HIGH SPEED IMAGING IN TWO DIMENSIONS FROM A SINGLE-ELEMENT DETECTOR WITHOUT SCANNING

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NON-SCANNING SINGLE-ELEMENT DETECTOR IMAGING THROUGH SPATIALLY MODULATED EXCITATION

Laser scanning microscopy (LSM) techniques (e.g., confocal and multiphoton) provide superior imaging in biological tissues the exhibit optical scattering because single-element detectors provide strong discrimination against scattering-induced image distortions. Despite robust imaging performance, LSM techniques provided limited image update rates because serial acquisition of each voxel (or pixel) is required to construct a full image. Multifocal techniques to address slow image update rates suffer from a background noise and loss of signal-to-noise because array detectors such as CCDs are required to record the array of foci in parallel. We introduce a new approach in which we encode spatial information into the temporal signal from a single-element detector. By applying a time-dependent intensity modulation with a linear sweep in modulation frequency across a line illumination beam, we map spatial information onto the frequency domain of a single-element electronic detector. Through holographic heterodyne holography, we map 2D images (one transverse and one longitudinal dimension) with a single element detector.

Figure 1: (a) Time trace of modulated single-element imaging. (b) Frequency of electronic signal with sidebands containing spatial information. Dye-transferred images in absorption (c) and fluorescent (d) modes [1]. Tomography angular projects (e) and reconstruction (f) [2].

Figure 1 shows the temporal signal and frequency domain obtained from single-element detector modulated imaging. Modulation is transferred to both absorption and fluorescent mode imaging [1]. 2D images can be obtained topographically [2] or with heterodyne holography [3]. Robust imaging is preserved with optical scattering because the correlation between modulation frequency and spatial position are not corrupted by scattering events.