IMAGING THROUGH SCATTERING MEDIA USING D-SHAPED APERTURES

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1. IMAGING WITH D-SHAPED APERTURES

Many years ago now a technique was developed for imaging through scattering media, using illumination and detection by D-shaped pupil apertures [1,2]. In this way, it is arranged that the illumination and detection paths do not overlap except in the focal region. This method can be used for either reflectance or fluorescence imaging. The approach is now becoming popular again [3]. Potential applications are in ophthalmology, developmental biology, small animal imaging and clinical diagnosis. An optical model has been developed for investigating the imaging performance of such systems [4]. We have found that a strong on-axis amplitude is produced with defocus, by the Poisson spot principle. This on-axis component does overlap for illumination and detection, thus reducing the rejection of scattered light. The effect of altering the system parameters and the shape of the pupils has been investigated.

2. FOCAL MODULATION MICROSCOPY

We have developed a new imaging technique that greatly increases the penetration depth for imaging into scattering media. This is also based on the use of D-shaped pupils, but in this case two D-shaped pupils are used for simultaneous illumination by two beams of different frequency. The sample is thus illuminated in the focal region only, by a temporally modulated excitation that produces a modulated fluorescence signal, detected using lock-in techniques. Penetration depths of around 700μm have been achieved.

A similar analysis to that used in the first section has also been applied to focal modulation microscopy. We can show the rejection of scattered light by considering the concepts of integrated intensity [6] and signal/background ratio.

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