

THREE-DIMENSIONAL IMAGING THROUGH FOURIER-DOMAIN INTEGRAL MICROSCOPY

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In 1908 Lippmann [1] postulated the possibility of capturing perspective information of 3D scenes by simply inserting a microlens array in front of a photographic film. This technique, named as integral imaging, permitted the capture of a collection of elemental images, each with different view of the 3D object. Later, in 1992, Adelson and Wang [2] introduced the concept of plenoptic function, which describes the radiance of each luminous light-ray in the space as a function of the angle and position. This function provides the formal support to the integral-imaging technique.

The integral-imaging concept was applied to microscopy, for the first time, by Jang and Javidi [3], but only with the purpose of displaying microscopic images. It is remarkable the contribution made by Levoy et al. [4] who adapted to microscopy the plenoptic concept. Very recently, the name integral microscopy (iMic) has been coined to refer to this technique. The improvement of the resolution of integral microscopes has aimed many research efforts. In this sense, are noticeable the application of ad-hoc deconvolution tools, the use of 4D interpolation techniques, or, more recently [5], the application of physical interpolation based in time multiplexing. The main drawback of iMics is their poor resolution. Factors that favor the loss of resolution are the limited number of pixels, the vignetting in the collected microimages and the comparable sizes of image PSF and microlens-array pitch.

To avoid the later drawbacks, in this contribution we report a novel architecture in which the lens array is not placed at the image plane, but at the pupil plane. This new realization of the plenoptic concept is named as Fourier-domain integral microscopy (FiMic). The FiMic has some apparent advantages over the iMic. First is the fact it outputs directly the perspective views of the 3D sample, and therefore much computation time is saved. Second is that there is no conflict between the microscope PSF and the microlenses sizes, and thus, no resolution is lost due to such conflict. Third advantage is the strong reduction in vignetted pixels. Final advantage is a strong gain in compactness (take into account that the FiMic does not need any tube lens). A preliminary realization of FiMic was reported in [6].

In the presentation we show the scheme of the microscope, together with the updated pre-prototype and some examples of 3D images reconstructed from captured microimages.

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