Strength of Power Flow in Poynting Vector Visualizer

Dan Styer, 4 March 2010

The Poynting Vector Visualizer of January–February 2010 (designed and written by Noah Morris) is a great step forward but it has one problem.

The Poynting Vector flow lines correctly point in the direction of the Poynting Vector. But the density of field lines should be proportional to the amount of flow, and currently it isn't.

This is especially apparent in the configuration `3R'sinParallel.txt`. Fifteen lines flow into the 60 ohm resistor, and fifteen lines flow out, too!

I'd like to make the number of flow line launches proportional to the magnitude of the Poynting Vector, namely EB. The number of lines launched by a battery (properly, "an emf device") of length ℓ with potential change ΔV would be given through

$$\text{density of lines} \propto EB \tag{1}$$

$$\frac{\text{number of lines}}{\ell} \propto EB = \frac{\Delta V}{\ell} B \tag{2}$$

$$\text{number of lines} \propto B\Delta V \tag{3}$$

Currently, flow lines are launched at a fixed separation ΔV. They should be launched at a fixed separation of $B\Delta V$.

The following algorithm does this task. (It will trace most flow lines twice.)

TargetLineSeparation := the desired spacing of lines in $B\Delta V$ (a positive real number)
FOR each rectangle DO
    Find B within this rectangle
    Crawl the edge of this rectangle, find V_{min} and V_{max}, and the location of V_{min}
    Nlines := TRUNC $\left[\dfrac{\text{ABS}(B) * (V_{\text{max}} - V_{\text{min}})}{\text{TargetLineSeparation}} \right] - 1$
    IF (Nlines > 0) THEN
        VoltageLineSeparation := $(V_{\text{max}} - V_{\text{min}})$/REAL(Nlines + 1)
        $V_{\text{start}} := V_{\text{min}}$
        Start at the location of V_{min}
        Craw the edge of this rectangle
            IF $[V_{\text{here}} \geq (V_{\text{start}} + \text{VoltageLineSeparation})]$
            OR $[V_{\text{here}} \leq (V_{\text{start}} - \text{VoltageLineSeparation})]$
            THEN launch a flow line and trace it along the equipotential of value V_{here}
                    to the edge of the rectangle
            $V_{\text{start}} := V_{\text{here}}$
        Keep crawling until starting location is reached
    END IF
END DO