

# INTEGRAL-IMAGING FLUORESCENCE MICROSCOPY: 3D IMAGES CAPTURED IN A SINGLE SNAPSHOT

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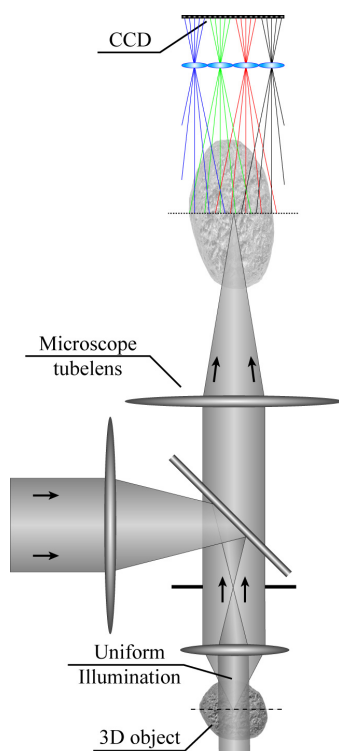
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Integral Imaging (InI) is a very promising technique for the acquisition and display of images of 3D scenes. Based on an old concept published by Lippmann more than one century ago [1], InI produces auto-stereoscopic 3D images which can be observed directly with no need of additional viewing devices such as special goggles. The multi-view nature of InI allows viewing of 3D colour images to multiple audiences.



The Lippmann idea was that one can record in a 2D matrix sensor many elemental images of a 3D scene, so that any elemental image stores the information of different perspectives of the object. When this info is projected onto a matrix display (like LCD or OLED) placed in front of an array of microlenses, any pixel of the display generates a conical ray-bundle. And it is, precisely, the intersection of ray-bundles which produces the local concentration of light-density that permits the reconstruction of the scene. This reconstructed scene is perceived as 3D by the observer, whatever his/her position.

Although InI concept was initially intended for the capture and display of 3D pictures or movies, along the last decade it has been used for other interesting applications. One is the digital reconstruction, by means of back-projection algorithms, of spatially incoherent 3D scenes. This procedure can be applied to fluorescence microscopy, provided that the InI pickup system is placed in front of the intermediate real image produced by a conventional optical microscope [2]. From the set of elemental images of the intermediate image of the 3D specimen, obtained after a single snapshot, it is possible to reconstruct, plane by plane, the stack of 2D sections that constitute the 3D image of the sample.

Further computational processing applied over the spatial spectral content of the elemental-image set can confer this hybrid system important optical-sectioning capacity [3].

InI microscopy captures 3D information in parallel without any scanning. Thus, its successful implementation can become an attractive alternative to other 3D fluorescence microscopy techniques

[1] M. G. Lippmann, *J. Phys. (Paris)* **7**, 821-825 (1908).

[2] J. S. Jang and B. Javidi, *Opt. Lett.* **29**, 1230-1232 (2004).

[3] G. Saavedra et al., *Opt. Express* **16**, 17154-17160 (2008).