Abstract

Metamaterials consist of a lattice of conducting, nonmagnetic elements that can be described by an effective magnetic permeability and an effective electrical permittivity , both of which can exhibit values not found in naturally occurring materials. Because the electromagnetic fields in conducting metamaterials can be localized to regions much smaller than the incident wavelength, it can be difficult to perform accurate numerical simulations. My initial idea of this project is inspired from the paper of *T. Weiland and R. Schuhmann titled numerical simulation of left-handed metamaterials: Comparison of calculations and experiments ,JOURNAL OF APPLIED PHYSICS VOLUME 90, NUMBER 10 15 NOVEMBER 2001*

In the original paper the computation was done using **finite integration technique with perfect boundary approximation.**

COMPUTATIONAL APPROACH : Accurate geometric modeling of spatially intricate structures is required. The capacitance between closely spaced conducting elements plays a critical role in the electromagnetic response of metamaterials. electro- magnetic metamaterials can be formed from repeated unit cells containing scattering elements. These periodic structures can be efficiently modeled by simulating the properties of a single unit cell and applying various forms of periodic boundary conditions. The numerical solution of maxwell's equation produces the local field, we need to find out the macroscopic parameter that average over the local fields which arrives at a systenm that can be generally described by the effective electrical permittivity and magnetic permeability.

This can be achieved by the FIT algorithm, or by the common form of it i.e Finite Difference Time Domain (FDTD)method.The FIT is based on the segmentation of the computational domain by a doublet of two computational grids, a primary and a dual grid. The degrees of freedom of this method are the integral state variables which are defined as the integrals of the electric and magnetic field vectors over the lines and facets of either the single or the dual grid.

We can also invent a new part of this project by combining the leap frog time integration scheme with the FIT technique that would bring the process close to FDTD process.

The process can be done again using FDTD algorithm and we can compare the results against the experimental data available.

Also with these two algorithms implemented we can see which model works better and why and what are the constraints.

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[1] ** I intend to learn the FIT and FDTD and leap frog method for integration and solve the maxwell's equation numerically.