

反卷积在生物组织光传输特性研究中的应用

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生物组织中的光传输特性可以以点扩散函数表征,即在线状光束入射条件下,生物组织中某一深度层面上的光强度场分布。为获得点扩散函数的具体形式,已发展了多种理论分析方法,其中以Monte Carlo模拟方法最具代表性。但现有理论计算方法都要以生物组织的光学参数已知为前提,而光学参数的准确度直接影响着计算的精度。从线性平移不变系统理论出发,生物组织内一定深度层面上的光强分布被看成是光源强度分布与点扩散函数的卷积,从而提出通过测量在轴对称的准直扩展光源照射条件下,组织中特定层面上的光强度分布,利用反卷积重建生物组织的点扩散函数的方法,并将这种方法应用于典型生物组织透射面上点扩散函数的重建,得到了相应的点扩散函数。实验结果与Monte Carlo模拟的结果吻合较好,表明该方法从实验上获得生物组织点扩散函数的正确性和有效性。

APPLICATION OF DECONVOLUTION IN THE RESEARCH OF LIGHT TRANSMITTING PROPERTY IN BIOLOGICAL TISSUES

Many methods have been proposed to investigate light distribution in the bio-tissues irradiated by a beam of pencil light--point-spread function(psf). Among them, Monte Carlo method is the most effective and exact one. But all the existing methods depend on the exact determination of optical parameters of the bio-tissues. In this paper, bio-tissues are regarded as a linear space invariant system, thus the light distribution in the bio-tissues of certain depth is the convolution of incident light source and point-spread function of bio-tissue. On the contrary, if the light distribution in certain depth of the bio-tissue can be measured by experiment, one can obtain the psf by deconvolution of the source and the measured light distributions. Based on this consideration, a new method to determine psf is proposed, and which is applied in reconstructing the point-spread function of two kinds of typical bio-tissues--porcine dermis and muscle, and the corresponding point-spread functions are obtained. The results are compared with those obtained by Monte Carlo method, which verified that the reconstructing method is effective tools to obtain the point-spread function of bio-tissue. The method proposed in this paper can be used in the research of light transmitting property of all bio-tissues, especially for the tissues whose optical parameters are unknown.

关键词

生物组织(Bio-tissues); Monte Carlo 模拟(Monte Carlo simulation); 光分布(Light distribution); 反卷积(Deconvolution); 点扩散函数(Point-spread function)