Below-given figures show arrays of dipoles (two blue arms of the length l with a symmetrical feeding). The nth dipole is excited by the current with the amplitude I_n and the phase φ_n. Frequency of the current is f. The distance between dipoles is d. Dipoles are parallel to the planar reflector (the gray surface). The distance between dipoles and the reflector is h.

Your tasks follow:

1. The general radiation function $\underline{F}(\psi_x, \psi_y, \psi_z)$ should be derived using spatial angles.
2. In MATLAB, normalized directivity patterns in E and H planes should be plotted both in Cartesian coordinates and in polar ones.
3. Using a numerical integration, the radiation resistance R_Σ related to I_{max}, the directivity D_{max} and the gain G_{max} in the main lobe direction should be evaluated in MATLAB. The directivity evaluated in MATLAB should be compared with the simplified evaluation based on the width of the main lobe in E and H planes.

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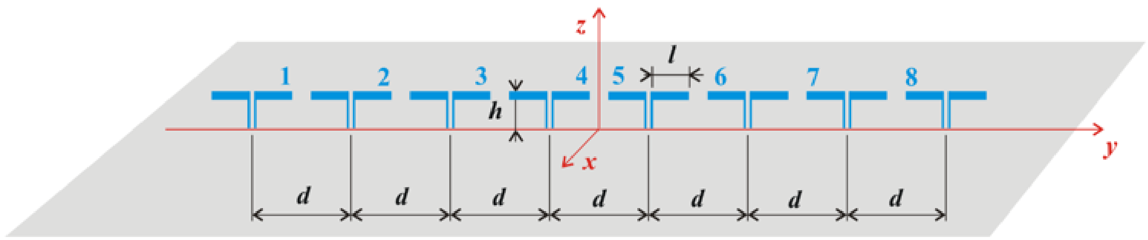
$I_4 = I_5 = 1.0$ A, $I_3 = I_6 = 0.8$ A, $I_2 = I_7 = 0.5$ A, $I_1 = I_8 = 0.2$ A, $\varphi_n = 0°$ for all n;
$h = 0.12$ m; $l = 0.12$ m; $d = 0.25$ m; $f = 600$ MHz



$$F0(\Psi y) = \frac{\cos(kl * \cos(\Psi y)) - \cos(kl)}{\sin(\Psi y)}$$

$$\Delta r1 = \frac{1}{2} * d * \cos(\Psi y) \quad \Delta r2 = 1 + \frac{1}{2} * d * \cos(\Psi y)$$

$$\Delta r3 = 2 + \frac{1}{2} * d * \cos(\Psi y) \ \Delta r4 = 3 + \frac{1}{2} * d * \cos(\Psi y)$$

$$E = 60 * I1 * F0 * \frac{e^{-jkr-\Delta r4}}{r} + 60 * I2 * F0 * \frac{e^{-jkr-\Delta r3}}{r} + 60 * I3 * F0 * \frac{e^{-jkr-\Delta r2}}{r} 60 * I4 * F0 * \frac{e^{-jkr-\Delta r1}}{r}$$

$$60 * I5 * F0 * \frac{e^{jkr-\Delta r1}}{r} + 60 * I6 * F0 * \frac{e^{jkr-\Delta r2}}{r} + 60 * I7 * F0 * \frac{e^{jkr-\Delta r3}}{r} 60 * I8 * F0 * \frac{e^{jkr-\Delta r4}}{r}$$

$$E = 60 * F0 * \frac{e^{-jkr}}{r} (I1 * 2\cos(k\Delta r4) + I2 * 2\cos(k\Delta r3) + I3 * 2\cos(k\Delta r2) + I4 * 2\cos(k\Delta r1))$$

$$E = 60 * F0 * Fs * \frac{e^{jkr-\Delta r1}}{r} * (e^{-jk\Delta r5} - e^{jk\Delta r5})$$

$$E = 60 * F0 * Fs * \frac{e^{jkr-\Delta r1}}{r} * (2\sin(k\Delta r5))$$

$$\Delta r5 = h * \cos(\Psi z)$$

$$E = 60 * F0 * Fs * Fr * \frac{e^{-jkr}}{r}$$

$$Dmax = \frac{35000}{4 * \theta E * \theta H} = \frac{35000}{4 * 8.2 * 59} = 18{,}086$$

Matlab D = 20,924

Rm = 501,767 Ohm

$$Gmax = 10\log(D) = 12{,}573$$