMS design, a compound Cartesian oval surface, and a differential equation method for the limit case of small pupil. At the point-size pupil limit, it is proven that these three methods coincide.

In the second part, previous 2D designs are extended to 3D by rotation and the astigmatism of the image has been studied. As an advanced variation, the differential equation method is used to provide the freedom to control the tangential rays and sagittal rays simultaneously. As a result, designs without astigmatism (at the small pupil limit) on a curved object surface have been obtained. Finally, this anastigmatic differential equation method has been extended to 3D for the general case, in which freeform surfaces are designed.

2.1.3 Guillermo del Campo Jiménez

Title: VLC oriented energy efficient driver techniques

Abstract: LEDs are substituting fluorescent and incandescent bulbs as illumination sources due to their low power consumption and long lifetime. Visible Light Communications (VLC) makes use of the LEDs short switching times to transmit information. Although LEDs switching speed is around Mbps range, higher speeds (hundreds of Mbps) can be reached by using high bandwidth-efficiency modulation techniques. However, the use of these techniques requires a more complex driver which elevates drastically its power consumption. In this work an energy efficiency analysis of the different VLC modulation techniques and drivers is presented. Besides, the design of new schemes of VLC drivers is described.

2.1.4 João Mendes-Lopes

Title: 9-Fold Fresnel Köhler Concentrator For Increased Uniform Irradiance On High Concentrations

Abstract: Non-uniform irradiance patterns created by Concentrated Photovoltaics (CPV) concentrators over Multi-Junction Cells (MJC) can originate significant power losses, especially when there are different spectral irradiance distributions over the different MJC junctions. This fact has an increased importance considering the recent advances in 4 and 5 junction cells. The spectral irradiance distributions are especially affected with thermal effects on Silicone-on-Glass (SoG) CPV systems. This work presents a new CPV optical design, the 9-fold Fresnel Köhler concentrator, prepared to overcome these effects at high concentrations while maintaining a large acceptance angle, paving the way for a future generation of high efficiency CPV systems of 4 and 5 junction cells.

2.1.5 Marina Buljan

Title: Quasi-aplanatic free-form V-groove collimators for LED color mixing

Abstract: Two quasi-aplanatic free-form solid V-groove collimators are presented in this work. Both optical designs are originally designed using the Simultaneous Multiple Surface method in three dimensions (SMS 3D). The second optically active surface in both free-form V-groove devices is designed a posteriori as a grooved surface. First two mirror (XX) design is designed in order to clearly show the design procedure and working principle of these devices. Second, RXI free-form design is comparable with existing RXI collimators; it is a compact and highly efficient design made of polycarbonate (PC) performing very good colour mixing of the RGGB LED sources placed off-axis. There have been presented rotationally symmetric non-aplanatic high efficiency collimators with colour mixing property to be improved and rotationally symmetric aplanatic devices with good colour mixing property and efficiency to be improved. The aim of this work was to design a free-form device in order to improve colour mixing property of the rotationally symmetric non-aplanatic RXI devices and the efficiency of the aplanatic ones.

2.1.6 Jiayao Liu

Title: Single optical surface imaging designs with unconstrained object to image mapping with non-rotational symmetry

Abstract: Novel imaging designs with a single freeform optical surface (either refractive or reflective) are presented. In these designs, not only the mapping is obtained in the design process, but also the shape of the object is found. In the examples considered, the image is virtual and located at infinity and is seen from known pupil, which can emulate a human eye.

In the first introductory part, 2D designs and 3D designs by rotation using the differential equation method for the limit case of small pupil have been reviewed. Furthermore, the differential equation method is used to provide the freedom to control the tangential rays and sagittal rays simultaneously.

In the second part, according to the study of astigmatism of different types of design with rotational symmetry, the differential equation method for 3D rotational design without astigmatism (at the small pupil limit) on a curved object surface has been extended to 3D freeform design. The result of this extended method has been proved to coincide with the former 3D design by rotation which is a special case of 3D freeform design. Finally, the initial condition has been used as an additional freedom to control the shape of the object surface. As a result, a reflective design with a much flatter object surface has been obtained.

2.2 CodeV training course

We intended to provide a 1 day workshop of technical software to the members of the Chapter provided by one of the senior members or an invited person from the Academy. Luckily, we had the opportunity of attending a much more complete course, fully supported by the University. 80% of the chapter members attended the course.

A five days´ training course for CodeV "Image forming systems" has been held in Madrid. The course covered the basics on modeling, analyzing, optimizing, and tolerancing image-forming optical systems using CODE V, including hands-on workshops. After the course, our members are able to model an optical system given its design parameters, evaluate the system to determine its quality,

optimize the system to improve its quality and evaluate the manufacturability of the final design.

After the course, and to celebrate the Chapter's activity throughout the year, all chapter members were invited for a dinner.

3 Financial Statement

SPIE student chapter fund	+ 376,67 €
Monthly presentations	125€
End of year dinner	-221.10€
Current Balance	**30.57€**