PHYS468 Research Proposal

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Maxwell's equations describe the propagation of electromagnetic waves in different materials. Analytic solutions exist in specific cases, but this is not always the case. In more complex cases, an analytic solution may not be obtainable so one must approximate a solution. One way to do this is by solving Maxwell's equations numerically.

The most common scheme for numerically solving Maxwell's equations is known as the finite-difference time domain (FDTD) method. This scheme, devised by Kane Yee in 1966, is simple to implement and easily understood. However, the scheme in its original form is only second-order convergent and requires meeting stability conditions which limit the maximum time-step size.

FDTD is not the only way to solve Maxwell's equations numerically. While FDTD discretize all variables in Maxwell's equations, another method, known as the method of lines (MOL), leaves one variable continuous while discretizing the rest. This method forms a system of ODEs to be solved numerically.

My research will compare these methods of numerical solving Maxwell's equations. By doing so, I will be addressing two important questions: how accurate are the current numerical methods? And how much do different methods compare in accuracy? Specifically, I will

- Implement FDTD and MOL methods in Python to solve Maxwell's equations numerically.
- Compare the relative accuracy of these methods for different boundary conditions and the accuracy against known solutions.
- Investigate accuracy as a function of step size.
- Write a report including a literature review, the derivations of these schemes and their boundary conditions, accuracy measurement methods and measurement results.