Modeling electromagnetic wave's propagation in medical imaging of the human retina

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ABSTRACT

The human retina is a complex structure in the eye that is responsible for the sense of vision. It is part of the central nervous system, composed by several layers, among which the outer nuclear layer that comprises the cells bodies of light sensitive photoreceptor cells (rods and cones). There are a number of eye-related pathologies that can be identified by the detailed analysis of the retinal layers. These pathologies can be diagnosed more conclusively with the help of the increasingly popular noninvasive optical imaging technique optical coherence tomography (OCT) [2]. In this talk we report a methodology to assess cell level alterations on the human retina responsible for functional changes observable in the OCT data in healthy ageing and in disease conditions, in the absence of structural alterations.

In particular, we will discuss the mathematical model that describes the electromagnetic wave's propagation through the eye's structures in order to create a virtual OCT scan. We use a leap-frog type discontinuous Galerkin method for the discretization of the time-dependent Maxwell's equations [1] and we will focus on deriving stability and convergent estimates of fully discrete schemes. We consider anisotropic permittivity tensors, which arise naturally in our application of interest. An important aspect in computational electromagnetic problems is the implementation of the boundary conditions.

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