ECE 742 Final Project

Michelle King Suraj Suri

May 2, 2018

1 Theory

1.1 PML

Perfectly Matched Layer (PML) boundary conditions are absorbing boundary conditions. PML BCs decay the wave within a boundary layer at the edge of the simulation. The edge of the simulation BC can be implemented as PEC. Well-implemented PML BCs completely decay the wave from the time it enters the boundary layer to the time after it reflects and attempts to leave.

1.2 Graded Conductivity

Reflection Factor

$$R(\theta) = \exp^{-2\eta cos(\theta)\int_0^d \sigma_x(x)dx}$$

Where σ_x is the graded conductivity of the PML material.
θ is the angle of incidence of the wave. So steeper angles of θ will result in higher values of reflection error.
We want to minimize relfection R but also make sure the wave decays completely in the PML boundary layer.

We are going to compare the error for different types of grading profiles. And/or we can use different values in the grading profile

1.2.1 Polynomial grading

Where the graded conductivity is:

$$\sigma_x = (\frac{x}{d})^m \sigma_{x,max}$$

And the graded value for κ_x is:

$$\kappa_x = 1 + (\kappa_{x,max} - 1)(\frac{x}{d})^m$$

Reflection factor simplifies to

1.2.2 Geometric grading

Where the graded conductivity is:

$$\sigma_x = (g^{\frac{1}{\Delta}})^x \sigma_{x,0}$$

$\sigma_{x,0}$ is the conductivity at the surface of the PML.
g is a scaling factor. Nearly optimal: $2 \leq g \leq 3$
Δ is spacing of FDTD lattice.

And the graded value for κ_x is:

$$\kappa_x = [(\kappa_{max})^{\frac{1}{d}} g^{\frac{1}{\Delta}}]^x$$

2 Code

3 Error Analysis

Insert Error Analysis Here

PMLs are exact for continuous functions, but error is introduced for discrete functions. Having a large step discontinuity can

3.0.1 Error of Polynomial Grading

3.0.2 Error of Geometric Grading

4 Fix me: Bibliography

Susan's book - third edition