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Super Wide Band Monopole Fractal Antenna

Tanzeela Konian[1*], P.Vamshi [2], D.Gayatri [3], D. Deepthi [4], A.Vijaya[5]

Department of ECE, KITS, Warangal, Telangana, India

ABSTRACT: Fractal antennas currently referred to as super wide band antennas, SWB antennas are being taken into consideration in miltary and civilian system because of their broadband qualities which can give high data rate services.SWB antennas with compact sizes and geometries should meet the requirement of having reflection ratio bandwidth greater than 10:1.The simulations of this antenna are done in HFSS(High frequency structure simulator) software and each parameter of this antenna is set to satisfy the requirement of reflection ratio bandwidth and peak gain within the operating frequency band are measured.

KEYWORDS: Reflection ratio bandwidth, Peak gain, Fractal antenna, HFSS

I. INTRODUCTION

Back in the days, late 1950s to 1960s, antennas with a reflection ratio bandwidth of 10:1 or greater are referred as frequency-independent antennas, Because of their broadband characteristics, large bandwidth and high data rates by which we can send information, voice and video at faster rate. Because of this many more 2D and 3D UWB and SWB antennas have been introduced. In recent years, it has been proved that SWB antennas are more effective because UWB covers short data transmission but SWB can cover both short and long- range data transmissions. In comparison to UWB antenna, SWB can provide increased channel capacity, greater time accuracy and superior resolution.

Because of vast advancements in wireless communication systems, there is a growing demand for low-cost, small, easy to construct antennas. Therefore, Fundamental issues of any antenna are miniaturization and bandwidth. Fractal geometries have recently been identified as an interesting research topic in construction of ultra-compact antennas with effective impedance matching. Because of its space- filling qualities, long electrical lengths , jagged shapes of geomentry, effective radiation ,self-similarity properties and multi band behavior.

Antenna for SWB applications requires wide band impedance matching and compact design which is shown in super wide band monopole antenna design. In this paper we are designing a fractal monopole antenna to attain SWB characteristics. Here we are combining

both the concepts of fractal and monopole antenna to achieve the properties of fractal like miniaturization and broadband characteristics, likewise omnidirectional radiation pattern and wide operation bandwidth of monopole antenna

II. ANTENNA DESIGN

The design for fractal monopole antenna is shown in FIG 1. The dimensions of desired antenna are listed in Table 1. It is designed and etched on 1.6mm thick FR4 epoxy substrate which is having 4.4 relative permittivity and loss tangent of 0.02. In five intermediate steps this antenna design is made . Initially a semi elliptical monopole as partial ground plane is designed. Which is of major radius 14.5 and center position of 0,0,16 and ratio of 1.72413

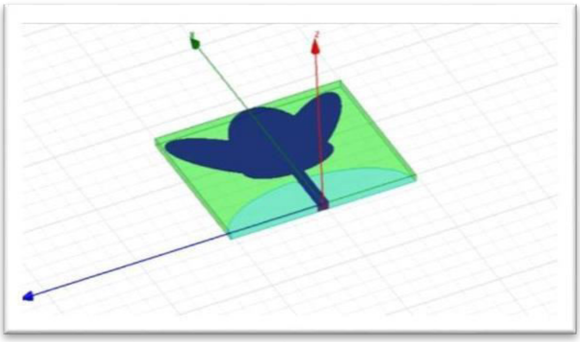

FIG 1. A SWB monopole fractal antenna

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In the next step create triangle polyline and use more function and subtract the triangle from ellipse. Create a rectangle of center position 0,-25,-16 in Z axis and X size of -40 and Y size of -65. For patch create ellipse 1,2,3 and 4 of dimensions as shown in Table 1.Then use rotate and move function for ellipse 2 and ellipse 3 for changing positions on axis.

NAME	CENTER POSITION	AXIS	MAJOR RADIUS	RATIO
ELLIPSE 1	21,0,0	Z	6	2
ELLIPSE 2	33,0,0	Z	18	0.333333333333
ELLIPSE 3	33,0,0	Z	18	0.333333333333
ELLIPSE 4	30,0,0	Z	15	0.666666666667

TABLE 1. Measurments of designed antenna.

- Double click on HFSS icon and select new project and click project on tool bar and select insert hfss design where we can obtain the representation of x, y, z axis.
- It is designed and etched on 1.6mm thick FR4 epoxy substrate which is having 4.4 relative permittivity and loss tangent of 0.02

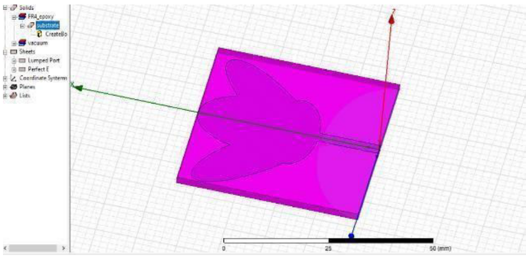

Figure 2. FR4 epoxy substrate

This antenna is designed by five intermediate steps

- Initially a semi elliptical monopole as partial ground plane is designed which is having major radius of 14.5 and center position of 0,0,-1.6 and ratio of 1.7241379310345
- In next step create triangle polyline and use move function and subtract triangle from ellipse

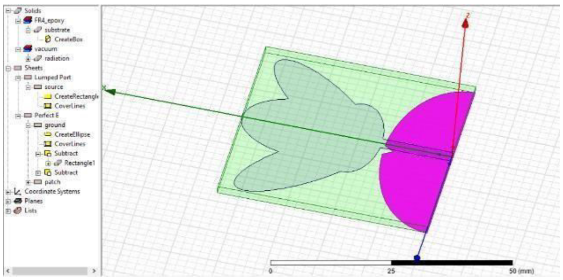

Figure 3. partial ground plane

- Create rectangle of center position 0,-25,-16 in z axis and x size of -40 and y size of -65.
- For patch create rectangle of Centre position of 0,-1.5,0 of z axis and x size of 15.3 and y size of 3
- Next create ellipse 1,ellipse 2,ellipse 3,ellipse 4 of respective dimensions as shown in table. Use rotate and move function for ellipse 2 and ellipse 3 for changing positions on axis

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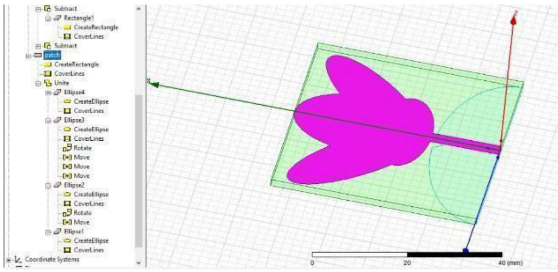

Figure 4. Patch of the designed antenna

- Unite the four ellipse and patch. Assign perfect E boundary for ground and patch
- Create a source with dimension of X,Y,Z sizes -2.9,-2.9 and -1.6 respectively with center position (0,1.5,0) and assign excitation to lumped port

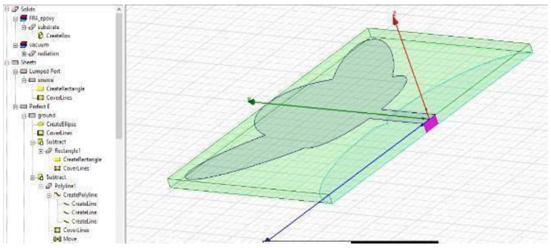

Figure 5. Lumped port of the source

- Last step is to create radiation box around antenna with vacuum of center position 75,50,- 35 and x size of -100 and y size of -100 and z size of 75 and final design is shown in figure 1.

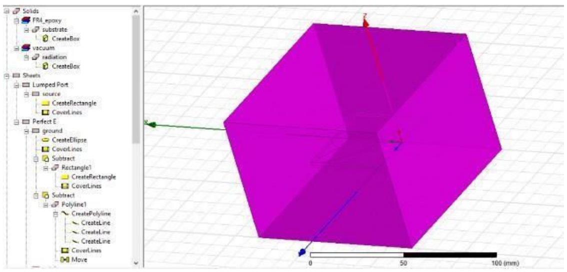

Figure 6. Radiation box around the antenna

II. SIMULATION OF ANTENNA

After designing of desired antenna simulation is carried out.

- Firstly validation check is performed after designing and check for any warnings or error in design

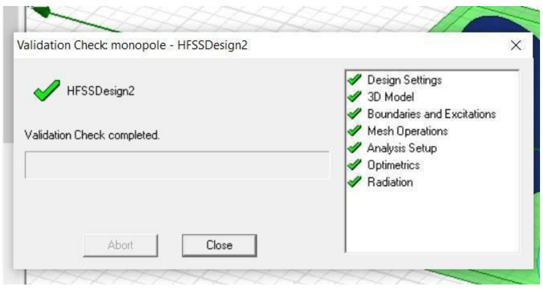

Figure 7. performing validation check

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- Next analysis setup is assigned to the antenna, sweep in range of 0 to 30 GHz with step size of 0.1GHz
- After that antenna is simulated.

- The required antenna parameters like radiation patterns and reflection coefficient graphs are observed in HFSS

III. SIMULATION RESULTS

Here we use HFSS software to do all simulations like radiation coefficients, radiation patterns, reflection ratio and peak gain.

1. RETURN LOSS

In order to radiate antenna well, the power which is return back to feed must be less. This can be observed by measuring return loss. Power loss is mainly because of discontinuity between transmission line. The antenna return loss is expressed by scatting parameter S11 – parameters. In given S11 notation first number shows port number and second number indicating the incident port. If antenna and feed lines are matched, we can say power reflected from the antenna is reduced and antenna delivering maximum power. S11 parameter of elliptical monopole antenna is shown in the figure.

From graph it is observed that antenna is working well at these frequencies 5.6 GHZ, 13.33 GHz and 22 GHz . The first response frequency is taken at 5GHz, it depends on dimensions of elliptical ring size. Second resonance frequency occurred at 13.3 GHz and third resonance frequency at 22 GHz. Antenna will radiate perfectly if the S parameter is less than -10db.

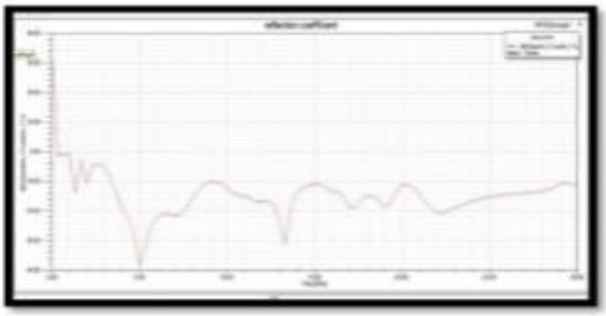

Figure 8. Reflection coefficient graph of designed antenna

2. VOLTAGE STANDING WAVE RATIO(VSWR):

VSWR gives measure about how efficient antenna impedance matched to transmission line. VSWR must be small for getting better impedance matching between antenna and transmission line. In ideal case the minimum value of VSWR must be 1. In this case no power can reflect through antenna. VSWR can be expressed as VSWR = (1+)/(1-)

Where is reflection coefficient the VSWR of the elliptical monopole antenna is shown in figure 9. From given graph it is clear that operating frequencies 5GHz, 13.33 GHz, 22GHz of given antenna are below 2. This concludes that power reflected from designed antenna is very less.

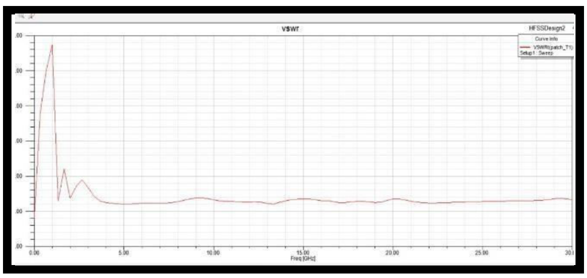

Figure 9. VSWR graph of designed antenna .

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3.RADIATION PATTERN:

Radiation pattern gives radiated power variance as function of direction of the antenna. Power variation can be calculated as far field or near field. The region which close to antenna called near field or induction field far region from antenna is called far field or radiation field. Figure shows polar plot representation of antenna at operating frequencies it gives E-field values in db. at each angle.

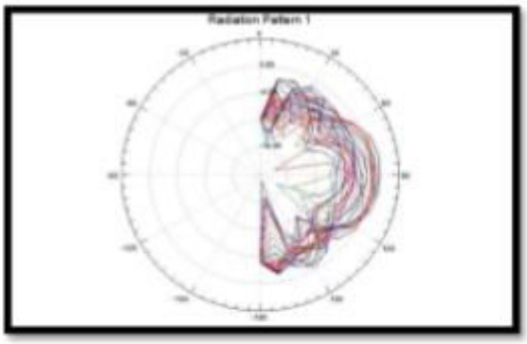

Figure 10. Radiation pattern of designed antenna

IV. CONCLUSION

Elliptical monopole antenna for SWB applications is designed and analyzed. From results it is indicated that at 5 GHz, 13.33 GHz and 22 GHz antenna can work well impedance matching can be improved by giving dual steps feed between elliptical ring and feed line. Further improvement of antenna impedance matching can be obtained by providing additional steps taking among elliptical rings and feed line.

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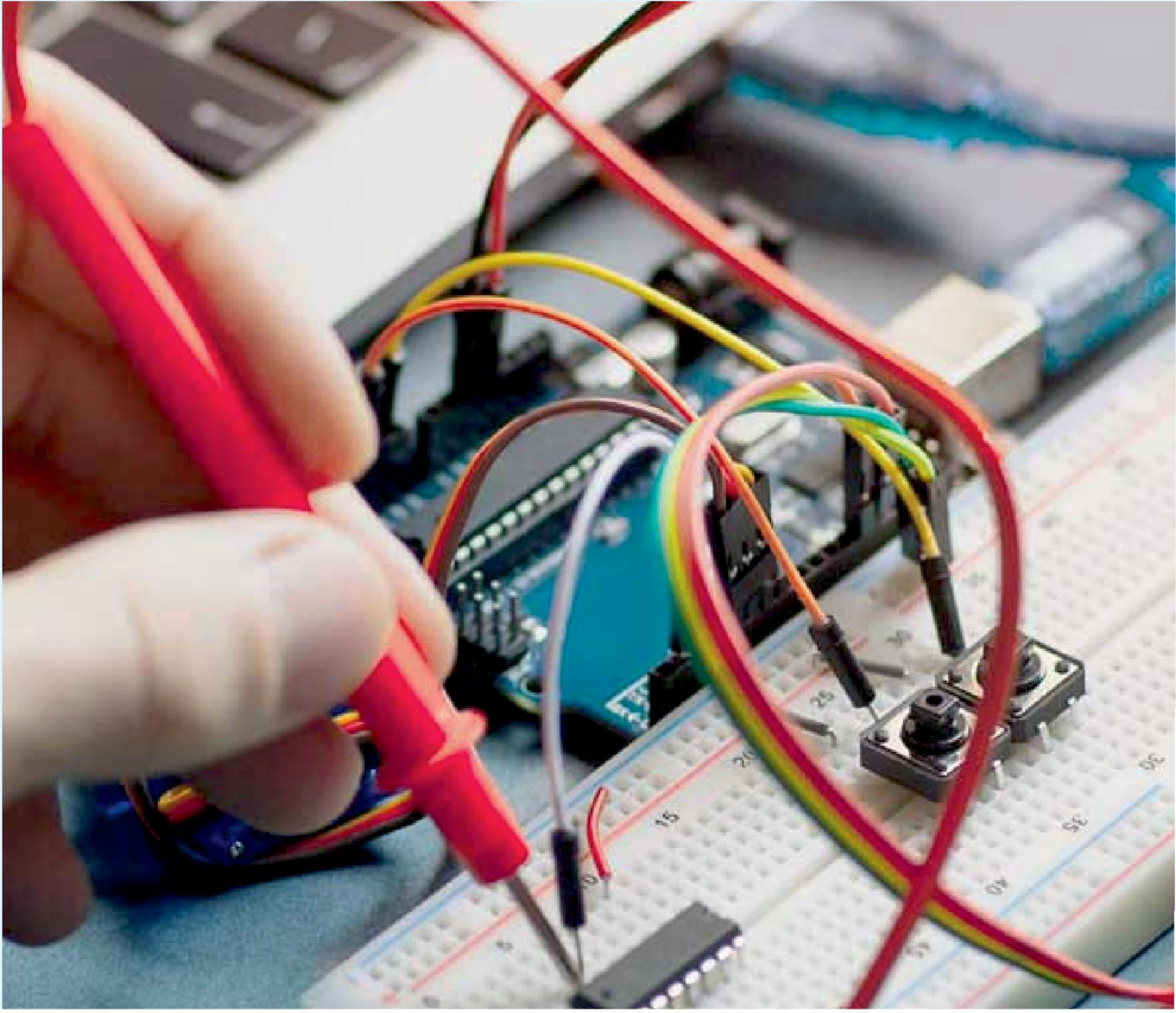

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