How to Understand Time-Space Synchronized FDTD Algorithm

Part 2

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In part 1 I explained the idea of estimating a function derivative with many function values. In this part I'll explain an issue of computing domain boundary.

Suppose we use 5 function values to estimate a function derivative,

$$v(s-2\Delta s), v(s-\Delta s), v(s), v(s+\Delta s), v(s+2\Delta s)$$

Suppose our computing domain is

$$|s| \le s_{max}$$

When our calculation is approaching the computing domain boundary, for example,

$$s = -s_{max} + \Delta s$$

then the 5 required function values should be

$$v(-s_{max}-\Delta s), v(-s_{max}), v(-s_{max}+\Delta s), v(-s_{max}+2\Delta s), v(-s_{max}+3\Delta s)$$

We can see that it involves a value outside the computing domain $v(-s_{max}-\Delta s)$. How do we get around this problem?

There can be many ways to handle this issue. All algorithms need to handle this issue, not just the TSS. To implement TSS algorithm, I have also need to use a way to handle this issue.

I used a simple way to handle this issue, I just use the nearest available values to replace the unavailable values. For the above example, the function value set is adjusted to

$$v(-s_{max}+4\Delta s), v(-s_{max}), v(-s_{max}+\Delta s), v(-s_{max}+2\Delta s), v(-s_{max}+3\Delta s)$$

Equations (52), (53), and (54) in TSS.PDF implement this idea of "using nearest available values".