Reconfigurable Design Model of Bow-Tie Dipole Adjacent Lossy Dielectric Using Optimisation Method in Hybrid Electromagnetic Technique

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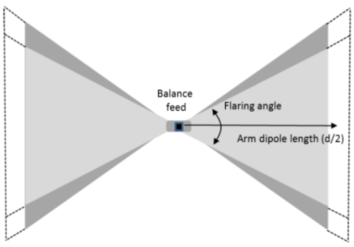
The optimization of Bowtie antenna next to lossy dielectric rectangular volume shown in Fig. 1 is simulated and studied to achieve stable frequency response over a wide range. The dielectric has dimensions 1.25λ (the wavelength is corresponding to the centre frequency 2.5 GHz), 0.833λ and 1.66λ, with ε_r = 52, σ = 0.85 inserted into the total field region of the hybrid domain. The separation distance 'd' between the dipole and the dielectric was varied over three values; these are 10, 20 and 30 mm. This problem was simulated using hybrid MoM/FDTD [1]. The antenna design was optimised using the FireFly algorithm [2]. Details of all methods were demonstrated in Table 1. The Hygence surface that encloses the dielectric material was modelled using a number of cubical cells equal to 58×42×74 (the cell size is equivalent to 0.025λ, that is 3 mm). We have set up three cases for the flare angle and then optimised the length arm of the Bowtie antenna for distances from the dielectric volume. It is aimed to achieve the matching over a wide bandwidth around 2.5 GHz. Therefore the fitness function for the FF algorithms was covered by few frequencies components that possible to meet the best matching at the port of the antenna. The cumulative function for case 3 at 30 mm is shown in Fig. 2 with good convergence rate to optimum solution. The return loss for various lengths of antenna arm (d/2) was illustrated into the Fig. 3 for the case 1. It is quite clear a bandwidth of around 1750 MHz can be achieved for few arm lengths as optimised clearly for flare angle about 30 degrees.



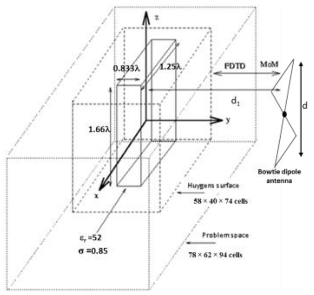


Fig. 1a Basis geometry for the Bowtie antenna, Fig. 1b Hybrid MoM/FDTD model used for this work..

Table 1. Input MoM, FDTD and FF parameters of Example 2.**FDTD parameters**

Formulation	Total/scattered field
Operating frequencies	1.5, 2.5, 3 GHz
px, py, pz	58,42,74
mx, my, mz	78,62,94
Total number of FDTD cells	77×61×93 = 436821
nlayer	8
Δ	0.003
Δt	4 ps
Time cycles	25
ax, ay, az	17,17,23
xmin, xmax	*nlayer*+6, mx-*nlayer*-6
ymin, ymax	*nlayer*+6, my-*nlayer*-6
zmin, zmax	*nlayer*+6, my-*nlayer*-6
Huygens surface size (S_c) mm	174 × 126 × 222
MoM parameters: Bowtie antenna	
flare angle: Case 1: 25 to 35, Case 2: 45 to 55, Case 3: 55 to 65	
d1: Case 1: 10 mm, Case 2: 20 mm, Case 3: 30 mm	
Length (d/2)	15 mm to 30 mm
The **FF method** is characterized by the following: Max gen = 100, γ = 1, npop, 20, βmin = 0.2 and α = 0.5.	

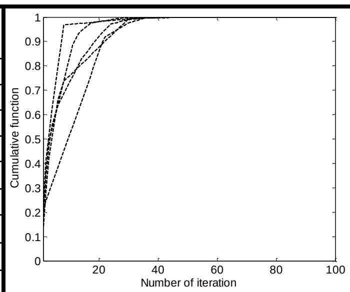


Fig. 2, Case 3 at d1 = 3 cm for 5 attempts of the FF algorithm; variations of cumulative function.

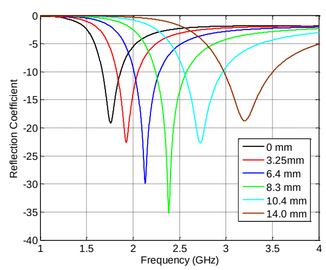


Fig. 3 Return loss at the input port for different cuts distances from the edge of the antenna arm.

1. R. Abd-Alhameed and PS Excell, "Broadband antenna response using hybrid technique combining frequency domain MoM and FDTD," Applied Computational Electromagnetics Society journal, pp. 70-77, 2005.
2. F.M.A.Abdussalam , R.A. Abd-Alhameed, S.M.R. Jones, "The Computation of Complex resonance of Microstrip Antenna using Method of Moment and Firefly Algorithms," Antennas and Propagation Conference (LAPC), 2016.