COMPARATIVE STUDY OF TWO STRUCTURED ILLUMINATION SETUPS WITH TUNABLE FREQUENCY

A. Gimeno-Gómez, J.C. Barreiro-Hervás, G. Saavedra-Tortosa, M. Martinez-Corral.
3D Imaging & Display Laboratory, Universitat de València, E46100 Burjassot (Spain)
email: Alejandro.Gimeno@uv.es

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In structured illumination microscopy (SIM) samples are illuminated with an intensity periodic pattern. After post-processing, this technique allows to obtain images with an extended resolution and/or increased optical sectioning. The final performance of the SIM setup depends on the frequency of the periodic pattern used in illumination. Recently, the use of a Wollaston prism (WP) or a Fresnel biprism (FB) to generate an intensity interference pattern with tunable frequency has been proposed [1-2]. These elements act by splitting any point source in two, separated by a distance that can be controlled by the distance between the WP or the BP from the original source. Thus, by axially shifting these elements respect to a point source, an interference pattern with tunable spatial frequency can be generated. This performance is especially desirable in SIM, since the same setup can be easily adapted to obtain optimal results in many different practical situations.

Note, however, that the ability of the SIM technique to produce accurate images with super-resolution and/or optical sectioning is strongly affected by the spatial quality of the periodic pattern. In this work we present a study of the spatial properties of the illumination field generated when using a realistic finite-size WP. We compare these results with the illumination obtained when a FB is used instead.

Thus, we study the irradiance distribution in the interference region when the illumination system is generated by a FB and when it is based on a WP of comparable finite sizes. We describe the illumination field in the framework of the Fresnel diffraction theory and then we simulate its propagation throughout the system. The interferential patterns so obtained present three types of modulation respect to the ideal sinusoidal distributions, namely, a global envelope, a local change of the visibility and a local phase modulation or jitter. The results show that the system based on a WP generates a symmetric envelope that is smoother than the illumination based on a FB. In addition, with the WP the central plane show an interferential pattern that does not present any type of modulation, being in theory a perfect cosine. All these features were experimentally checked, and the results are shown in this work.

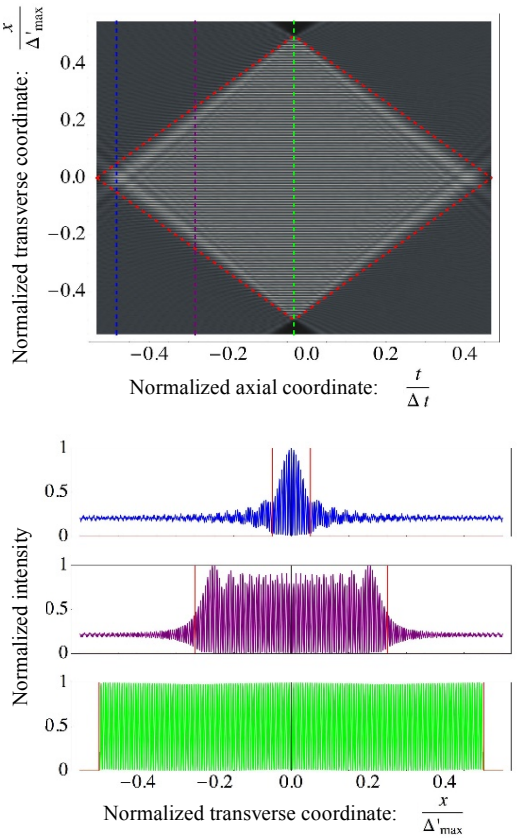

Figure 1: Interference field generated by a WP-based illumination system.

References

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