RAY-TRAICING FOR 3D MICROSCOPE PSF COMPUTATION BASED ON THE REFRACTIVE INDEX MAP.

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KEY WORDS: Point Spread Function, variant PSF, 3D deconvolution, ray-tracing.

1. Abstract:

The TDM (Tomographic diffractive microscope) [1] can provide a 3D optical index map of a specimen. To simulate the propagation of a light ray through the specimen, the principle of finite elements can be used for calculation of meridional rays in inhomogeneous media [2]. Actually, the volume is divided into slices, themselves divided into finite elements that have a constant refractive index according to the TDM resolution level. The ray trajectory is calculated by a simple algorithm initially proposed in [2]. The ray-tracing method does not require an explicit formula for the index distribution, it require only the numerical variation of absorption and refractive index given by the TDM.

Initially the author [2] proposed a 2D geometrical interpretation of the wave propagation, following this principle, we proposed an alternative computation scheme, giving similar results at a less computing cost, and easily adaptable to the 3D case.

As in [3] we propose to use the mean index value in each elementary box, according to the limited resolution achieved by the microscope. The implementation of the 3D ray paths computation was done in C++ language (OpenCV & CImg libraries). A recent method [4] can give better results for gradient-index media presenting also index steps e.g between two mediums but at a higher computational cost. The implementation was validated using a comparison between the analytical solution of the ray path in an optic fiber and the computed solution as presented in [2] and [4].

The propagated light field in the exit pupil can be computed using this method, therefore the specimen dependent PSF(x,y,z) can be calculated by the projection of the pupil function on the Ewald sphere followed by a Fourier transform. Further applications in the field of optical engineering and specifically in adaptive optics for fluorescence microscopy are considered.

The authors thank the ANR (Agence Nationale de la Recherche) for his support to the project DIAMOND.

2. REFERENCES:


