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MODELLING OF METAMATERIALS BASED ON AN IMPROVED FDTD METHOD

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Since it's developpment in the 60's, the Yee algorithm [1], a second order time domain algorithm, is still often the method of choice for industrial simulations due to its simplicity and low computational costs. Unfortunately this method is limited to structured meshes. Although alternatives have been suggested to improve the accuracy of the scheme in the case of curved interfaces, these methods are not as efficient as the original scheme. Therefore, this work is based on the method developped by Xie [3] who employed a primal unstructured Delaunay mesh and its orthogonal Voronoi dual graph to generate an unstructured mesh. During my PhD we extended this method from PEC to isotropic, anisotropic, dispersive and chiral materials. This extension is the basis required for the simulation of Metamaterials, artificial materials with properties which are not found in nature. For electromagnetic metamaterials, these properties are produced by merging resonating metallic inclusions within a dielectric matrix. A metamaterial typically consists of thousands of unit cells, which would make it computationally to expensive to model each of them, therefore we developped a multiscale approach which allows us to deduce the material parameters of a metamaterial from a single unit celll.

We present an overview of the different key steps starting from a simple isotropic dielectric material to a metamaterial as well as the experimental technique and multi-scale approach [2].

REFERENCES

[1] K. Yee, Numerical solution of initial boundary value problems involving Maxwell's equations in isotropic media. *IEEE Transactions on Antennas and Propagation*, Vol. **14** (3), pp. 302–307, 1966.

[2] A. Gansen, Multiscale Modelling of Anisotropic Composite Media for EMC Applications. *PhD Thesis*, Swansea University, 2017.

[3] Z.Q.Xie, O.Hassan and K.Morgan. Tailoring unstructured meshes for use with a 3D time domain co-volume algorithm for computational electromagnetics. *International Journal for Numerical Methods in Engineering*, Vol.**87**(1-5):48-65, 2010.

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