The Primitive Yee Cell

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The Yee cell[1] is simply a way of shifting the different field components of the electric and magnetic field in order to make an electromagnetic finite-differenc time-domain (FDTD) simulation stable.

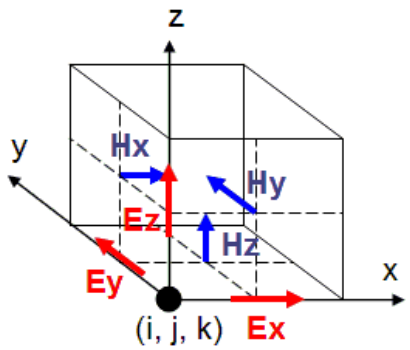

Figure 1: The primitive Yee cell. Borrowed from http://tx.technion.ac.il/~graanan/Project/Theory.htm

Figure 1 shows the shifts to the field components used in the primitive Yee cell. Specifically, if the grid spacing in all three dimensions is 1, then the location of the six field components are

- $E_x[i,j,k] \rightarrow (i+0.5, j, k)$,
- $E_y[i,j,k] \rightarrow (i, j+0.5, k)$,
- $E_z[i,j,k] \rightarrow (i, j, k+0.5)$,
- $H_x[i,j,k] \rightarrow (i, j+0.5, k+0.5)$,
- $H_y[i,j,k] \rightarrow (i+0.5, j, k+0.5)$, and
- $H_z[i,j,k] \rightarrow (i+0.5, j+0.5, k)$,

where the notation is A[index] $\rightarrow$ (location in grid).

Lastly, note that this scheme of offsets naturally fits the two update equations used in electromagnetic FDTD[2],

$$\frac{\partial}{\partial t}\epsilon E = \nabla \times H - J, \text{ and} \tag{1}$$

$$\frac{\partial}{\partial t}\mu H = -\nabla \times E - M, \tag{2}$$

where J and M are electric and magnetic current sources, respectively.

References

[1] K. Yee, "Numerical solution of initial boundary value problems involving maxwell's equations in isotropic media," IEEE Trans. Antennas Propag. Mag. **14**, 302-307 (1966).

[2] Allen Taflove, Susan C. Hagness, *Computational Electrodynamics, Third Edition* (Artech House, 2005).