Design and Implementation of the Dipole Antenna using COMSOL Multiphysics

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Abstract
A dipole antenna is the simplest type of radio antenna, consisting of a two conductive wire rod that is half the length of the maximum wavelength the antenna is to generate. The dipole antenna is one of the moststraightforward antenna configurations. It can be realized with two thin metallic rods that have a sinusoidal voltage difference applied between them. In this paper this model approaches the analytic solution for dipole antenna and which will be designed using COMSOL Multiphysics. Radio frequency voltages are applied to dipole antennas at the center, between the two conductors.The magnitude of the electric field antenna is designed for a frequency of 0.074948GHz.

Keywords
Dipole Antenna, Isotropic, Wavelength, Frequency, Lambda.

I. Introduction
Dipole antenna were invented in 1886 by a German physicist named Heinrich Hertz. A dipole antenna is a simple type of antenna which consisting of a conductive wire rod that is half the length of the maximum wavelength the antenna is to generate. This wire rod is split in the middle, and the two sections are separated by an insulator. Each rod is connected to a coaxial cable at the end closest to the middle of the antenna. Dipole antennas are oriented vertically, horizontally or in slants. Polarization of electromagnetic fields radiated by dipole transmitting antennas correspond to element orientation. Radio frequency current in dipoles is at its maximum at the centers of the dipole and at its minimum at ends of the elements, and vice versa for RF voltages.

II. Dipole Antenna
The dipole antenna is one of the most straightforward antenna configurations. It can be realized with two thin metallic rods that have a sinusoidal voltage difference applied between them. The length of the rods is chosen such that they are quarter wavelength elements at the operating frequency. Such an antenna has a well-known torus like radiation pattern.

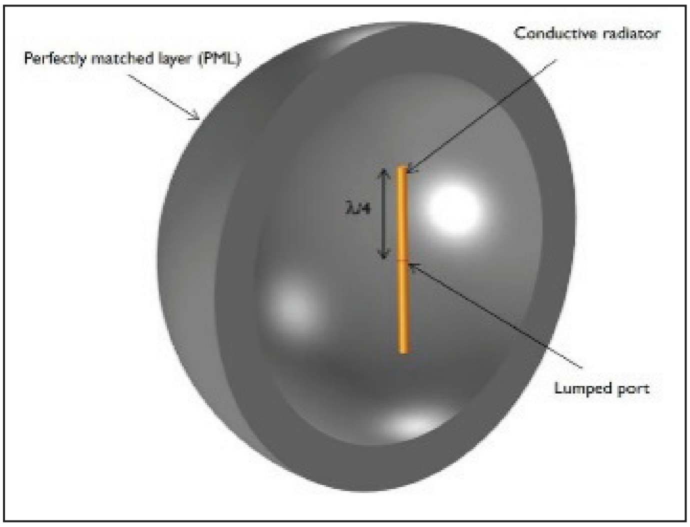

Fig. 1: Dipole Antenna

The model of the antenna consists of two cylinders representing each of the dipole arms.The dipole arm surface are modelled using the Impedance Boundary Condition, which is appropriate for conductive surfaces that have dimensions much larger that skin depth. This boundary condition introduces a finite conductivity at the surface as well as relative losses.
The air domain around the antenna is modelled as sphere of free space of radius 2m, which is approximately the boundary between the near-field and the far-field. This sphere of air is truncated with a Perfectly Matched Layer (PML) that as an absorber of outgoing radiation. The far-field pattern is computed on the boundary between the air and the PML domains.The mesh is manually adjusted such that there are five elements per free space wavelength and that the boundaries of the antenna are meshed more finely. The PML is swept with a total of five elements along the radial direction. Table 1 gives the local variable are required in designing of the dipole antenna. The free space wavelength at the antenna's operating frequency is 4m. thus each of the antenna arms is 1m long and aligned with z-axis.The arm radius is chosen to be 0.05m. in the limit as the radius approaches zero, thus antenna approaches the analytic solution.
A small cylinder gap of size 0.01m between the antenna arms represents the voltage source. The power supply and feed structure are not modelled explicitly, and it is assumed that a uniform voltage difference is applied across these faces. This source induces electromagnetic fields and surface currents on the adjacent conductive faces.

III. Model Geometry
This interface, the maximum mesh element size should be limited to a fraction of the wavelength. the domain size that can be simulated thus scales with the amount of available computer memory and the wavelength. the physics interference supports the study types frequency domain, model analysis, and boundary analysis. This frequency domain study type is used for source driven simulations for a single frequency or a sequence of frequencies. This physics interface solves the time-harmonic wave equation for the electric field.

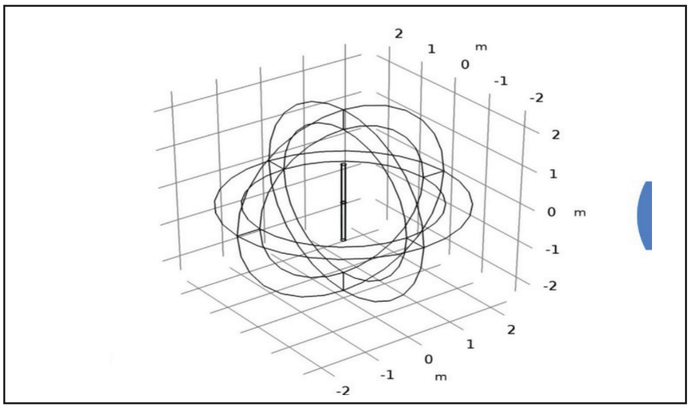

Fig. 2: Model Geometry

the Study type that represents the solver or set of solvers that will be used for the computation.

Table 1: The Local Variables are Required in Designing of the Dipole Antenna

Name	Expression	Value	Description
lambda0	4[m]	4m	Operating wavelength
arm_length	lambda0/4	1m	Dipole antenna arm length
r_antenna	arm_length/20	0.05m	Dipole antenna arm radius
gap_size	arm_length/100	0.01m	Gap between arms

IV. Simulation Results

The magnitude of the electric field around the antenna is shown in Fig. 3. The fields appear artificially high near the exicution, as well as at the ends of the arms.these peaks in the intensity are due to local singularities, the fields at sharp transitions in the model are locally artifically high, but they do not affect the results some distance(1-2 elements) away from these regions.

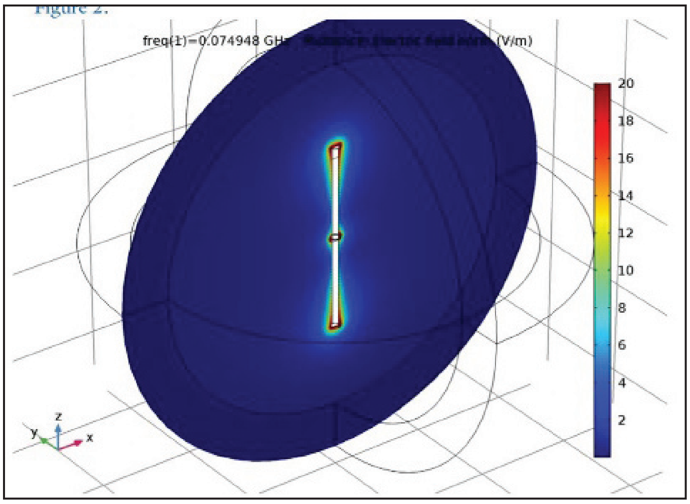

Fig. 3: Electric Field Magnitude Around the Antenna

The polor plot of the far-field pattren in the xy-plane shows the expected isotropic radiation attren. The 3D visualization of the far-field intensisty in figure4, show the expected torus shaped pattren.

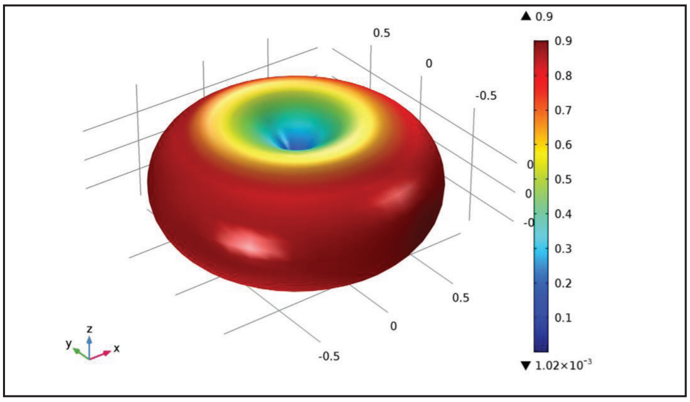

Fig. 4: 3D Plot of the Far-Field Pattern of Dipole Antenna

The impedence as seen by the port is evaluated to be 121+28i ohm which agrees reasonably with expectations. In the limit the antenna radius and gap height go to zero and in the limit of mesh refinement, the model approches the ana;ytic solution for a dipole antenna.

V. Conclusion

The dipole antenna is one of the most straightforward antenna configuration. In this paper it presents theanalytic solution for dipole antenna and it will be designed using COMSOL Multiphysics.The fields appear artificially high near the execution, as well as at the end of the arms.A 3D plot of the far-field pattern of the dipole antenna shown the expected torus shaped pattern. The magnitude of the electric field antenna is designed for the frequency of 0.074948GHz.

VI. Future Work

The dipole antenna is a variant of coaxial antenna it will be designed by using COMSOL Multiphysics. In future the coaxial antenna will be designed by using COMSOL Multiphysics and it generate the microwave coaxial antenna. This has some advantages over other thermal ablation technique in the ablation is rapid and area of ablation is immediately hypoedic technique on real time ultrasound monitoring.

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